Overview

KEMET's KC-LINK surface mount capacitors are designed to meet the growing demand for fast switching wide bandgap (WBG) semiconductors that operate at higher voltages, temperatures, and frequencies. By utilizing KEMET's robust and proprietary COG/NPO base metal electrode (BME) dielectric system, these capacitors are well suited for power converters, inverters, snubbers, and resonators, where high efficiency is a primary concern. With extremely low effective series resistance (ESR) and very low thermal resistance, KC-LINK capacitors can operate at very high ripple currents with no change in capacitance versus DC voltage, and negligible change in capacitance versus temperature. With an operating temperature of 150°C, these capacitors can be mounted close to fast switching semiconductors in high power density applications, which require minimal cooling.



Benefits

- EIA 1812, 2220, and 3640 case size
- · AEC-Q200 automotive qualified
- Flexible termination option available
- · Very high ripple current capability
- Extremely low equivalent series resistance (ESR)
- Extremely low equivalent series inductance (ESL)
- Operating temperature range of -55°C to +150°C
- High frequency operation (> 10 MHz)
- · No capacitance shift with voltage
- No piezoelectric noise
- High thermal stability
- · RoHS compliant and Pb-free



KC-LINK COG dielectric technology also exhibits high mechanical robustness compared to other dielectric technologies, allowing the capacitor to be mounted without the use of lead frames. This provides extremely low effective series inductance (ESL) increasing the operating frequency range allowing for further miniaturization. For added reliability, KC-LINK is now available with flexible termination technology that provides superior flex performance over standard termination systems, addressing the primary failure mode of MLCC's flex cracks.

In addition to commercial grade, automotive grade devices are available and meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.



Applications

- Wide bandgap (WBG), silicon carbide (SiC) and gallium nitride (GaN) systems
- EV/HEV (drive systems, charging)
- Wireless charging
- · Photovoltaic systems
- · Power converters
- Inverters
- · LLC resonant converters
- DC link
- Snubber





Typical Performance



*Ripple current measurements conditions.- Ripple current measurement were took under ambient temperature. Ripple current measurements performed with a peak capacitor temperature of 150°C. Samples mounted to heat sink with no forced air cooling.

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Ordering Information

| CKC | 33 | C | 224 | K | C | G | Α | С | TU |
|------------------|-------------------------------------|---------------------------------------|---|---|--|------------|-------------------------|-----------------------|--|
| Series | Case Size (L"x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (V) | Dielectric | Subclass Designation | Termination Finish | Packaging (Suffix/C-Spec) |
| CKC = KC-LINK | 18 = 1812 21 = 2220 33 = 3640 | C = Standard X = Flex ¹ | Two single digits and number of zeros. Use 9 for 1.0 – 9.9 pF e.g., 2.2 pF = 229 | F = ±1% G = ±2% J = ±5% K = ±10% M = ±20% | C = 500 V W = 650 V D = 1,000 V E = 1,200 V J = 1,700 V G = 2,000 V | G = COG | A = N/A | C = 100% matte Sn | See "Packaging C-Spec Ordering Options Table" |

¹ Flexible termination is only available for EIA 1812 and 2220 case sizes.

Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions.



Packaging C-Spec Ordering Options Table

| Packaging Type | Packaging/Grade Ordering Code (C-Spec) |
|---|---|
| Commerc | cial Grade |
| Bulk Bag ¹ /Unmarked | Not required (Blank) |
| 7" Reel/Unmarked | TU |
| 13" Reel (Embossed Plastic Tape)/Unmarked | 7210 |
| Automoti | ve Grade ² |
| 7" Reel | AUTO |
| 13" Reel (Embossed Plastic Tape)/Unmarked | AUT07210 |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging. "Bulk Bag" packaging option is not available for case sizes larger than 2225 (5664 Metric).

² For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information."



Dimensions – Millimeters (Inches)



Standard Termination

| KC-LINK CODE | EIA SIZE CODE | METRIC SIZE CODE | L LENGTH | W WIDTH | T THICKNESS | B Bandwidth | S SEPARATION Minimum | Mounting Technique |
|-----------------|---------------------|------------------------|-------------------------------|--------------------------------|------------------------------|-------------------------------|----------------------------|-----------------------|
| 18 | 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | | 0.60 (0.024) ±0.35 (0.014) | | |
| 21 | 2220 | 5650 | 5.70 (0.224) ±0.40 (0.016) | 5.00 (0.197) ±0.40 (0.016) | See Table 2 for Thickness | 0.60 (0.024) ±0.35 (0.014) | N/A | Solder Reflow Only |
| 33 | 3640 | 9210 | 9.30 (0.366) ±0.40 (0.016) | 10.20 (0.402) ±0.40 (0.016) | | 1.27 (0.050) ±0.40 (0.016) | | |

Flex Termination

| KC-LINK CODE | EIA SIZE CODE | METRIC SIZE CODE | L LENGTH | W WIDTH | T THICKNESS | B Bandwidth | S SEPARATION Minimum | Mounting Technique |
|-----------------|---------------------|------------------------|-------------------------------|-------------------------------|-----------------|-------------------------------|----------------------------|-----------------------|
| 18 | 1812 | 4532 | 4.50 (0.178) ±0.40 (0.016) | 3.20 (0.126) ±0.30 (0.012) | See Table 2 for | 0.70 (0.028) ±0.35 (0.014) | N / A | Solder Reflow |
| 21 | 2220 | 5650 | 5.90 (0.232) ±0.75 (0.030) | 5.00 (0.197) ±0.40 (0.016) | Thickness | 0.70 (0.028) ±0.35 (0.014) | N/A | Only |



Table 1 – Capacitance Range/Selection Waterfall Standard Termination

| | | Ca | ISA S | Size | Seri | AS | CI | KC18 | BC | | CI | KC2 [°] | 1 C | | CKC33C | | | | | |
|-------------|-------------|----------------|------------------|-------|--------|------|------|------|----------|------|-------|------------------|------------|-------|--------|------|-------|-------|------|------|
| | | | | | | | 1812 | | 2220 | | | | 3640 | | | | | | | |
| Canacitance | Capacitance | Voltage Code | | С | W | D | С | W | D | E | J | С | W | D | Ε | J | G | | | |
| oupuontanoe | Code | | Rated Voltage | | | 0 | 0 | 8 | 0 | 0 | 8 | 8 | 8 | 0 | 0 | 8 | 8 | 8 | 8 | |
| | | | | (VDC |) | | 50 | 65 | 10 10 | 50 | 65 | ĕ | 120 | 110 | 50 | 65 | 10 | 120 | 110 | 200 |
| | | 0 | | | Falar | | | | Pro | duct | Avail | abilit | ty and | d Chi | p Thi | ckne | ss Co | des | | |
| | | Lap | acita | nce | olera | ance | | Se | ee Pa | ckag | ing S | pecs | for C | hip T | Thick | ness | Dime | ensio | ns | |
| 4,700 pF | 472 | F | G | J | K | М | GD | GD | GD | JK | JK | JK | JK | JK | MA | MA | MA | MA | MA | MA |
| 5,100 pF | 512 | F | G | J | K | M | GD | GD | GD | JL | JL | JL | JL | JL | MA | MA | MA | MA | MA | MA |
| 5,600 pF | 562 | F | G | J | K | M | GD | GD | GD | JL | JL | JL | JL | JL | MA | MA | MA | MA | MA | MA |
| 6,200 pF | 622 | F | G | J | K | M | GH | GH | GH | JN | JN | JN | JN | JN | MA | MA | MA | MA | MA | MA |
| 6,800 pF | 682 | F | G | J | K | M | GH | GH | GH | JN | JN | JN | JN | JN | MA | MA | MA | MA | MA | MA |
| 7,500 pF | 752 | F | G | J | K | M | GK | GK | GK | JK | JK | JK | JK | | MB | MB | MB | MB | MB | MB |
| 8,200 pF | 822 | F | G | J | K | M | GK | GK | GK | JL | JL | JL | JL | | MB | MB | MB | MB | MB | MB |
| 9,100 pF | 912 | F | G | J | K | M | GM | GM | GM | JL | JL | JL | JL | | MB | MB | MB | MB | MB | MB |
| 10,000 pF | 103 | F | G | J | K | M | GM | GM | GM | JL | JL | JL | JL | | MB | MB | MB | MB | MB | MB |
| 12,000 pF | 123 | F | G | J | K | M | GO | GO | GO | JN | JN | JN | JN | | MB | MB | MB | MB | MB | MB |
| 15,000 pF | 153 | F | G | J | K | М | GO | GO | GO | JE | JE | JE | | | MC | MC | MC | MC | MC | MC |
| 18,000 pF | 183 | F | G | J | K | М | GH | GH | | JE | JE | JE | | | MC | MC | MC | MC | MC | |
| 22,000 pF | 223 | F | G | J | K | М | GH | GH | | JK | JK | JK | | | MC | MC | MC | MC | MC | |
| 27,000 pF | 273 | F | G | J | K | М | GK | GK | | JL | JL | JL | | | MB | MB | MB | MB | | |
| 33,000 pF | 333 | F | G | J | K | М | GM | GM | | JN | JN | JN | | | MB | MB | MB | MB | | |
| 39,000 pF | 393 | F | G | J | К | М | GO | GO | | JE | JE | | | | мс | мс | мс | мс | | |
| 47,000 pF | 473 | F | G | J | к | м | GO | GO | | JE | JE | | | | мс | мс | мс | мс | | |
| 56.000 pF | 563 | F | G | J | к | м | | | | JK | JK | | | | мс | мс | мс | | | |
| 68.000 pF | 683 | F | G | J | к | м | | | | JL | JL | | | | мс | мс | | | | |
| 82.000 pF | 823 | F | G | J | к | м | | | | JL | JL | | | | MB | MB | | | | |
| 0.1 uF | 104 | F | G | J | К | М | | | | JN | JN | | | | MB | MB | | | | |
| 0.12 uF | 124 | F | G | J | к | м | | | | | | | | | MB | МВ | | | | |
| 0.15 uF | 154 | F | G | J | к | м | | | | | | | | | мс | мс | | | | |
| 0.18 µF | 184 | F | G | J | K | M | | | | | | | | | MC | | | | | |
| 0.22 µF | 224 | F | G | J | K | M | | | | | | | | | MC | | | | | |
| | | Ra | ted V | oltag | je (Vl | DC) | 500 | 650 | 1000 | 500 | 650 | 1000 | 1200 | 1700 | 500 | 650 | 1000 | 1200 | 1700 | 2000 |
| Capacitance | Capacitance | Voltage Code C | | | C | W | D | C | W | D | Ε | J | С | W | D | Ε | J | G | | |
| oupuonunoo | Code | | | | | 1812 | | | | 2220 |) | | 3640 | | | | | | | |
| | | (| Case Size/Series | | C | KC18 | C | | C | KC22 | 20 | | | | CKC | 33C | | | | |

Note: Flexible termination available only for EIA 1812 and 2220.

Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Plastic | Quantity | Thickness | Case | Thickness ± | Plastic Quantity | | |
|-----------|-------------------|-------------|---------|----------|-----------|-------------------|-------------|------------------|----------|--|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | |
| GD | 1812 | 1.25 ± 0.15 | 1,000 | 4,000 | JL | 2220 | 2.00 ± 0.20 | 500 | 2,000 | |
| GH | 1812 | 1.40 ± 0.15 | 1,000 | 4,000 | JN | 2220 | 2.50 ± 0.20 | 500 | 2,000 | |
| GK | 1812 | 1.60 ± 0.20 | 1,000 | 4,000 | MA | 3640 | 1.40 ± 0.15 | 250 | 1,000 | |
| GM | 1812 | 2.00 ± 0.20 | 500 | 2,000 | MB | 3640 | 2.00 ± 0.20 | 250 | 1,000 | |
| GO | 1812 | 2.50 ± 0.20 | 500 | 2,000 | MC | 3640 | 2.50 ± 0.20 | 250 | 1,000 | |
| JE | 2220 | 1.40 ± 0.15 | 1,000 | 4,000 | | | | | | |
| JK | 2220 | 1.60 ± 0.20 | 1,000 | 4,000 | | | | | | |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | Thickness | Case | Thickness ± | 7" Reel | 13" Reel | |
| Code | Size ¹ | Range (mm) | Plastic | Quantity | Code | Size ¹ | Range (mm) | Plastic | Quantity | |

Package quantity based on finished chip thickness specifications.



Table 3 – Performance & Reliability: Test Methods and Conditions

| Test | Reference | Test Con | ndition | | Limits |
|---|-------------------|--|--|---------------------------------------|--|
| Visual and Mechanical | KEMET Internal | No defects that may affe | ect performance (10X) | Dimensions according KEMET Spec Sheet | |
| Capacitance | КЕМЕТ | 1 kHz ±50 Hz and 1.0 ±0 | $0.2 V_{\rm rms}$ if capacitance | 2 | Within Toloronoo |
| (Cap) | Internal | Capacitance measurements indexed to a referee t | (including tolerance) ime of 1,000 hours |) are | within Tolerance |
| Dissipation Factor (DF) | KEMET Internal | 1 kHz ±50 Hz and | d 1.0 ±0.2 V _{rms} | | Dissipation factor (DF) maximum limit at 25°C = 0.1% |
| Insulation Resistance (IR) | KEMET Internal | 500 VDC applied for 120 | 0±5 seconds at 25°C | | Within Specification To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits. |
| | | | | 1,000 MΩ-μF or 100 GΩ | |
| Temperature | | Frequency: 1 Frequ | kHz ±50 Hz th reference to +25°C applied. cation sheet for voltag | ge | |
| Coefficient of Capacitance | KEMET Internal | 1 | | ±30 PPM / °C | |
| (TCC) | | 2 | -55°C | | |
| | | 3 +2 | 25°C (Reference) | | |
| | | 4 | +150°C | | |
| Dielectric | | Rated DC Voltage | DWV Voltage (% of Rated) | | Cap: Initial Limit DF: Initial Limit |
| Withstanding Voltage | KEMET Internal | 500 V 650 V | 150% | | IR: Initial Limit |
| (DWV) | | ≥ 1,000 V | 120% | | Withstand test voltage without insulation breakdown or damage. |
| | | (5 ±1 seconds and charge/disc | harge not exceeding | 50 mA) | , s |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | KEMET Internal | Maximum % capacitand | ce loss/decade hour | | 0% Loss/Decade Hour |
| Terminal Strength | Kemet Internal | Shear stress test per Time: 60±1 Case Size 3640 | specific case size, seconds Force 18N | | No evidence of mechanical damage |



Table 3 – Performance & Reliability: Test Methods and Conditions cont.

| Test | Reference | Test Condition | Limits |
|-----------------------------|---------------------------|--|---|
| Board Flex | AEC-Q200-005 | Standard Termination system 3.0 mm Test time: 60±5 seconds Ramp time: 1 mm/seconds 50 F R230 t t t t t t t t t t t t t t t t t t t | No evidence of mechanical damage |
| Solderability | J-STD-002 | Magnification 50X. Conditions: a) Method B, 4 hours at 155°C, dry heat at 235°C b) Method B at 215°C category 3 c) Method D, category 3 at 260°C | Visual Inspection. 95% coverage on termination. No leaching |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to +150°C) 2-3 cycles per hour Soak Time 1 or 5 minutes | Measurement at 24 hours ±4 hours after test conclusion. Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and 200 VDC. Add 100 K Ω resistor. Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K Ω resistor. | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5% |
| Moisture Resistance | MIL-STD-202 Method 106 | Number of cycles required 10, 24 hours per cycle. Steps 7a and 7b not required | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5% |
| Thermal Shock | MIL-STD-202 Method 107 | Number of cycles required 5, (-55°C to 125°C) Dwell time 15 minutes. | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| High Temperature Life | MIL-STD-202 | 1,000 hours at 150°C with 1.0 X rated voltage applied. | Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift |
| Storage Life | Method 108 | 1,000 hours at 150°C, Unpowered | IR: 10% of Initial Limit DF Limits Maximum: 0.5% |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Test from 10 – 2,000 Hz | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Mechanical Shock | MIL-STD-202 Method 213 | 1,500 g's 0.5ms Half-sine, Velocity Change 15.4 ft/second (Condition F) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents | Visual Inspection 10X Readable marking, no decoloration or stains. No physical damage. |



Table 4 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| KC- LINK CODE | EIA SIZE CODE | METRIC SIZE CODE | Density Level A: Maximum (Most) Land Protrusion | | | | | Density Level B: Median (Nominal) Land Protrusion | | | | | Density Level C: Minimum (Least) Land Protrusion | | | | |
|---------------------|---------------------|------------------------|---|------|-------|-------|-------|---|------|-------|-------|-------|--|------|-------|-------|-------|
| OODL | C Y X V1 V2 | | | | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | | |
| 18 | 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 |
| 21 | 2220 | 5650 | 2.75 | 1.70 | 5.50 | 8.20 | 6.50 | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | 2.55 | 1.30 | 5.30 | 6.60 | 5.60 |
| 33 | 3640 | 9210 | 4.45 | 1.70 | 10.70 | 11.60 | 11.70 | 4.35 | 1.50 | 10.60 | 10.70 | 11.10 | 4.25 | 1.30 | 10.50 | 10.00 | 10.80 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1210 case size.





Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | tion Due To: | Days Prior To | |
|-----------------------------|----------------------------------|----------------|------------------|--|
| C-Spec | Process/Product change | Implementation | | |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum | |
| AUTO | Yes (without approval) | Yes | 90 days minimum | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | | PPAP (Product Part Approval Process) Level | | | | | | | | | |
|-----------------------------|---|--|---|---|---|--|--|--|--|--|--|
| C-Spec | 1 | 2 | 3 | 4 | 5 | | | | | | |
| KEMET assigned ¹ | • | • | • | • | • | | | | | | |
| AUTO | | | 0 | | | | | | | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Soldering Process

Recommended Reflow Soldering Profile

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.



capacitor body surface that is facing up during assembly reflow.

Storage & Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. In addition, temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years upon receipt.



Construction

Standard Termination



Flex Termination





Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12, 16 and 24 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic (mm)

| | | Embossed Plastic | | | | |
|---------------|-------------------|--------------------------|----------|--|--|--|
| EIA Case Size | Tape Size (W)* | 7" Reel | 13" Reel | | | |
| | (11) | Pitch (P ₁)* | | | | |
| 1812, 2220 | 12 | 8 | 8 | | | |
| 3640 | 24 | 16 | 16 | | | |

*Refer to Figure 1 for W and P_1 carrier tape reference locations. *Refer to Tables 4 and 5 for tolerance specifications.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 - Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | | | |
|--------------|--|----------------------------------|------------------------------|------------------------------|-----------------------------|---------------------------|----------------------|--------------------------------|---------------------------|--|--|--|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S1 Minimum Note 3 | T Maximum | T ₁ Maximum | | | | |
| 12 mm | 1.5+0.10/-0.0 (0.059+0.004/-0.0) | 1.5 (0.059) | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.05 (0.079±0.002) | 30 (1.181) | 0.600 (0.024) | 0.600 (0.024) | 0.600 (0.024) | | | | |
| 24 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 (0.059) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.10 (0.078 ±0.003) | 30 (1.181) | 5 (0.196) | 0.250 (0.009) | 0.350 (0.013) | | | | |
| | | V | ariable Dimer | nsions — Milli | meters (Inche | es) | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B ₀ | and K_0 | | | | |
| 12 mm | Single (4 mm) and Double (8 mm) | | 10.25 (0.404) | 5.5±0.05 (0.217±0.002) | 8.0±0.10 (0.315±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | to F | | | | |
| 24 mm | 16 mm | 22.25 (0.875) | 11.5 ±0.10 (0.452 ±0.003) | 16.0 ±0.10 (0.629 ±0.004) | 3 (0.118) | 24.3 (0.956) | 24.3 (0.956) | NO | ie 5 | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6).

3. If S1 < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Document 481 paragraph 4.3 (b)).

4. B1 dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3).

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 mm and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4)

(e) For KPS Series product, A0 and B0 are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see Addendum in EIA Document 481 for standards relating to more precise taping requirements.



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 Newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 Newton (10 to 130 gf) |
| 24 mm | 0.1 to 1.6 Newton (10 to 160 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300±10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 2 – Maximum Component Rotation



Figure 3 – Maximum Lateral Movement



Figure 4 – Bending Radius





Figure 5 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 7 – Reel Dimensions

Metric will govern

| | Constant Dimensions - Millimeters (Inches) | | | | | | | | | | | |
|-----------|--|-------------------------------------|--------------------------------------|----------------------------|--|--|--|--|--|--|--|--|
| Tape Size | A | B Minimum | С | D Minimum | | | | | | | | |
| 12 mm | 178±0.20 (7.008±0.008) | 1.5 (0.059) | 13.0+0.5/-0.2 (0.521+0.02/-0.008) | 20.2 (0.795) | | | | | | | | |
| 24 mm | 24 mm 0r 330±0.20 (13.000±0.008) | | 13.0 ±0.2 (0.521 ±0.008) | 21 (0.826) | | | | | | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | | | | | |
| 12 mm | 50 | 12.4+2.0/-0.0 (0.488+0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape | | | | | | | | |
| 24 mm | (1.969) | 25 +1.0/-0.0 (0.984 +0.039/-0.0) | 27.4 ±1.0 (1.078 ±0.039) | width without interference | | | | | | | | |



Figure 6 – Tape Leader & Trailer Dimensions



Figure 7 – Maximum Camber





CAPACITOR OUTLINE DRAWINGS



DIMENSIONS—MILLIMETERS AND (INCHES)

| | KEMET | | | | т | |
|-------|-------|--|--|------------|-------------|-------------------------|
| STYLE | CODE | L | w | MIN. | MAX. | BW |
| CDR01 | C0805 | 2.03 ±.38 (.080 ±.015) | 1.27 ±.38 (.050 ±.015) | .56 (.022) | 1.40 (.055) | .51 ± 0.25 (.020 ±.010) |
| CDR02 | C1805 | 4.57 ±.38 (.180 ±.015) | 1.27 ±.38 (.050 ±.015) | .56 (.022) | 1.40 (.055) | .51 ± 0.25 (.020 ±.010) |
| CDR03 | C1808 | 4.57 ±.38 (.180 ±.015) | 2.03 ±.38 (.080 ±.015) | .56 (.022) | 2.03 (.080) | .51 ± 0.25 (.020 ±.010) |
| CDR04 | C1812 | 4.57 ±.38 (.180 ±.015) | 3.18 ±.38 (.125 ±.015) | .56 (.022) | 2.03 (.080) | .51 ± 0.25 (.020 ±.010) |
| CDR05 | C1825 | $\begin{array}{c} +.51 \\ 4.57 \\38 \end{array} \left(\begin{array}{c} +.020 \\ .180 \\015 \end{array} \right)$ | $ \begin{array}{c} +.51 \\ 6.35 \\38 \end{array} \left(\begin{array}{c} +.020 \\ .250 \\015 \end{array} \right) $ | .51 (.020) | 2.03 (.080) | .51 ± 0.25 (.020 ±.010) |
| CDR06 | C2225 | 5.72 ±.51 (.225 ±.020) | 6.35 ±.51 (.250 ±.020) | .51 (.020) | 2.03 (.080) | .51 ± 0.25 (.020 ±.010) |
| CDR31 | C0805 | 2.00 ±.20 (.078 ±.008) | 1.25 ±.20 (.049 ±.008) | | 1.30 (.051) | .50 ± 0.20 (.020 ±.008) |
| CDR32 | C1206 | 3.20 ±.20 (.125 ±.008) | 1.60 ±.20 (.062 ±.008) | | 1.30 (.051) | .50 ± 0.20 (.020 ±.008) |
| CDR33 | C1210 | 3.20 ±.25 (.125 ±.010) | 2.50 ±.25 (.098 ±.010) | | 1.50 (.059) | .50 ± 0.25 (.020 ±.010) |
| CDR34 | C1812 | 4.50 ±.25 (.176 ±.010) | 3.20 ±.25 (.125 ±.010) | | 1.50 (.059) | .50 ± 0.25 (.020 ±.010) |
| CDR35 | C1825 | 4.50 ±.30 (.176 ±.012) | 6.40 ±.30 (.250 ±.012) | | 1.50 (.059) | .50 ± 0.30 (.020 ±.012) |

Note: For MIL-C55681 "S" Endmet, the length, width and thickness positive tolerances (including bandwidth) cited above are allowed to increase by the following

amounts: Length

| CDR01 | 0.51MM (.020) | 0.38MM (.015) |
|----------|---------------|---------------|
| CDR02-06 | 0.64MM (.025) | 0.38MM (.015) |
| CDR31-35 | 0.60MM (.023) | 0.30MM (.012) |

±.1 pF ±.25 pF ±.5 pF ±1% ±5% ±10% ±20%

Width

MIL-PRF-55681 PART NUMBER ORDERING INFORMATION



Part Number Example: C0805P101K1GML (14 digits - no spaces)

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Established Reliability

RATINGS & PART NUMBER REFERENCE

| Charac- | Сар | Avail. | KEMET | MIL-PRF-55681 |
|-------------------------------|--------|-------------|-------------------------|--|
| teristics pF Tol. Part Number | | Part Number | Part Number | |
| | 100 |) Volt - | C0805 Size (Military C | DR01) |
| | 10 | J,K | C0805P100(3)1G(4)L | CDR01BP100B(3)Z(4) |
| | 12 | J | C0805P120J1G(4)L | CDR01BP120BJZ(4) |
| | 15 | J,K | C0805P150(3)1G(4)L | CDR01BP150B(3)Z(4) |
| | 18 | J | C0805P180J1G(4)L | CDR01BP180BJZ(4) |
| | 22 | J,K | C0805P220(3)1G(4)L | CDR01BP220B(3)Z(4) |
| | 27 | J | C0805P270J1G(4)L | CDR01BP270BJZ(4) |
| BP | 33 | J,K | C0805P330(3)1G(4)L | CDR01BP330B(3)Z(4) |
| | 39 | J | C0805P390J1G(4)L | CDR01BP390BJZ(4) |
| | 47 | J,K | C0805P470(3)1G(4)L | CDR01BP470B(3)Z(4) |
| | 56 | J | C0805P560J1G(4)L | CDR01BP560BJZ(4) |
| | 68 | J,K | C0805P680(3)1G(4)L | CDR01BP680B(3)Z(4) |
| | 82 | J | C0805P820J1G(4)L | CDR01BP820BJZ(4) |
| | 100 | J,K | C0805P101(3)1G(4)L | CDR01BP101B(3)Z(4) |
| BP or | 120 | J,K | C0805P121(3)1(2)(4)L | CDR01B(1)121B(3)Z(4) |
| BX BX | 150 | J,K | C0805P151(3)1(2)(4)L | CDR01B(1)151B(3)Z(4) |
| БЛ | 180 | J,K | C0805P181(3)1(2)(4)L | CDR01B(1)181B(3)Z(4) |
| | 220 | K,M | C0805P221(3)1X(4)L | CDR01BX221B(3)Z(4) |
| | 270 | K | C0805P271K1X(4)L | CDR01BX271BKZ(4) |
| | 330 | K,M | C0805P331(3)1X(4)L | CDR01BX331B(3)Z(4) |
| | 390 | К | C0805P391K1X(4)L | CDR01BX391BKZ(4) |
| | 470 | K,M | C0805P471(3)1X(4)L | CDR01BX471B(3)Z(4) |
| | 560 | К | C0805P561K1X(4)L | CDR01BX561BKZ(4) |
| | 680 | K,M | C0805P681(3)1X(4)L | CDR01BX681B(3)Z(4) |
| вх | 820 | K | C0805P821K1X(4)L | CDR01BX821BKZ(4) |
| | 1,000 | K,M | C0805P102(3)1X(4)L | CDR01BX102B(3)Z(4) |
| | 1,200 | K | C0805P122K1X(4)L | CDR01BX122BKZ(4) |
| | 1,500 | K,M | C0805P152(3)1X(4)L | CDR01BX152B(3)Z(4) |
| | 1,800 | K | C0805P182K1X(4)L | CDR01BX182BKZ(4) |
| | 2,200 | K,M | C0805P222(3)1X(4)L | CDR01BX222B(3)Z(4) |
| | 2,700 | ĸ | C0805P272K1X(4)L | CDR01BX272BKZ(4) |
| | 3,300 | | C0805P332(3)1A(4)L | CDRUIDA332D(3)Z(4) |
| | 2 000 | VOIL - V | | |
| BX | 3,900 | KM | C0805P392K3X(4)L | CDR01DA392ARZ(4) CDR01BY472A(2)7(4) |
| | 100 | Volt - | C1805 Size (Military C | DR(12) |
| | 220 | IK | C1805P221(3)1G(4) | CDR02BP221B(3)7(4) |
| BP | 220 | .1 | C1805P271.I1G(4) | CDR02BP271B.IZ(4) |
| | 3 900 | ĸ | C1805P392K1X(4) | CDR02BX392BKZ(4) |
| | 4,700 | K.M | C1805P472(3)1X(4)L | CDR02BX472B(3)Z(4) |
| - | 5,600 | K | C1805P562K1X(4)L | CDR02BX562BKZ(4) |
| вх | 6.800 | K.M | C1805P682(3)1X(4)L | CDR02BX682B(3)Z(4) |
| | 8,200 | K | C1805P822K1X(4)L | CDR02BX822BKZ(4) |
| | 10,000 | K,M | C1805P103(3)1X(4)L | CDR02BX103B(3)Z(4) |
| | 50 | Volt - (| C1805 Size (Military CI | DR02) |
| | 12,000 | K | C1805P123K5X(4)L | CDR02BX123AKZ(4) |
| вv | 15,000 | K,M | C1805P153(3)5X(4)L | CDR02BX153A(3)Z(4) |
| DX | 18,000 | ĸ | C1805P183K5X(4)L | CDR02BX183AKZ(4) |
| | 22,000 | K,M | C1805P223(3)5X(4)L | CDR02BX223A(3)Z(4) |
| | 100 |) Volt - | C1808 Size (Military C | DR03) |
| | 330 | J,K | C1808P331(3)1G(4)L | CDR03BP331B(3)Z(4) |
| BP | 390 | J | C1808P391J1G(4)L | CDR03BP391BJZ(4) |
| | 470 | IK | C1808P471(3)1G(4) | CDR03BP471B(3)7(4) |

| Charac- | Cap | Avail. | KEMET | MIL-PRF-55681 | | | | | | |
|---------------------------------------|------------------------------|----------|-------------------------|--------------------|--|--|--|--|--|--|
| teristics | eristics pF Tol. Part Number | | Part Number | | | | | | | |
| | 100 V | olt - C1 | 808 Size (Military CDR | 03) cont. | | | | | | |
| | 560 | J | C1808P561J1G(4)L | CDR03BP561BJZ(4) | | | | | | |
| DD | 680 | J,K | C1808P681(3)1G(4)L | CDR03BP681B(3)Z(4) | | | | | | |
| вр | 820 | Ĵ | C1808P821J1G(4)L | CDR03BP821BJZ(4) | | | | | | |
| | 1,000 | J,K | C1808P102(3)1G(4)L | CDR03BP102B(3)Z(4) | | | | | | |
| | 12,000 | K | C1808P123K1X(4)L | CDR03BX123BKZ(4) | | | | | | |
| | 15,000 | K,M | C1808P153(3)1X(4)L | CDR03BX153B(3)Z(4) | | | | | | |
| BV | 18,000 | ĸ | C1808P183K1X(4)L | CDR03BX183BKZ(4) | | | | | | |
| Бл | 22,000 | K,M | C1808P223(3)1X(4)L | CDR03BX223B(3)Z(4) | | | | | | |
| | 27,000 | ĸ | C1808P273K1X(4)L | CDR03BX273BKZ(4) | | | | | | |
| | 33,000 | K,M | C1808P333(3)1X(4)L | CDR03BX333B(3)Z(4) | | | | | | |
| 50 Volt - C1808 Size (Military CDR03) | | | | | | | | | | |
| | 39,000 | K | C1808P393K5X(4)L | CDR03BX393AKZ(4) | | | | | | |
| DV | 47.000 | K.M | C1808P473(3)5X(4)L | CDR03BX473A(3)Z(4) | | | | | | |
| вх | 56.000 | Ŕ | C1808P563K5X(4)L | CDR03BX563AKZ(4) | | | | | | |
| | 68,000 | K,M | C1808P683(3)5X(4)L | CDR03BX683A(3)Z(4) | | | | | | |
| | 100 |) Volt - | C1812 Size (Military C | DR04) | | | | | | |
| | 1,200 | J | C1812P122J1G(4)L | CDR04BP122BJZ(4) | | | | | | |
| | 1,500 | J,K | C1812P152(3)1G(4)L | CDR04BP152B(3)Z(4) | | | | | | |
| | 1,800 | Ĵ | C1812P182J1G(4)L | CDR04BP182BJZ(4) | | | | | | |
| вр | 2,200 | J.K | C1812P222(3)1G(4)L | CDR04BP222B(3)Z(4) | | | | | | |
| | 2,700 | Ĵ | C1812P272J1G(4)L | CDR04BP272BJZ(4) | | | | | | |
| | 3,300 | J,K | C1812P332(3)1G(4)L | CDR04BP332B(3)Z(4) | | | | | | |
| | 39,000 | Ŕ | C1812P393K1X(4)L | CDR04BX393BKZ(4) | | | | | | |
| BX | 47,000 | K,M | C1812P473(3)1X(4)L | CDR04BX473B(3)Z(4) | | | | | | |
| | 56,000 | ĸ | C1812P563K1X(4)L | CDR04BX563BKZ(4) | | | | | | |
| | 50 | Volt - | C1812 Size (Military CI | DR04) | | | | | | |
| | 82,000 | K | C1812P823K5X(4)L | CDR04BX823AKZ(4) | | | | | | |
| | 100,000 | K,M | C1812P104(3)5X(4)L | CDR04BX104A(3)Z(4) | | | | | | |
| BX | 120,000 | К | C1812P124K5X(4)L | CDR04BX124AKZ(4) | | | | | | |
| | 150,000 | K,M | C1812P154(3)5X(4)L | CDR04BX154A(3)Z(4) | | | | | | |
| | 180,000 | ĸ | C1812P184K5X(4)L | CDR04BX184AKZ(4) | | | | | | |
| | 100 |) Volt - | C1825 Size (Military C | DR05) | | | | | | |
| | 3,900 | J,K | C1825P392(3)1G(4)L | CDR05BP392B(3)Z(4) | | | | | | |
| BP | 4,700 | J,K | C1825P472(3)1G(4)L | CDR05BP472B(3)Z(4) | | | | | | |
| | 5,600 | J,K | C1825P562(3)1G(4)L | CDR05BP562B(3)Z(4) | | | | | | |
| | 68,000 | K,M | C1825P683(3)1X(4)L | CDR05BX683B(3)Z(4) | | | | | | |
| | 82,000 | K | C1825P823K1X(4)L | CDR05BX823BKZ(4) | | | | | | |
| BX | 100,000 | K,M | C1825P104(3)1X(4)L | CDR05BX104B(3)Z(4) | | | | | | |
| | 120,000 | K | C1825P124K1X(4)L | CDR05BX124BKZ(4) | | | | | | |
| | 150,000 | K,M | C1825P154(3)1X(4)L | CDR05BX154B(3)Z(4) | | | | | | |
| | 50 | Volt - (| C1825 Size (Military CI | DR05) | | | | | | |
| | 220,000 | K,M | C1825P224(3)5X(4)L | CDR05BX224A(3)Z(4) | | | | | | |
| BX | 270,000 | K | C1825P274K5X(4)L | CDR05BX274AKZ(4) | | | | | | |
| | 330,000 | K,M | C1825P334(3)5X(4)L | CDR05BX334A(3)Z(4) | | | | | | |
| | 100 |) Volt - | C2225 Size (Military C | DR06) | | | | | | |
| | 6,800 | J,K | C2225P682(3)1G(4)L | CDR06BP682B(3)Z(4) | | | | | | |
| BP | 8,200 | J,K | C2225P822(3)1G(4)L | CDR06BP822B(3)Z(4) | | | | | | |
| | 10,000 | J,K | C2225P103(3)1G(4)L | CDR06BP103B(3)Z(4) | | | | | | |
| | 50 | Volt - (| C2225 Size (Military CI | DR06) | | | | | | |
| BY | 390,000 | K | C2225P394K5X(4)L | CDR06BX394AKZ(4) | | | | | | |
| DA | 470,000 | K,M | C2225P474(3)5X(4)L | CDR06BX474A(3)Z(4) | | | | | | |

(1) To complete Part Number for Dielectric, insert P or X symbol - as defined by Military specification.

(2) To complete Part number for Dielectric, insert G or X symbol. ("G" for Military "BP", or "X" for Military "BX.")

(3) To complete Part Number, insert Capacitance Tolerance symbol lwhen applicable) as available in MIL-PRF-5682: B - ±0.1pF,

C - ±0.25pF, D - ±0.5pF, F - ±1%, J - ±5%, K - ±10%, M - ±20%. NOTE: Available tolerances are listed in columns above.

(4) To complete Part Number, insert Failure Rate symbol: M - 1.0%; P - 0.1%, R - 0.01%; S - 0.001%.

Note: All MIL_PRF-55681 and KEMET Part Numbers tabulated above assume the use of MIL-PRF-55681 "Z", KEMET "L" end metalization. If MIL-PRF-55681 "U", "W" (KEMET "L") or MIL-PRF-55681 "S" (KEMET "H") or MIL-PRF-55681 "Y" (KEMET "C') is required, please change designators accordingly.

MARKING

See page 97 for MIL-PRF-55681 Marking.



Established Reliablility

RATINGS & PART NUMBER REFERENCE

| Сар | Avail. | KEMET | MIL-PRF-55681 | 1 | Сар | Avail. | KEMET | MIL-PRF-55681 |
|-----|--------|----------------------------|--------------------|---|--------|--------|----------------------------|--------------------|
| pF | Tol. | Part Number | Part Number | | pF | Tol. | Part Number | Part Number |
| | 100 Vo | olt - BP - C0805 Size (Mil | itary CDR31) | 1 | - | 100 Vo | olt - BP - C0805 Size (Mi | itary CDR31) |
| 1.0 | B,C | C0805N109(3)1G(4)L | CDR31BP1R0B(3)Z(4) | 1 | 91 | F,J,K | C0805N910(3)1G(4)L | CDR31BP910B(3)Z(4) |
| 1.1 | B,C | C0805N119(3)1G(4)L | CDR31BP1R1B(3)Z(4) | | 100 | F,J,K | C0805N101(3)1G(4)L | CDR31BP101B(3)Z(4) |
| 1.2 | B,C | C0805C129(3)1G(4)L | CDR31BP1R2B(3)Z(4) | | 110 | F,J,K | C0805N111(3)1G(4)L | CDR31BP111B(3)Z(4) |
| 1.3 | B,C | C0805N139(3)1G(4)L | CDR31BP1R3B(3)Z(4) | | 120 | F,J,K | C0805N121(3)1G(4)L | CDR31BP121B(3)Z(4) |
| 1.5 | B,C | C0805N159(3)1G(4)L | CDR31BP1R5B(3)Z(4) | | 130 | F,J,K | C0805N131(3)1G(4)L | CDR31BP131B(3)Z(4) |
| 1.6 | B,C | C0805N169(3)1G(4)L | CDR31BP1R6B(3)Z(4) | | 150 | F,J,K | C0805N151(3)1G(4)L | CDR31BP151B(3)Z(4) |
| 1.8 | B,C | C0805N189(3)1G(4)L | CDR31BP1R8B(3)Z(4) | | 160 | F,J,K | C0805N161(3)1G(4)L | CDR31BP161B(3)Z(4) |
| 2.0 | B,C | C0805N209(3)1G(4)L | CDR31BP2R0B(3)Z(4) | | 180 | F,J,K | C0805N181(3)1G(4)L | CDR31BP181B(3)Z(4) |
| 2.2 | B,C | C0805N229(3)1G(4)L | CDR31BP2R2B(3)Z(4) | | 200 | F,J,K | C0805N201(3)1G(4)L | CDR31BP201B(3)Z(4) |
| 2.4 | B,C | C0805N249(3)1G(4)L | CDR31BP2R4B(3)Z(4) | | 220 | F,J,K | C0805N221(3)1G(4)L | CDR31BP221B(3)Z(4) |
| 2.7 | B,C,D | C0805N279(3)1G(4)L | CDR31BP2R7B(3)Z(4) | | 240 | F,J,K | C0805N241(3)1G(4)L | CDR31BP241B(3)Z(4) |
| 3.0 | B,C,D | C0805N309(3)1G(4)L | CDR31BP3R0B(3)Z(4) | | 270 | F,J,K | C0805N271(3)1G(4)L | CDR31BP271B(3)Z(4) |
| 3.3 | B,C,D | C0805N339(3)1G(4)L | CDR31BP3R3B(3)Z(4) | | 300 | F,J,K | C0805N301(3)1G(4)L | CDR31BP301B(3)Z(4) |
| 3.6 | B,C,D | C0805N369(3)1G(4)L | CDR31BP3R6B(3)Z(4) | | 330 | F,J,K | C0805N331(3)1G(4)L | CDR31BP331B(3)Z(4) |
| 3.9 | B,C,D | C0805N399(3)1G(4)L | CDR31BP3R9B(3)Z(4) | | 360 | F,J,K | C0805N361(3)1G(4)L | CDR31BP361B(3)Z(4) |
| 4.3 | B,C,D | C0805N439(3)1G(4)L | CDR31BP4R3B(3)Z(4) | | 390 | F,J,K | C0805N391(3)1G(4)L | CDR31BP391B(3)Z(4) |
| 4.7 | B,C,D | C0805N479(3)1G(4)L | CDR31BP4R7B(3)Z(4) | | 430 | F,J,K | C0805N431(3)1G(4)L | CDR31BP431B(3)Z(4) |
| 5.1 | B,C,D | C0805N519(3)1G(4)L | CDR31BP5R1B(3)Z(4) | | 470 | F,J,K | C0805N471(3)1G(4)L | CDR31BP471B(3)Z(4) |
| 5.6 | B,C,D | C0805N569(3)1G(4)L | CDR31BP5R6B(3)Z(4) | | | 50 Vo | lt - BP - C0805 Size (Mili | itary CDR31) |
| 6.2 | B,C,D | C0805N629(3)1G(4)L | CDR31BP6R2B(3)Z(4) | | 510 | F,J,K | C0805N511(3)5G(4)L | CDR31BP511A(3)Z(4) |
| 6.8 | B,C,D | C0805N689(3)1G(4)L | CDR31BP6R8B(3)Z(4) | | 560 | F,J,K | C0805N561(3)5G(4)L | CDR31BP561A(3)Z(4) |
| 7.5 | B,C,D | C0805N759(3)1G(4)L | CDR31BP7R5B(3)Z(4) | | 620 | F,J,K | C0805N621(3)5G(4)L | CDR31BP621A(3)Z(4) |
| 8.2 | B,C,D | C0805N829(3)1G(4)L | CDR31BP8R2B(3)Z(4) | | 680 | F,J,K | C0805N681(3)5G(4)L | CDR31BP681A(3)Z(4) |
| 9.1 | B,C,D | C0805N919(3)1G(4)L | CDR31BP9R1B(3)Z(4) | | | 100 Vo | olt - BX - C0805 Size (Mi | litary CDR31) |
| 10 | F,J,K | C0805N100(3)1G(4)L | CDR31BP100B(3)Z(4) | | 470 | K,M | C0805N471(3)1X(4)L | CDR31BX471B(3)Z(4) |
| 11 | F,J,K | C0805N110(3)1G(4)L | CDR31BP110B(3)Z(4) | | 560 | K,M | C0805N561(3)1X(4)L | CDR31BX561B(3)Z(4) |
| 12 | F,J,K | C0805N120(3)1G(4)L | CDR31BP120B(3)Z(4) | | 680 | K,M | C0805N681(3)1X(4)L | CDR31BX681B(3)Z(4) |
| 13 | F,J,K | C0805N130(3)1G(4)L | CDR31BP130B(3)Z(4) | | 820 | K,M | C0805N821(3)1X(4)L | CDR31BX821B(3)Z(4) |
| 15 | F,J,K | C0805N150(3)1G(4)L | CDR31BP150B(3)Z(4) | | 1,000 | K,M | C0805N102(3)1X(4)L | CDR31BX102B(3)Z(4) |
| 16 | F,J,K | C0805N160(3)1G(4)L | CDR31BP160B(3)Z(4) | | 1,200 | K,M | C0805N122(3)1X(4)L | CDR31BX122B(3)Z(4) |
| 18 | F,J,K | C0805N180(3)1G(4)L | CDR31BP180B(3)Z(4) | | 1,500 | K,M | C0805N152(3)1X(4)L | CDR31BX152B(3)Z(4) |
| 20 | F,J,K | C0805N200(3)1G(4)L | CDR31BP200B(3)Z(4) | | 1,800 | K,M | C0805N182(3)1X(4)L | CDR31BX182B(3)Z(4) |
| 22 | F,J,K | C0805N220(3)1G(4)L | | | 2,200 | K,M | C0805N222(3)1X(4)L | CDR31BX222B(3)Z(4) |
| 24 | F,J,K | C0805N240(3)1G(4)L | | | 2,700 | K,M | C0805N272(3)1X(4)L | CDR31BX272B(3)Z(4) |
| 27 | F,J,K | C0805N270(3)1G(4)L | | | 3,300 | K,M | C0805N332(3)1X(4)L | CDR31BX332B(3)Z(4) |
| 30 | F,J,K | CU805N300(3)1G(4)L | | | 3,900 | K,M | C0805N392(3)1X(4)L | CDR31BX392B(3)Z(4) |
| 33 | F,J,K | C0805N330(3)1G(4)L | | | 4,700 | K,M | C0805N472(3)1X(4)L | CDR31BX472B(3)Z(4) |
| 36 | F,J,K | CU805N360(3)1G(4)L | | | | 50 Vo | lt - BX - C0805 Size (Mili | itary CDR31) |
| 39 | F,J,K | C0805N390(3)1G(4)L | | | 5,600 | K,M | C0805N562(3)5X(4)L | CDR31BX562A(3)Z(4) |
| 43 | F,J,K | C0805N430(3)1G(4)L | | | 6,800 | K,M | C0805N682(3)5X(4)L | CDR31BX682A(3)Z(4) |
| 47 | F,J,K | CU805N470(3)1G(4)L | CDK31BP470B(3)Z(4) | | 8,200 | K,M | C0805N822(3)5X(4)L | CDR31BX822A(3)Z(4) |
| 51 | F,J,K | C0805N510(3)1G(4)L | CDK31BP510B(3)Z(4) | | 10,000 | K,M | C0805N103(3)5X(4)L | CDR31BX103A(3)Z(4) |
| 56 | | | CDR31DP30UB(3)Z(4) | | 12,000 | K,M | C0805N123(3)5X(4)L | CDR31BX123A(3)Z(4) |
| 62 | F,J,K | | ODR3TBP620B(3)Z(4) | | 15,000 | K,M | C0805N153(3)5X(4)L | CDR31BX153A(3)Z(4) |
| 68 | F,J,K | | CDR3TBP080B(3)Z(4) | | 18,000 | K,M | C0805N183(3)5X(4)L | CDR31BX183A(3)Z(4) |
| /5 | F,J,K | C0805N/50(3)1G(4)L | CDR31BP750B(3)Z(4) | | | | | |

(1) To complete Part Number for Dielectric, insert P or X symbol – as defined by Military specification.

(2) To complete Part number for Dielectric, insert G or X symbol. ("G" for Military "BP", or "X" for Military "BX.")

(3) To complete Part Number, insert Capacitance Tolerance symbol lwhen applicable) as available in MIL-PRF-5682: B - ±0.1pF,

 $C = \pm 0.25pF$, $D = \pm 0.5pF$, $F = \pm 1\%$, $J = \pm 5\%$, $K = \pm 10\%$, $M = \pm 20\%$. NOTE: Available tolerances are listed in columns above.

(4) To complete Part Number, insert Failure Rate symbol: M – 1.0%; P – 0.1%, R – 0.01%; S – 0.001%.

Note: All MIL_PRF-55681 and KEMET Part Numbers tabulated above assume the use of MIL-PRF-55681 "Z", KEMET "L" end metalization. If MIL-PRF-55681 "U", "W" (KEMET "L") or MIL-PRF-55681 "S" (KEMET "H") or MIL-PRF-55681 "Y" (KEMET "C') is required, please change designators accordingly.

MARKING

See page 97 for MIL-PRF-55681 Marking.



Established Reliability

RATINGS & PART NUMBER REFERENCE

| Cap | Avail. | KEMET | MIL-PRF-55681 | | Cap | Avail. | KEMET | MIL-PRF-55681 |
|-----|--------|--------------------------|---------------------|---|--------|--------|--------------------------|--|
| pF | Tol. | Part Number | Part Number | | pF | Tol. | Part Number | Part Number |
| | 100 Vo | lt - BP - C1206 Size (Mi | litary CDR32) | | | 100 Vo | It - BP - C1206 Size (Mi | litary CDR32) |
| 1.0 | B,C | C1206N109(3)1G(4)L | CDR32BP1R0B(3)Z(4) | | 110 | F,J,K | C1206N111(3)1G(4)L | CDR32BP111B(3)Z(4) |
| 1.1 | B,C | C1206N119(3)1G(4)L | CDR32BP1R1B(3)Z(4) | | 120 | F.J.K | C1206N121(3)1G(4)L | CDR32BP121B(3)Z(4) |
| 1.2 | B,C | C1206C129(3)1G(4)L | CDR32BP1R2B(3)Z(4) | | 130 | F.J.K | C1206N131(3)1G(4)L | CDR32BP131B(3)Z(4) |
| 1.3 | B,C | C1206N139(3)1G(4)L | CDR32BP1R3B(3)Z(4) | | 150 | F.J.K | C1206N151(3)1G(4)L | CDR32BP151B(3)Z(4) |
| 1.5 | B,C | C1206N159(3)1G(4)L | CDR32BP1R5B(3)Z(4) | | 160 | F.J.K | C1206N161(3)1G(4)L | CDR32BP161B(3)Z(4) |
| 1.6 | B.C | C1206N169(3)1G(4)L | CDR32BP1R6B(3)Z(4)) | | 180 | F.J.K | C1206N181(3)1G(4)L | CDR32BP181B(3)Z(4) |
| 1.8 | B,C | C1206N189(3)1G(4)L | CDR32BP1R8B(3)Z(4) | | 200 | F.J.K | C1206N201(3)1G(4)L | CDR32BP201B(3)Z(4) |
| 2.0 | B.C | C1206N209(3)1G(4)L | CDR32BP2R0B(3)Z(4) | | 220 | F.J.K | C1206N221(3)1G(4)L | CDR32BP221B(3)Z(4) |
| 2.2 | B.C | C1206N229(3)1G(4)L | CDR32BP2R2B(3)Z(4) | | 240 | F.J.K | C1206N241(3)1G(4)L | CDR32BP241B(3)Z(4) |
| 2.4 | B.C | C1206N249(3)1G(4)L | CDR32BP2R4B(3)Z(4) | | 270 | F.J.K | C1206N271(3)1G(4)L | CDR32BP271B(3)Z(4) |
| 2.7 | B.C.D | C1206N279(3)1G(4)L | CDR32BP2R7B(3)Z(4) | | 300 | F.J.K | C1206N301(3)1G(4) | CDR32BP301B(3)Z(4) |
| 3.0 | B.C.D | C1206N309(3)1G(4)L | CDR32BP3R0B(3)Z(4) | | 330 | FJK | C1206N331(3)1G(4) | CDR32BP331B(3)Z(4) |
| 3.3 | B.C.D | C1206N339(3)1G(4)L | CDR32BP3R3B(3)Z(4) | | 360 | FJK | C1206N361(3)1G(4) | CDR32BP361B(3)Z(4) |
| 3.6 | B.C.D | C1206N369(3)1G(4)L | CDR32BP3R6B(3)Z(4) | | 390 | F.J.K | C1206N391(3)1G(4) | CDR32BP391B(3)Z(4) |
| 3.9 | B.C.D | C1206N399(3)1G(4)L | CDR32BP3R9B(3)Z(4) | | 430 | F.J.K | C1206N431(3)1G(4) | CDR32BP431B(3)Z(4) |
| 4.3 | B.C.D | C1206N439(3)1G(4)L | CDR32BP4R3B(3)Z(4) | | 470 | F.J.K | C1206N471(3)1G(4) | CDR32BP471B(3)Z(4) |
| 4.7 | B.C.D | C1206N479(3)1G(4)L | CDR32BP4R7B(3)Z(4) | | 510 | F.J.K | C1206N511(3)1G(4) | CDR32BP511B(3)Z(4) |
| 5.1 | B.C.D | C1206N519(3)1G(4)L | CDR32BP5R1B(3)Z(4) | | 560 | F.IK | $C_{1206N561(3)1G(4)}$ | CDR32BP561B(3)Z(4) |
| 5.6 | B.C.D | C1206N569(3)1G(4)L | CDR32BP5R6B(3)Z(4) | | 620 | F.J.K | C1206N621(3)1G(4) | CDR32BP621B(3)Z(4) |
| 6.2 | B.C.D | C1206N629(3)1G(4)L | CDR32BP6R2B(3)Z(4) | | 680 | F.J.K | C1206N681(3)1G(4) | CDR32BP681B(3)Z(4) |
| 6.8 | B.C.D | C1206N689(3)1G(4)L | CDR32BP6R8B(3)Z(4) | | 750 | F.IK | C1206N751(3)1G(4) | CDR32BP751B(3)Z(4) |
| 7.5 | BCD | C1206N759(3)1G(4) | CDR32BP7R5B(3)Z(4) | | 820 | FIK | C1206N821(3)1G(4) | CDR32BP821B(3)Z(4) |
| 8.2 | BCD | C1206N829(3)1G(4) | CDR32BP8R2B(3)Z(4) | | 910 | F.IK | C1206N911(3)1G(4) | CDR32BP911B(3)Z(4) |
| 91 | BCD | C1206N919(3)1G(4) | CDR32BP9R1B(3)Z(4) | | 1 000 | F.IK | C1206N102(3)1G(4) | CDR32BP102B(3)Z(4) |
| 10 | F.J.K | C1206N100(3)1G(4)L | CDR32BP100B(3)Z(4) | | 1,000 | 50 Vol | t - BP - C1206 Size (Mil | itary CDR32) |
| 11 | F.J.K | C1206N110(3)1G(4)L | CDR32BP110B(3)Z(4) | | 1 100 | FIK | C1206NI112(3)5G(4)I | CDR32BP112A(3)7(4) |
| 12 | FJK | C1206N120(3)1G(4) | CDR32BP120B(3)Z(4) | | 1,100 | | C1200N112(3)5G(4)L | CDR32BF112A(3)Z(4) CDR32BD122A(3)Z(4) |
| 13 | F.J.K | C1206N130(3)1G(4)L | CDR32BP130B(3)Z(4) | | 1,200 | | C1200N122(3)5G(4)L | CDR32BF122A(3)Z(4) CDR32BD132A(3)Z(4) |
| 15 | F.J.K | C1206N150(3)1G(4)L | CDR32BP150B(3)Z(4) | | 1,500 | FIK | C1206N152(3)5G(4)L | CDR32BP152A(3)Z(4) |
| 16 | FJK | C1206N160(3)1G(4) | CDR32BP160B(3)Z(4) | | 1,500 | | C1206N162(3)5C(4)L | CDR32BP162A(3)Z(4) |
| 18 | FJK | C1206N180(3)1G(4) | CDR32BP180B(3)Z(4) | | 1,000 | | C1200N102(3)5G(4)L | CDR32BF102A(3)Z(4) CDR32BD182A(3)Z(4) |
| 20 | F.J.K | C1206N200(3)1G(4)L | CDR32BP200B(3)Z(4) | | 2,000 | | C1200N102(3)5G(4)L | CDR32BF102A(3)Z(4) |
| 22 | FJK | C1206N220(3)1G(4) | CDR32BP220B(3)Z(4) | | 2,000 | | C1206N222(3)5G(4)L | CDR32BF202A(3)Z(4) |
| 24 | F.J.K | C1206N240(3)1G(4)L | CDR32BP240B(3)Z(4) | | 2,200 | 100 Vo | It - BX - C1206 Size (Mi | litary CDR32) |
| 27 | F.J.K | C1206N270(3)1G(4)L | CDR32BP270B(3)Z(4) | | 4 700 | K M | C100CN1470(0)4V(4)1 | |
| 30 | F.J.K | C1206N300(3)1G(4)L | CDR32BP300B(3)Z(4) | | 4,700 | K,IVI | C1200N472(3)1X(4)L | CDR32BX472B(3)Z(4) |
| 33 | F.J.K | C1206N330(3)1G(4)L | CDR32BP330B(3)Z(4) | | 5,000 | K M | C1200N302(3)1X(4)L | CDR32BA302B(3)Z(4) |
| 36 | F.J.K | C1206N360(3)1G(4)L | CDR32BP360B(3)Z(4) | | 0,000 | K M | C1200N002(3)1X(4)L | CDR32BA002B(3)Z(4) |
| 39 | F.J.K | C1206N390(3)1G(4)L | CDR32BP390B(3)Z(4) | | 0,200 | | C12001022(3)1X(4)L | CDR32BA022B(3)Z(4) |
| 43 | F.J.K | C1206N430(3)1G(4)L | CDR32BP430B(3)Z(4) | | 12,000 | K,IVI | C1200N103(3)1X(4)L | CDR32BX103B(3)Z(4) |
| 47 | F.J.K | C1206N470(3)1G(4)L | CDR32BP470B(3)Z(4) | | 12,000 | K M | C1200N123(3)1X(4)L | CDR32BA123B(3)Z(4) |
| 51 | F.J.K | C1206N510(3)1G(4)L | CDR32BP510B(3)Z(4) | | 15,000 | F0 Vol | C1200N153(3)1X(4)L | CDR32BA133B(3)Z(4) |
| 56 | F,J,K | C1206N560(3)1G(4)L | CDR32BP560B(3)Z(4) | | 40.000 | 50 00 | | |
| 62 | F,J,K | C1206N620(3)1G(4)L | CDR32BP620B(3)Z(4) | | 18,000 | K,IVI | C1206N183(3)5X(4)L | |
| 68 | F,J.K | C1206N680(3)1G(4)L | CDR32BP680B(3)Z(4) | | 22,000 | K,M | C1206N223(3)5X(4)L | |
| 75 | F,J,K | C1206N750(3)1G(4)L | CDR32BP750B(3)Z(4) | | 27,000 | K,M | C1206N273(3)5X(4)L | |
| 82 | F,J,K | C1206N820(3)1G(4)L | CDR32BP820B(3)Z(4) | | 33,000 | K,IVI | C1206N333(3)5X(4)L | |
| 91 | F,J.K | C1206N910(3)1G(4)L | CDR32BP910B(3)Z(4) | | 39,000 | K,IVI | C1206N393(3)5X(4)L | CDR32BX393A(3)Z(4) |
| 100 | F.J.K | C1206N101(3)1G(4)L | CDR32BP101B(3)Z(4) | I | | | | |

(1) To complete Part Number for Dielectric, insert P or X symbol - as defined by Military specification.

(2) To complete Part number for Dielectric, insert G or X symbol. ("G" for Military "BP", or "X" for Military "BX.")

(a) To complete Part Number, insert Capacitance Tolerance symbol (when applicable) as available in MIL-PRF-5682: B – ±0.1pF, C – ±0.25pF, D – ±0.5pF, F – ±1%, J – ±5%, K – ±10%, M – ±20%. NOTE: Available tolerances are listed in columns above.
 (4) To complete Part Number, insert Failure Rate symbol: M – 1.0%; P – 0.1%, R – 0.01%; S – 0.001%.

Note: All MIL_PRF-55681 and KEMET Part Numbers tabulated above assume the use of MIL-PRF-55681 "Z", KEMET "L" end metalization. If MIL-PRF-55681 "U", "W" (KEMET "L") or MIL-PRF-55681 "S" (KEMET "H") or MIL-PRF-55681 "Y" (KEMET "C') is required, please change designators accordingly.

MARKING

See page 97 for MIL-PRF-55681 Marking.



Established Reliability

RATINGS & PART NUMBER REFERENCE

| Сар | Avail. | KEMET | MIL-PRF-55681 | 1 I | Cap | Avail. | KEMET | MIL-PRF-55681 |
|---------|-----------|-------------------------|--------------------|-----|---------|-----------|-------------------------|--------------------|
| pF | Tol. | Part Number | Part Number | | pF | Tol. | Part Number | Part Number |
| | 100 Volt | - BP - C1210 Size (Mili | tary CDR33) | 1 1 | | 100 Volt | - BX - C1812 Size (Mili | tary CDR34) |
| 1.000 | F.J.K | C1210N102(3)1G(4)L | CDR33BP102B(3)Z(4) | 1 1 | 27.000 | K.M | C1812N273(3)1X(4)L | CDR34BX273B(3)Z(4) |
| 1,100 | F,J,K | C1210N112(3)1G(4)L | CDR33BP112B(3)Z(4) | | 33.000 | K.M | C1812N333(3)1X(4)L | CDR34BX333B(3)Z(4) |
| 1,200 | F,J,K | C1210N122(3)1G(4)L | CDR33BP122B(3)Z(4) | | 39.000 | К.́М | C1812N393(3)1X(4)L | CDR34BX393B(3)Z(4) |
| 1,300 | F,J,K | C1210N132(3)1G(4)L | CDR33BP132B(3)Z(4) | | 47.000 | К.́М | C1812N473(3)1X(4)L | CDR34BX473B(3)Z(4) |
| 1,500 | F,J,K | C1210N152(3)1G(4)L | CDR33BP152B(3)Z(4) | | 56,000 | К,́М | C1812N563(3)1X(4)L | CDR34BX563B(3)Z(4) |
| 1,600 | F,J,K | C1210N162(3)1G(4)L | CDR33BP162B(3)Z(4) | | | 50 Volt | BX - C1812 Size (Milit | ary CDR34) |
| 1,800 | F,J,K | C1210N182(3)1G(4)L | CDR33BP182B(3)Z(4) | | 100,000 | K,M | C1812N104(3)5X(4)L | CDR34BX104A(3)Z(4) |
| 2,000 | F,J,K | C1210N202(3)1G(4)L | CDR33BP202B(3)Z(4) | | 120,000 | K,M | C1812N124(3)5X(4)L | CDR34BX124A(3)Z(4) |
| 2,200 | F,J,K | C1210N222(3)1G(4)L | CDR33BP222B(3)Z(4) | | 150,000 | K,M | C1812N154(3)5X(4)L | CDR34BX154A(3)Z(4) |
| | 50 Volt - | BP - C1210 Size (Milit | ary CDR33) | | 180,000 | K,M | C1812N184(3)5X(4)L | CDR34BX184A(3)Z(4) |
| 2,400 | F,J,K | C1210N242(3)5G(4)L | CDR33BP242A(3)Z(4) | 1 [| | 100 Volt | - BP - C1825 Size (Mili | tary CDR35) |
| 2,700 | F,J,K | C1210N272(3)5G(4)L | CDR33BP272A(3)Z(4) | | 4,700 | F,J,K | C1825N472(3)1G(4)L | CDR35BP472B(3)Z(4) |
| 3,000 | F,J,K | C1210N302(3)5G(4)L | CDR33BP302A(3)Z(4) | | 5,100 | F,J,K | C1825N512(3)1G(4)L | CDR35BP512B(3)Z(4) |
| 3,300 | F,J,K | C1210N332(3)5G(4)L | CDR33BP332A(3)Z(4) | | 5,600 | F,J,K | C1825N562(3)1G(4)L | CDR35BP562B(3)Z(4) |
| | 100 Volt | - BX - C1210 Size (Mili | tary CDR33) | | 6,200 | F,J,K | C1825N622(3)1G(4)L | CDR35BP622B(3)Z(4) |
| 15,000 | K,M | C1210N153(3)1X(4)L | CDR33BX153B(3)Z(4) | | 6,800 | F,J,K | C1825N682(3)1G(4)L | CDR35BP682B(3)Z(4) |
| 18,000 | K,M | C1210N183(3)1X(4)L | CDR33BX183B(3)Z(4) | | 7,500 | F,J,K | C1825N752(3)1G(4)L | CDR35BP752B(3)Z(4) |
| 22,000 | K,M | C1210N223(3)1X(4)L | CDR33BX223B(3)Z(4) | | 8,200 | F,J,K | C1825N822(3)1G(4)L | CDR35BP822B(3)Z(4) |
| 27,000 | K,M | C1210N273(3)1X(4)L | CDR33BX273B(3)Z(4) | | 9,100 | F,J,K | C1825N912(3)1G(4)L | CDR35BP912B(3)Z(4) |
| | 50 Volt - | BX - C1210 Size (Milit | ary CDR33) | | 10,000 | F,J,K | C1825N103(3)1G(4)L | CDR35BP103B(3)Z(4) |
| 39,000 | K,M | C1210N393(3)5X(4)L | CDR33BX393A(3)Z(4) | | | 50 Volt - | BP - C1825 Size (Milit | ary CDR35) |
| 47,000 | K,M | C1210N473(3)5X(4)L | CDR33BX473A(3)Z(4) | | 11,000 | F,J,K | C1825N113(3)5G(4)L | CDR35BP113A(3)Z(4) |
| 56,000 | K,M | C1210N563(3)5X(4)L | CDR33BX563A(3)Z(4) | | 12,000 | F,J,K | C1825N123(3)5G(4)L | CDR35BP123A(3)Z(4) |
| 68,000 | K,M | C1210N683(3)5X(4)L | CDR33BX683A(3)Z(4) | | 13,000 | F,J,K | C1825N133(3)5G(4)L | CDR35BP133A(3)Z(4) |
| 82,000 | K,M | C1210N823(3)5X(4)L | CDR33BX823A(3)Z(4) | | 15,000 | F,J,K | C1825N153(3)5G(4)L | CDR35BP153A(3)Z(4) |
| 100,000 | K,M | C1210N104(3)5X(4)L | CDR33BX104A(3)Z(4) | | 16,000 | F,J,K | C1825N163(3)5G(4)L | CDR35BP163A(3)Z(4) |
| | 100 Volt | - BP - C1812 Size (Mili | tary CDR34) | | 18,000 | F,J,K | C1825N183(3)5G(4)L | CDR35BP183A(3)Z(4) |
| 2,200 | F,J,K | C1812N222(3)1G(4)L | CDR34BP222B(3)Z(4) | | 20,000 | F,J,K | C1825N203(3)5G(4)L | CDR35BP203A(3)Z(4) |
| 2,400 | F,J,K | C1812N242(3)1G(4)L | CDR34BP242B(3)Z(4) | | 22,000 | F,J,K | C1825N223(3)5G(4)L | CDR35BP223A(3)Z(4) |
| 2,700 | F,J,K | C1812N272(3)1G(4)L | CDR34BP272B(3)Z(4) | | | 100 Volt | - BX - C1825 Size (Mili | tary CDR35) |
| 3,000 | F,J,K | C1812N322(3)1G(4)L | CDR34BP302B(3)Z(4) | | 56,000 | K,M | C1825N563(3)1X(4)L | CDR35BX563B(3)Z(4) |
| 3,300 | F,J,K | C1812N332(3)1G(4)L | CDR34BP332B(3)Z(4) | | 68,000 | K,M | C1825N683(3)1X(4)L | CDR35BX683B(3)Z(4) |
| 3,600 | F,J,K | C1812N362(3)1G(4)L | CDR34BP362B(3)Z(4) | | 82,000 | K,M | C1825N823(3)1X(4)L | CDR35BX823B(3)Z(4) |
| 3,900 | F,J,K | C1812N392(3)1G(4)L | CDR34BP392B(3)Z(4) | | 100,000 | K,M | C1825N104(3)1X(4)L | CDR35BX104B(3)Z(4) |
| 4,300 | F,J,K | C1812N432(3)1G(4)L | CDR34BP432B(3)Z(4) | | 120,000 | K,M | C1825N124(3)1X(4)L | CDR35BX124B(3)Z(4) |
| 4,700 | F,J,K | C1812N472(3)1G(4)L | CDR34BP472B(3)Z(4) | | 150,000 | K,M | C1825N154(3)1X(4)L | CDR35BX154B(3)Z(4) |
| | 50 Volt - | BP - C1812 Size (Milit | ary CDR34) | | | 50 Volt - | BX - C1825 Size (Milit | ary CDR35) |
| 5,100 | F,J,K | C1812N512(3)5G(4)L | CDR34BP512A(3)Z(4) | | 180,000 | K,M | C1825N184(3)5X(4)L | CDR35BX184A(3)Z(4) |
| 5,600 | F,J,K | C1812N562(3)5G(4)L | CDR34BP562A(3)Z(4) | | 220,000 | K,M | C1825N224(3)5X(4)L | CDR35BX224A(3)Z(4) |
| 6,200 | F,J,K | C1812N622(3)5G(4)L | CDR34BP622A(3)Z(4) | | 270,000 | K,M | C1825N274(3)5X(4)L | CDR35BX274A(3)Z(4) |
| 6,800 | F,J,K | C1812N682(3)5G(4)L | CDR34BP682A(3)Z(4) | | 330,000 | K,M | C1825N334(3)5X(4)L | CDR35BX334A(3)Z(4) |
| 7,500 | F,J,K | C1812N752(3)5G(4)L | CDR34BP752A(3)Z(4) | | 390,000 | K,M | C1825N394(3)5X(4)L | CDR35BX394A(3)Z(4) |
| 8,200 | F,J,K | C1812N822(3)5G(4)L | CDR34BP822A(3)Z(4) | | 470,000 | K,M | C1825N474(3)5X(4)L | CDR35BX474A(3)Z(4) |
| 9,100 | F,J,K | C1812N912(3)5G(4)L | CDR34BP912A(3)Z(4) | | | | | |
| 10,000 | F,J,K | C1812N103(3)5G(4)L | CDR34BP103A(3)Z(4) | | | | | |

(1) To complete Part Number for Dielectric, insert P or X symbol - as defined by Military specification.

(2) To complete Part number for Dielectric, insert G or X symbol. ("G" for Military "BP", or "X" for Military "BX.")

(a) To complete Part Number, insert Capacitance Tolerance symbol lwhen applicable) as available in MIL-PRF-5682: B – ±0.1pF,

 $C = \pm 0.25 pF$, $D = \pm 0.5 pF$, $F = \pm 1\%$, $J = \pm 5\%$, $K = \pm 10\%$, $M = \pm 20\%$. NOTE: Available tolerances are listed in columns above.

(4) To complete Part Number, insert Failure Rate symbol: M - 1.0%; P - 0.1%, R - 0.01%; S - 0.001%.

Note: All MIL_PRF-55681 and KEMET Part Numbers tabulated above assume the use of MIL-PRF-55681 "Z", KEMET "L" end metalization. If MIL-PRF-55681 "U", "W" (KEMET "L") or MIL-PRF-55681 "S" (KEMET "H") or MIL-PRF-55681 "Y" (KEMET "C') is required, please change designators accordingly.

| MARKIN | G | |
|-------------------------|---------|----------|
| See page 97 for MIL-PRI | F-55681 | Marking. |

MIL-PRF-55681 MAXIMUM INDIVIDUAL PACKAGING QUANTITIES

| CHIP | | BULK- | BULK - ANTI-STATIC | CHIP | | BULK- | BULK - ANTI-STATIC |
|-------|--------|---------|-----------------------|-------|--------|---------|-----------------------|
| SIZE | REELED | STD BAG | BAG | SIZE | REELED | STD BAG | BAG |
| C0805 | 2,500 | 25,000 | 10,000 | C1808 | 2,500 | 7,500 | 3,000 |
| C1206 | 2,500 | 25,000 | 10,000 | C1812 | 1,100 | 7,500 | 3,000 |
| C1210 | 2,500 | 25,000 | 10,000 | C1825 | 1,100 | 7,500 | 1,000 |
| C1805 | 2,500 | 7,500 | 3,000 | C2225 | 1,100 | 5,000 | 1,000 |

MIL-PRF-55681 chips available in 7" reels only.

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CERAMIC CHIP CAPACITORS



Packaging Information

Tape & Reel Packaging

KEMET offers Multilayer Ceramic Chip Capacitors packaged in 8mm and 12mm plastic tape on 7" and 13" reels in accordance with EIA standard 481-1: Taping of surface mount components for automatic handling. This packaging system is compatible with all tape fed automatic pick and place systems. See page 78 for details on reeling quantities for commercial chips and page 87 for MIL-PRF-55681 chips.



SURFACE MOUNT LAND DIMENSIONS - CERAMIC CHIP CAPACITORS - MM

| Grid Plac Cou | emer rtyaro | nt d — C — | → | |
|---------------------|----------------|------------------|------------------------------------|---|
| | | + | | |
| — | | | +Y+ → | I |

| | | Ref | low So | lder | | Wave Solder | | | | |
|---------------------|------|------|--------|--------|--------|-------------|------|---------|--------|------|
| Dimension | Z | G | Х | Y(ref) | C(ref) | Z | G | X | Y(ref) | Smin |
| 0402 | 2.14 | 0.28 | 0.74 | 0.93 | 1.21 | | Not | Recomme | nded | |
| 0603 | 2.78 | 0.68 | 1.08 | 1.05 | 1.73 | 3.18 | 0.68 | 0.80 | 1.25 | 1.93 |
| 0805 | 3.30 | 0.70 | 1.60 | 1.30 | 2.00 | 3.70 | 0.70 | 1.10 | 1.50 | 2.20 |
| 1206 | 4.50 | 1.50 | 2.00 | 1.50 | 3.00 | 4.90 | 1.50 | 1.40 | 1.70 | 3.20 |
| 1210 | 4.50 | 1.50 | 2.90 | 1.50 | 3.00 | 4.90 | 1.50 | 2.00 | 1.70 | 3.20 |
| 1812 | 5.90 | 2.30 | 3.70 | 1.80 | 4.10 | | | | | |
| 1825 | 5.90 | 2.30 | 6.90 | 1.80 | 4.10 | | | | | |
| 2220 | 7.00 | 3.30 | 5.50 | 1.85 | 5.15 | | Not | Recomme | nded | |
| 2225 | 7.00 | 3.30 | 6.80 | 1.85 | 5.15 | | | | | |
| Calculation Formula | | | | | | | | | | |

Z = Lmin + 2Jt + Tt

G = Smax - 2Jh -Th

X = Wmin + 2Js + Ts Tt, Th, Ts = Combined tolerances



TANTALUM, CERAMIC AND ALUMINUM CHIP CAPACITORS

Packaging Information

Performance Notes

- 1. Cover Tape Break Force: 1.0 Kg Minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | |
|------------|------------|
| 8 mm | 0.1 Newton |
| 12 mm | 0.1 Newton |

0.1 Newton to 1.0 Newton (10g to 100g)

Peel Strength

m 0.1 Newton to 1.3 Newton (10g to 130g)

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

- **3. Reel Sizes:** Molded tantalum capacitors are available on either 180 mm (7") reels (standard) or 330 mm (13") reels (with C-7280). Note that 13" reels are preferred.
- **4. Labeling:** Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. Refer to EIA-556.

Embossed Carrier Tape Configuration: Figure 1



| Гable 1 — | - EMBOSSED | TAPE | DIMENSIONS | (Metric wi | ll govern) |
|-----------|------------|------|------------|------------|------------|
|-----------|------------|------|------------|------------|------------|

| | Constant Dimensions — Millimeters (Inches) | | | | | | | | | | | | |
|--|--|----------------|----------------|-----------------------------|-----------------------------|-----------------|--------------------|------------------------------|-------------|--|--|--|--|
| Tape Size | D _o | | E | P。 | P ₂ | T Max | T₁ Max | | | | | | |
| 8 mm and | 1.5 +0.10 -0 | 1.75 | ±0.10 | 4.0 ±0.10 | 2.0 ±0.05 | 0.600 | 0.100 | | | | | | |
| 12 mm | 12 mm (0.059 (0.069 ±0.004 +0.004, -0.0) | | ±0.004) | (0.157 ±0.004) | (0.079 ±0.002) | (0.024) | (0.004) | | | | | | |
| Variable Dimensions — Millimeters (Inches) | | | | | | | | | | | | | |
| Tape Size | Pitch | B₁ Max. | D₁ Min. | F | P ₁ | R Min. | T ₂ Max | W | $A_0B_0K_0$ | | | | |
| | | Note 1 | Note 2 | | | Note 3 | | | Note 4 | | | | |
| 8 mm | Single (4 mm) | 4.4 | 1.0 | 3.5 ±0.05 | 4.0 ±0.10 | 25.0 | 2.5 | 8.0 ±0.30 | | | | | |
| | | (0.173) | (0.039) | (0.138 ±0.002) | (0.157 ±0.004) | (0.984) | (0.098) | (.315 ±0.012) | | | | | |
| 12 mm | Double (8 mm) | 8.2 (0.323) | 1.5 (0.059) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 30.0 (1.181) | 4.6 (0.181) | 12.0 ±0.30 (0.472 ±0.012) | | | | | |

NOTES

- 1. B1 dimension is a reference dimension for tape feeder clearance only.
- 2. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.
- 3. Tape with components shall pass around radius "R" without damage (see sketch A). The minimum trailer length (Fig. 2) may require additional length to provide R min. for 12 mm embossed tape for reels with hub diameters approaching N min. (Table 2)
- 4. The cavity defined by A₀, B₀, and K₀ shall be configured to surround the part with sufficient clearance such that the chip does not protrude beyond the sealing plane of the cover tape, the chip can be removed from the cavity in a vertical direction without mechanical restriction, rotation of the chip is limited to 20 degrees maximum in all 3 planes, and lateral movement of the chip is restricted to 0.5 mm maximum in the pocket (not applicable to vertical clearance.)

TANTALUM, CERAMIC AND ALUMINUM CHIP CAPACITORS



Packaging Information

Embossed Carrier Tape Configuration (cont.)





Table 2 – REEL DIMENSIONS (Metric will govern)

| Tape Size | A Max | B* Min | С | D* Min | N Min | W ₁ | W ₂ Max | W ₃ |
|-----------|-------------------|----------------|--------------------------------|-----------------|----------------------------------|---|--------------------|--|
| 8 mm | 330.0 (12.992) | 1.5 (0.059) | 13.0 ± 0.20 (0.512 ± 0.008) | 20.2 (0.795) | 50.0 (1.969) See Note 3 | 8.4 +1.5, -0.0 (0.331 +0.059, -0.0) | 14.4 (0.567) | 7.9 Min (0.311) 10.9 Max (0.429) |
| 12 mm | 330.0 (12.992) | 1.5 (0.059) | 13.0 ± 0.20 (0.512 ± 0.008) | 20.2 (0.795) | Table 1 | 12.4 +2.0, -0.0 (0.488 +0.078, -0.0) | 18.4 (0.724) | 11.9 Min (0.469) 15.4 Max (0.606) |



CERAMIC CHIP CAPACITORS

Packaging Information

Punched Carrier (Paper Tape) Configuration (Ceramic Chips Only):



Table 1:8 & 12mm Punched Tape (Metric Dimensions Will Govern)

Constant Dimensions - Millimeters (Inches)

| Tape Size | D ₀ | E | P ₀ | P ₂ | T ₁ | G ₁ | G ₂ | R Min. |
|--------------------|--|-----------------------------|------------------------------|--------------------------------------|------------------------|------------------------|------------------------|------------------------------------|
| 8mm and 12mm | 1.5 +0.10, -0.0 (.059 +0.004, -0.0) | 1.75 ±0.10 (.069 ±0.004) | 4.0 ± 0.10 (.157 ± 0.004) | 2.0 ± 0.05 (.079 \pm 0.002) | 0.10 (.004) Max. | 0.75 (.030) Min. | 0.75 (.030) Min. | 25 (.984) See Note 2 Table 1 |

Table 1: 8 & 12mm Punched Tape (Metric Dimensions Will Govern)

Variable Dimensions - Millimeters (Inches)

| Tape Size | P ₁ | F | W | A ₀ B ₀ | Т | |
|-------------------------|--|-----------------------------|--------------------------------------|-------------------------------|---|--|
| 8mm 1/2 Pitch | 2.0 ± 0.10 (.079 ±.004) See Require- ments Section 3.3 (d) | 3.5 ± 0.05 (.138 ± .002) | 8.0 ± 0.3 (.315 ± 0.012) | See Note 1 Table 1 | 1.1mm (.043) Max. for Paper Base Tape and 1.6mm (.063) Max. for Non | |
| 8mm | $\begin{array}{c} 4.0 \pm 0.10 \\ (0.157 \pm .004) \end{array}$ | | | | Paper Base | |
| 12mm | $\begin{array}{c} 4.0 \pm 0.10 \\ (0.157 \pm .004) \end{array}$ | 5.5 ± 0.05 | 12.0 ± 0.3 | | See Note 3. | |
| 12mm Double Pitch | $\begin{array}{c} 8.0 \pm 0.10 \\ (0.315 \pm .004) \end{array}$ | (.217 ± .002) | (.472 ± .012) | | | |

Note:

1. A_0 , B_0 and T determined by the maximum dimensions to the ends of the terminals extending from the body and/or the body dimensions of the component. The clearance between the ends of the terminals or body of the component to the sides and depth of the cavity (A_0 , B_0 and T) must be within 0.05mm (.002) minimum and 0.50mm (.020) maximum. The clearance allowed must also prevent rotation of the component within the cavity of not more than 20 degrees (see sketches A and B).

2. Tape with components shall pass around radius "R" without damage.

3. KEMET nominal thicknesses are: 0402 = 0.6mm and all others 0.95mm minimum.





CERAMIC CHIP CAPACITORS

Packaging Information

Bulk Cassette Packaging (Ceramic Chips only) (Meets Dimensional Requirements IEC-286-6 and EIAJ 7201)



Table 2 – Capacitance Values Available In Bulk Cassette Packaging

| | Case Size | Dielectric | Voltage | Min. Cap Value | Max. Cap Value |
|----|--------------|------------|------------------------------|--|---------------------------------|
| | 0402 | All | All | All | All |
| | 0603 | All | All | All | All |
| | 0805 | C0G | 200 100 50 | 109 109 109 | 181 331 102 |
| | | X7R | 200 100 50 25 16 | 221 221 221 221 221 221 | 392 103 273 104 104 |
|)* | | Y5V | 25 16 | 104 104 | 224 224 |

Table 1 – Capacitor Dimensions for Bulk Cassette Packaging – Millimeters

| Metric Size Code | EIA Size Code | Length L | Width W | Thickness T | Bandwidth B | Minimum Separation S | Number of Pcs/Cassette |
|------------------------|----------------------|-------------|--|--|---|----------------------------|----------------------------|
| 1005 1608 2012 | 0402 0603 0805 | | $\begin{array}{c} 0.5 \pm 0.05 \\ 0.8 \pm 0.07 \\ 1.25 \pm 0.10 \end{array}$ | $\begin{array}{c} 0.5 \pm .05 \\ 0.8 \pm .07 \\ 0.6 \pm .10 \end{array}$ | 0.2 to 0.4 0.2 to 0.5 0.5 to 0.75 | 0.3 0.7 0.75 | 50,000 15,000 10,000 |

Terminations: KEMET nickel barrier layer with a tin overplate.

CAPACITOR MARKING TABLE (Marking Optional - Not Available for 0402 Size or Y5V Dielectric)

| Numeral | | | Capa | citance | e (pF) Fo | or Various | Numeral Ic | lentifiers | |
|--------------------|------|-----|------|---------|-----------|------------|------------|------------|------------|
| Alpha Character | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| A | 0.10 | 1.0 | 10 | 100 | 1000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 |
| В | 0.11 | 1.1 | 11 | 110 | 1100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 |
| С | 0.12 | 1.2 | 12 | 120 | 1200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 |
| D | 0.13 | 1.3 | 13 | 130 | 1300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 |
| E | 0.15 | 1.5 | 15 | 150 | 1500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 |
| F | 0.16 | 1.6 | 16 | 160 | 1600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 |
| G | 0.18 | 1.8 | 18 | 180 | 1800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 |
| н | 0.20 | 2.0 | 20 | 200 | 2000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 |
| J | 0.22 | 2.2 | 22 | 220 | 2200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 |
| К | 0.24 | 2.4 | 24 | 240 | 2400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 |
| L | 0.27 | 2.7 | 27 | 270 | 2700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 |
| M | 0.30 | 3.0 | 30 | 300 | 3000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 |
| N | 0.33 | 3.3 | 33 | 330 | 3300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 |
| P | 0.36 | 3.6 | 36 | 360 | 3600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 |
| Q | 0.39 | 3.9 | 39 | 390 | 3900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 |
| R | 0.43 | 4.3 | 43 | 430 | 4300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 |
| S | 0.47 | 4.7 | 47 | 470 | 4700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 |
| Т | 0.51 | 5.1 | 51 | 510 | 5100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 |
| U | 0.56 | 5.6 | 56 | 560 | 5600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 |
| V | 0.62 | 6.2 | 62 | 620 | 6200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 |
| W | 0.68 | 6.8 | 68 | 680 | 6800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 |
| X | 0.75 | 7.5 | 75 | 750 | 7500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 |
| Y | 0.82 | 8.2 | 82 | 820 | 8200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 |
| Z | 0.91 | 9.1 | 91 | 910 | 9100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 |
| а | 0.25 | 2.5 | 25 | 250 | 2500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 |
| b | 0.35 | 3.5 | 35 | 350 | 3500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 |
| d | 0.40 | 4.0 | 40 | 400 | 4000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 |
| е | 0.45 | 4.5 | 45 | 450 | 4500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 |
| l f | 0.50 | 5.0 | 50 | 500 | 5000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 |
| m | 0.60 | 6.0 | 60 | 600 | 6000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 |
| n | 0.70 | 7.0 | 70 | 700 | 7000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 |
| t | 0.80 | 8.0 | 80 | 800 | 8000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 |
| У | 0.90 | 9.0 | 90 | 900 | 9000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 |

Laser marking is available as an extra-cost option for most KEMET ceramic chips. Such marking is two sided, and includes a \overline{K} to identify KEMET, followed by two characters (per EIA-198 - see table below) to identify the capacitance value. Note that marking is not available for size 0402 nor for any Y5V chip. In addition, the 0603 marking option is limited to the \overline{K} only.





Overview

KEMET is approved to DSCC (Defense Supply Center, Columbus) drawing no. 03028 for surface mount EIA 0603 case size multilayer ceramic capacitors (MLCCs) in BR and BX dielectrics.

DSCC MLCC control drawings are managed by the Defense Logistics Agency (DLA) and represent devices with case sizes, voltage ratings, and capacitance offerings not currently referenced in a valid military specification. Approved devices must meet the stringent requirements, specifications and standards outlined by DSCC. DSCC drawing no. 03028 was developed in response to the growing need and demand within the defense and aerospace industries for EIA 0603 case size MLCCs not currently offered in MIL-PRF-55681. KEMET's DSCC approved capacitors meet the requirements, specifications and standards outlined in drawing no. 03028 as well as all referenced provisions per MIL-PRF-55681.

Benefits

- EIA 0603 case size
- Defense Supply Center, Columbus approved
- Federal Stock Control Number, Cage Code 31433
- Meets US Department of Defense (USDoD) specifications per MIL-PRF-55681
- Meets USDoD standards per MIL-STD-202 & MIL-STD-1285
 List as list little
- High reliability
- Surface mount device
- Non-polar

Applications

Typical applications include decoupling, bypass, filtering, blocking and energy storage for use in military and aerospace applications.

Outline Drawing



Dimensions - Millimeters (Inches)

| EIA SIZE CODE | METRIC SIZE CODE | L LENGTH^ | L W LENGTH ^A WIDTH ^A | | T THICKNESS Maximum |
|------------------|---------------------|---------------------------|---|---------------------------|---------------------------|
| 0603 | 1608 | 1.60 (.063) ± 0.15 (.006) | 0.81 (.032) ± 0.15 (.006) | 0.36 (.014) ± 0.15 (.006) | 0.91 (.036) |

^For symbol "U" termination add 0.020 inch (0.51mm) to the positive length tolerance and 0.015 inches (0.38mm) to the positive width and thickness tolerances.

Ordering Information

| 03028 | BX | 104 | Y | J | Z | С | 7189 |
|------------------------|------------|--------------------------|----------|--------------------------|-----------------------------------|-------------------------------|------------------------------|
| DSCC Drawing Number | Dielectric | Capacitance Code (pF) | Voltage | Capacitance Tolerance | End Metallization [^] | Group C Testing Option | Packaging/Grade (C-Spec)* |
| 03028 (0603 case size) | BR | 2 Sig. Digits + | W = 6.3V | J = ±5% | U = SnPb (4% min) | Blank = No group C testing | Blank = Bulk Bag |
| | ВX | Number of | X = 10V | K = ±10% | Z = SnPb (4% min) | C = Full group C | 7246 = Anti-Static Bulk Bag |
| | | Zeros | Y = 16V | M = ±20% | | L = 2,000 hour life test only | 7292 = Waffle Pack |
| | | | Z = 25V | | | M = 1,000 hour life test only | 7189 = 7" Reel Marked |
| | | | A = 50V | | | H = Low voltage humidity only | |
| | | | B = 100V | | | | |
| | | | C = 200V | | | | |

^ "U" = Base metallization-barrier metal-solder coated (tin/lead alloy, with a min of 4% lead). Melting point is +200°C or less. Metallization thickness is ≥ 60µ-inches.

^ "Z" = Base metallization-barrier metal-tinned (tin/lead alloy, with a min of 4% lead).

* Additional reeling or packaging options may be available. Contact KEMET for details.

Additional termination options may be available. Contact KEMET for details.



Electrical Parameters/Characteristics: BR Dielectric

| Operating Temperature Range | -55°C to +125°C |
|---|---|
| Capacitance Change with Reference to +25°C and 0 Vdc Applied: | ±15% |
| Capacitance Change with Reference to +25°C and 100% Rated Vdc Applied: | +15%, -40% |
| Aging Rate (Max % Cap Loss/Decade Hour) | 1% |
| Dielectric Withstanding Voltage | 250% |
| Dissipation Factor (DF%) Maximum Limits @ 25°C | 5% (10V), 3.5% (16V & 25V) and 2.5% (50V to 200V) |
| Insulation Resistance (IR) Limit @ 25°C Insulation Resistance (IR) Limit @ 125°C | 1000 megohm microfarads (minimum) or 100G Ω 100 megohm microfarads (minimum) or 10G Ω |

To obtain the IR limit, divide M Ω -µF value by the capacitance and compare to G Ω limit. Select the lower of the two limits. Capacitance and Dissipation Factor (DF) measured under the following conditions: 1kHz ± 50Hz and 1.0 ± 0.2 Vrms

Electrical Parameters/Characteristics: BX Dielectric

| Operating Temperature Range | -55°C to +125°C |
|---|---|
| Capacitance Change with Reference to +25°C and 0 Vdc Applied: | ±15% |
| Capacitance Change with Reference to +25°C and 100% Rated Vdc Applied: | +15%, -25% |
| Aging Rate (Max % Cap Loss/Decade Hour) | 1% |
| Dielectric Withstanding Voltage | 250% |
| Dissipation Factor (DF%) Maximum Limits @ 25°C | 5% (10V), 3.5% (16V & 25V) and 2.5% (50V to 200V) |
| Insulation Resistance (IR) Limit @ 25°C Insulation Resistance (IR) Limit @ 125°C | 1000 megohm microfarads (minimum) or 100G Ω 100 megohm microfarads (minimum) or 10G Ω |

To obtain the IR limit, divide M Ω -µF value by the capacitance and compare to G Ω limit. Select the lower of the two limits. Capacitance and Dissipation Factor (DF) measured under the following conditions: 1kHz ± 50Hz and 1.0 ± 0.2 Vrms

Qualification/Certification

| Inspection | Test method paragraph |
|--|-----------------------|
| Group I | |
| Voltage conditioning | 4.8.3 |
| DWV | 4.8.9 |
| IR (elevated temperature) | 4.8.6 |
| Capacitance | 4.8.4 |
| Dissipation factor | 4.8.5 |
| IR | 4.8.6 |
| DWV | 4.8.9 |
| Visual and mechanical examination | 4.8.2 |
| Group II | |
| Solderability | 4.8.10 |
| Group III | |
| Voltage-temperature limits | 4.8.11 |
| Thermal shock and immersion | 4.8.12 |
| Group IV | |
| Resistance to soldering heat | 4.8.13 |
| Moisture resistance | 4.8.14 |
| Group V | |
| Life (at elevated ambient temperature) | 4.8.16 |
| Group VIII | |
| Humidity, steady state, low voltage | 4.8.15 |

Qualification Inspection per MIL-PRF-55681







TCVC - 0603, 1000pF, 200V, BR





DSCC Approved 03028 (BR/BX Dielectrics)

| | | DSCC DRAWING NO. 03028 | | | | | | | | | | | | | | |
|-------------------|-------------|------------------------|------|-----|-----|-----|-----|------|----------|--------|-----|-----|-----|-----|------|------|
| | | DIELECTRIC | | | | BR | | | | | | | BX | | | |
| Capacitance pF | Cap Code | Voltage | 6.3V | 10V | 16V | 25V | 50V | 100V | 200V | 6.3V | 10V | 16V | 25V | 50V | 100V | 200V |
| | | Voltage Code | w | Х | Y | z | Α | в | С | w | Х | Y | z | Α | В | С |
| | | Cap Tolerance | | | | | | EIA | 4 0603 C | CASE S | IZE | | | | | |
| 100 | 101 | JKM | • | • | • | • | • | • | • | • | • | • | • | • | • | |
| 120 | 121 | JKM | • | • | • | • | • | • | • | • | • | • | • | • | • | |
| 150 | 151 | JKM | • | • | • | • | • | • | • | • | • | • | • | • | • | |
| 180 | 181 | JKM | • | • | • | • | • | • | • | • | • | • | • | • | • | |
| 220 | 221 | JKM | • | • | • | • | • | • | • | • | • | • | • | • | • | |
| 270 | 271 | JKM | ٠ | • | • | • | • | • | • | • | • | • | • | • | • | |
| 330 | 331 | JKM | • | • | • | • | • | • | • | • | • | • | • | • | • | |
| 390 | 391 | JKM | • | • | • | • | • | • | • | • | • | • | • | • | • | |
| 470 | 471 | JKM | • | • | • | • | • | • | • | • | • | • | • | • | • | |
| 560 | 561 | JKM | ٠ | • | • | • | • | • | • | • | • | • | • | • | • | |
| 680 | 681 | JKM | • | • | • | • | • | • | • | • | • | • | • | • | • | |
| 820 | 821 | JKM | • | • | • | • | • | • | • | • | • | • | • | • | • | |
| 1,000 | 102 | JKM | • | • | • | • | • | • | • | • | • | • | • | • | • | |
| 1,200 | 122 | JKM | • | • | • | • | • | • | | • | • | • | • | • | | |
| 1,500 | 152 | JKM | • | • | • | • | • | • | | • | • | • | • | • | | |
| 1,800 | 182 | JKM | • | • | • | • | • | • | | • | • | • | • | • | | |
| 2,200 | 222 | JKM | • | • | • | • | • | • | | • | • | • | • | • | | |
| 2,700 | 272 | JKM | • | • | • | • | • | • | | • | • | • | • | • | | |
| 3,300 | 332 | JKM | • | • | • | • | • | • | | • | • | • | • | • | | |
| 3,900 | 392 | JKM | • | • | • | • | • | • | | • | • | • | • | • | | |
| 4,700 | 472 | JKM | • | • | • | • | • | • | | • | • | • | • | • | | |
| 5,600 | 562 | JKM | • | • | • | • | • | | | • | • | • | • | | | |
| 6,800 | 682 | JKM | • | • | • | • | • | | | • | • | • | • | | | |
| 8,200 | 822 | JKM | • | • | • | • | • | | | • | • | • | • | | | |
| 10,000 | 103 | JKM | • | • | • | • | • | | | • | • | • | • | | | |
| 12,000 | 123 | | • | | | | | | | | | | | | | |
| 15,000 | 103 | JKW | • | | | | | | | | | | | | | |
| 18,000 | 103 | | • | | | | | | | | | | | | | |
| 22,000 | 223 | | • | | | | - | | | | | | · · | | | |
| 21,000 | 213 | | | | | | | | | | | | | | | |
| 30,000 | 303 | JKW | | | | | | | | | | | | | | |
| 47,000 | 173 | | | | | | | | | | | | | | | |
| 56,000 | 563 | | | | | | | | | | | | | | | |
| 68,000 | 683 | | | | | | | | | | | | | | | |
| 82,000 | 823 | | | | | | | | | | | | | | | |
| 100 000 | 104 | JKM | • | | | | | | | | | | | | | |
| 120,000 | 124 | JKM | - | | | | | | | - | | | | | | |
| 150.000 | 154 | ЈКМ | | | | | | | | | | | | | | |
| 180,000 | 184 | JKM | | | | | | | | | | | | | | |
| 220,000 | 224 | IKM | | | | | | | | | | | | | | |





Packaging Quantities

| | LOOSE PA | CKAGING | SECURE PACKAGING | | |
|-------------------------------|--------------------|----------------------|--------------------|----------------------|--|
| | BULK BAG (Default) | ANTI-STATIC BULK BAG | WAFFLE PACK | TAPE AND REEL | |
| Packaging C-Spec ¹ | N/A ² | 7246 | 7292 | 7189 | |
| Quantity | 1 Minimum | 1 Minimum | 100 Maximum / Tray | 4,000 Maximum / Reel | |

¹ A "Packaging C-Spec" is a 4-digit numeric code which identifies the packaging type. When ordering, the proper code must be included in the 15th through 18th character positions of the ordering code. See "Ordering Information" section of this document for further details. Product ordered without a "Packaging C-Spec" will default to our standard "Bulk Bag" packaging.

² A "Packaging C-spec" (see note ¹ above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag). The 15th through 18th character positions of the ordering code should be left blank. All product ordered without a "Packaging C-Spec" will default to our standard "Bulk Bag" packaging.

Soldering Process All parts incorporate the standard KEMET barrier layer of pure nickel with a tin-lead (SnPb) finish. Both "U" and "Z" termination finishes contain a minimum of 4% lead.

Marking

Marking is not available for DSCC approved EIA 0603 case size capacitors. These chips will be supplied unmarked.



HIGH RELIABILITY — GR900 / Q-SPEC

GR900 capacitors are intended for use in any application where the chance of failure must be reduced to the lowest possible level. While any well-made multilayer ceramic capacitor is an inherently reliable device, GR900 capacitors receive special attention in all phases of manufacture including:

- Raw Materials Selection
- Clean Room Production
- Individual Batch Testing
- C-SAM (when applicable)
- Singular Batch Identity is Maintained
- Destructive Physical Analysis

These parts are well worth the added investment in comparison to the cost of a device or system failure.

Typical applications include: Medical, Aerospace, Communication Satellites, Radar and Guidance Systems.

SCREENING AND SAMPLE TESTS

Each batch receives the following testing/inspections:

In Process Inspection (Per MIL-PRF-123):

- 1. 100% Visual Inspection.
- Destructive Physical Analysis: (DPA) A sample is pulled from each lot and examined per EIA-469 and KEMET's strict internal void and delamination criteria. Sampling plan is per MIL-PRF-123.
- C-SAM (GR900 / "A" in the fifth character position of the ordering code): May be performed on batches failing to meet the DPA criteria for removal of marginal product. Not required on each lot.

C-SAM (Q-SPEC / "Q" in the fifth character position of the ordering code): Receive 100% C-SAM of lot prior to application of end metallization.

Group A

1. Thermal Shock: Materials used in the construction of multilayer ceramic capacitors possess various thermal coefficients of expansion. To assure maximum uniformity, each part is temperature cycled in accordance to MIL-STD-202, Method 107, Condition A with Step 3 being 125°C. Number of cycles shall be 20 (100% of lot).

2. Voltage Conditioning: One of the most strenuous environments for any capacitor is the high temperature/high voltage test. All units are subject to twice-rated voltage to the units at the maximum rated temperature of 125°C for a minimum of 168 hours and a maximum of 264 hours. The voltage conditioning may be terminated at any time during 168 hours to 264 hours time interval that confirmed failures meet the requirements of the PDA during the last 48 hours of 1 unit or .4% (100% of lot).

Optional Voltage Conditioning (Accelerated Voltage

Conditioning): All conditions of the standard voltage conditioning apply with the exception of increased voltage and decreased test time. Refer to MIL-PRF-123 for the proper formula.

*Step 5 is performed on chips at this point (100% of lot).

3. Dielectric Withstanding Voltage: 250% of the DC rated voltage at 25°C (100% of lot).

4. Insulation Resistance: The 25°C measurement with rated voltage applied shall be the lesser of 100 G Ω or 1000 Megohm - Microfarads (100% of lot).

*5. Insulation Resistance: The 125°C measurement with rated voltage applied shall be the lesser of 10 G Ω or 100 Megohm - Microfarads (100% of lot). For chips, 125°C IR is performed prior to Step 3 above.

6. Storage at 150°C for 2 hours minimum without voltage applied followed by a 12-hour minimum stabilization period (temperature characteristic BX only).

7. Capacitance: Shall be within specified tolerance at 25° C (100% of lot). (Aging phenomenon is taken into account for BX dielectric to obtain capacitance.)

8. Dissipation Factor: Shall not exceed 2.5% for X7R (BX) dielectric, 0.15% for C0G (BP) dielectric at 25°C. (100% of lot.)

9. Percent Defective Allowable (PDA): The overall PDA is 8% for parts outside the MIL-PRF-123 values. The PDA is per MIL-PRF-123 for all parts that are valid MIL-PRF-123 values. The PD includes steps 1 through 8 above with the following exceptions. Capacitance exclusion - capacitance values no more than 5% or .5pF, whichever is greater for BX characteristic or 1% or .3pF, whichever is greater for BP characteristic beyond specified tolerance limit, shall be removed from the lot but shall not be considered defective for determination of the PD.

Insulation Resistance at 25°C — Product which is not acceptable for twice the military limit but is acceptable per the military limit, is removed from the lot but shall not be considered defective for determination of the PD.

10. Visual and Mechanical Examination: Performed per MIL-PRF-123 criteria.

11. Radiographic Examination (Leaded Devices Only): Radial devices receive a one-plane X-ray.

12. Destructive Physical Analysis (DPA): A sample is examined on each lot per EIA-469. Sampling Plan is per MIL-PRF-123.

STANDARD PACKAGING

All products are packaged in trays except C512 capacitors which are packaged 1 piece per bag.

*Note: All packaging is ESD protected.

DATA PACKAGE

A data package is sent with each shipment which contains:

1. Final Destructive Physical Analysis (DPA) report.

2. Certificate of Compliance stating that the parts meet all applicable requirements of the appropriate military specification to the best failure level to which KEMET is approved.

3. Summary of Group A Testing.

Group B

MIL-PRF-123 Group B testing is available with special order. Please contact KEMET for additional information and ordering details.



CAPACITOR OUTLINE DRAWINGS

*Add .38mm (.015") to the positive width and thickness tolerance dimensions and 0.64mm (.025") to the positive length tolerance dimension for solder coated(dipped) end metallization.

DIMENSIONS — MILLIMETERS (INCHES)

| | | | Т |
|------|-----------------------------|-----------------------------|--------------|
| Size | L | W | Thickness |
| Code | Length | Width | Max. |
| 0504 | 1.269 (.050) ± 0.254 (.010) | 1.015 (.040) ± 0.254 (.010) | 1.142 (.045) |
| 0805 | 2.03 (.080) ± 0.38 (.015) | 1.27 (.050) ± 0.38 (.015) | 1.4 (.055) |
| 1005 | 2.56 (.100) ± 0.38 (.015) | 1.27 (.050) ± 0.38 (.015) | 1.5 (.059) |
| 1206 | 3.07 (.120) ± 0.38 (.015) | 1.52 (.060) ± 0.38 (.015) | 1.6 (.065) |
| 1210 | 3.07 (.120) ± 0.38 (.015) | 2.56 (.100) ± 0.38 (.015) | 1.6 (.065) |
| 1805 | 4.57 (.180) ± 0.38 (.015) | 1.27 (.050) ± 0.38 (.015) | 1.4 (.055) |
| 1808 | 4.57 (.180) ± 0.38 (.015) | 2.03 (.080) ± 0.38 (.015) | 1.6 (.065) |
| 1812 | 4.57 (.180) ± 0.38 (.015) | 3.18 (.125) ± 0.38 (.015) | 2.03 (.080) |
| 1825 | 4.57 (.180) ± 0.38 (.015) | 6.35 (.250) ± 0.38 (.015) | 2.03 (.080) |
| 2225 | 5.59 (.220) ± 0.38 (.015) | 6.35 (.250) ± 0.38 (.015) | 2.03 (.080) |



2—200V 4—16V 5-50V

MARKING

Capacitors shall be legibly laser marked in contrasting color with the KEMET trademark and 2-digit capacitance symbol.



RATINGS AND PART NUMBER REFERENCE STYLE C0805

| CAPACITANCE pF | KEMET PART NUMBER | | | | |
|-------------------|----------------------|--|--|--|--|
| 100 V | OLT - BP | | | | |
| 240 | C0805A241(1)1GA(2) | | | | |
| 270 | C0805A271(1)1GA(2) | | | | |
| 300 | C0805A301(1)1GA(2) | | | | |
| 330 | C0805A331(1)1GA(2 | | | | |
| 360 | C0805A361(1)1GA(2 | | | | |
| 390 | C0805A391(1)1GA(2) | | | | |
| 430 | C0805A431(1)1GA(2) | | | | |
| 470 | C0805A471(1)1GA(2) | | | | |
| 50 V | OLT - BP | | | | |
| 510 | C0805A511(1)5GA(2) | | | | |
| 560 | C0805A561(1)5GA(2) | | | | |
| CAPACITANCE | KEMET | | | | |

| CAPACITANCE pF | KEMET PART NUMBER |
|-------------------|----------------------|
| 200 \ | OLT - BX |
| 180 | C0805A181(1)2XA(2) |
| 220 | C0805A221(1)2XA(2) |
| 270 | C0805A271(1)2XA(2) |
| 330 | C0805A331(1)2XA(2) |
| 390 | C0805A391(1)2XA(2) |
| 470 | C0805A471(1)2XA(2) |
| 560 | C0805A561(1)2XA(2) |
| 680 | C0805A681(1)2XA(2) |
| 820 | C0805A821(1)2XA(2) |
| 100 \ | /OLT - BX |
| 1000 | C0805A102(1)1XA(2) |
| 1200 | C0805A122(1)1XA(2) |
| 1500 | C0805A152(1)1XA(2) |
| 1800 | C0805A182(1)1XA(2) |
| 2200 | C0805A222(1)1XA(2) |
| 3300 | C0805A332(1)1XA(2) |
| 3900 | C0805A392(1)1XA(2) |
| 4700 | C0805A472(1)1XA(2) |
| 50 V | OLT - BX |
| 5600 | C0805A562(1)5XA(2) |
| 6800 | C0805A682(1)5XA(2) |
| 8200 | C0805A822(1)5XA(2) |
| 10,000 | C0805A103(1)5XA(2) |
| 22,000 | C0805A223(1)5XA(2) |
| 47,000 | C0805A473(1)5XA(2) |
| 25 V | OLT - BX |
| 100,000 | C0805A104(1)3XA(2) |
| | |

(1) Complete KEMET part number by inserting capacitance tolerance, as applicable as shown in ordering information on page 17.

BP CAPACITANCE TOLERANCE: ±1%, ±2%, ±5%, ±10%, ±20% (±0.5pF & ±0.25pF tolerances available 1.0 thru 10pF only) TEMPERATURE CHARACTERISTIC "G" BX CAPACITANCE TOLERANCE: ±5%, ±10%, ±20% TEMPERATURE CHARACTERISTIC "X"

(2) Complete part number by inserting end Metallization, as applicable as shown in ordering information on page 17.

C - Tin-Coated, Final (SolderGuard II)

- H Solder-Coated, Final (SolderGuard I)
- L 70/30 Tin/Lead Plated
- G Gold Plated

| | CAPACITANCE pF | KEMET PART NUMBER | | | | |
|---|-------------------|----------------------|--|--|--|--|
| E | 50 VC | DLT - BX | | | | |
| | 1500 | C0504A152(1)5XA(2) | | | | |
| | 1800 | C0504A182(1)5XA(2) | | | | |
| | 2200 | C0504A222(1)5XA(2) | | | | |
| | 2700 | C0504A272(1)5XA(2) | | | | |
| | 3300 | C0504A332(1)5XA(2) | | | | |
| | 3900 | C0504A392(1)5XA(2) | | | | |
| | 4700 | C0504A472(1)5XA(2 | | | | |
| | 5600 | C0504A562(1)5XA(2 | | | | |
| | 6800 | C0504A682(1)5XA(2 | | | | |
| Ē | | 100000000000000 | | | | |
| | DF | KEMET PART NUMBER | | | | |
| | 200 V | OLT - BP | | | | |
| | 1.0 | C0805A109(1)2GA(2 | | | | |
| | 1.1 | C0805A119(1)2GA(2 | | | | |
| | 1.2 | C0805A129(1)2GA(2 | | | | |
| | 1.5 | C0805A159(1)2GA(2 | | | | |
| | 1.6 | C0805A169(1)2GA(2 | | | | |
| | 1.8 | C0805A189(1)2GA(2 | | | | |
| | 2.0 | C0805A209(1)2GA(2 | | | | |
| | 2.2 | C0805A229(1)2GA(2 | | | | |
| | 2.4 | C0805A249(1)2GA(2 | | | | |
| | 2.7 | C0805A279(1)2GA(2 | | | | |
| | 3.0 | C0805A309(1)2GA(2 | | | | |
| | 3.3 | C0805A339(1)2GA(2 | | | | |
| | 3.6 | C0805A369(1)2GA(2 | | | | |
| | 3.9 | C0805A399(1)2GA(2 | | | | |
| | 4.3 | C0805A439(1)2GA(2 | | | | |
| | 4.7 | C0805A479(1)2GA(2 | | | | |
| | 5.1 | C0805A519(1)2GA(2 | | | | |
| | 5.6 | C0805A569(1)2GA(2 | | | | |
| | 6.2 | C0805A629(1)2GA(2 | | | | |
| | 0.0 | C0805A069(1)2GA(2 | | | | |
| | 8.2 | C0805A829(1)2GA(2 | | | | |
| | 0.2 | C0805A029(1)2GA(2 | | | | |
| | 10.0 | C0805A100(1)2GA(2 | | | | |
| | 11.0 | C0805A110(1)2GA(2 | | | | |
| | 12.0 | C0805A120(1)2GA(2 | | | | |
| | 13.0 | C0805A130(1)2GA(2 | | | | |
| | 15.0 | C0805A150(1)2GA(2 | | | | |
| | 16.0 | C0805A160(1)2GA(2 | | | | |
| | 18.0 | C0805A180(1)2GA(2 | | | | |
| | 20.0 | C0805A200(1)2GA(2 | | | | |
| | 22.0 | C0805A220(1)2GA(2 | | | | |
| | 24.0 | C0805A240(1)2GA(2 | | | | |
| | 27.0 | C0805A270(1)2GA(2 | | | | |
| | 30.0 | C0805A300(1)2GA(2 | | | | |
| | 33.0 | C0805A330(1)2GA(2 | | | | |
| | 36.0 | C0805A360(1)2GA(2 | | | | |
| | 39.0 | C0805A390(1)2GA(2 | | | | |
| | 43.0 | C0805A430(1)2GA(2 | | | | |
| | 47.0 | C0805A470(1)2GA(2 | | | | |
| | 51.0 | C0805A510(1)2GA(2 | | | | |
| | 62.0 | C0805A500(1)2GA(2 | | | | |
| | 75.0 | C0805A750(1)2GA(2 | | | | |
| | 82.0 | C0805A820(1)2GA(2 | | | | |
| | 91.0 | C0805A910(1)2GA(2 | | | | |
| | 100 | C0805A101(1)2GA(2 | | | | |
| | 110 | C0805A111(1)2GA(2 | | | | |
| | 120 | C0805A121(1)2GA(2 | | | | |
| | 130 | C0805A131(1)2GA(2 | | | | |
| | 150 | C0805A151(1)2GA(2 | | | | |
| | 160 | C0805A161(1)2GA(2 | | | | |
| | 180 | C0805A181(1)2GA(2 | | | | |
| | 200 | C0805A201(1)2GA(2 | | | | |
| | 220 | C0805A221(1)2GA(2 | | | | |

| CAPACITANCE | KEMET |
|-------------|--------------------|
| pF | PARTNUMBER |
| 200 V | OLT - BP |
| 1.0 | C0504A109(1)2GA(2) |
| 1.1 | C0504A119(1)2GA(2) |
| 1.2 | C0504A129(1)2GA(2) |
| 1.5 | C0504A169(1)2GA(2) |
| 1.0 | C0504A189(1)2GA(2) |
| 20 | C0504A209(1)2GA(2) |
| 2.2 | C0504A229(1)2GA(2) |
| 2.4 | C0504A249(1)2GA(2) |
| 2.7 | C0504A279(1)2GA(2) |
| 3.0 | C0504A309(1)2GA(2) |
| 3.3 | C0504A339(1)2GA(2) |
| 3.6 | C0504A369(1)2GA(2) |
| 3.9 | C0504A399(1)2GA(2) |
| 4.3 | C0504A439(1)2GA(2) |
| 4.7 | C0504A479(1)2GA(2) |
| 5.1 | C0504A519(1)2GA(2) |
| 5.6 | C0504A569(1)2GA(2) |
| 6.2 | C0504A629(1)2GA(2) |
| 7.5 | C0504A009(1)2GA(2) |
| 82 | C0504A829(1)2GA(2) |
| 91 | C0504A919(1)2GA(2) |
| 10.0 | C0504A100(1)2GA(2) |
| 11.0 | C0504A110(1)2GA(2) |
| 12.0 | C0504A120(1)2GA(2) |
| 13.0 | C0504A130(1)2GA(2) |
| 15.0 | C0504A150(1)2GA(2) |
| 16.0 | C0504A160(1)2GA(2) |
| 18.0 | C0504A180(1)2GA(2) |
| 20.0 | C0504A200(1)2GA(2) |
| 22.0 | C0504A220(1)2GA(2) |
| 24.0 | C0504A240(1)2GA(2) |
| 27.0 | C0504A270(1)2GA(2) |
| 30.0 | C0504A300(1)2GA(2) |
| 33.0 | C0504A330(1)2GA(2) |
| 39.0 | C0504A300(1)2GA(2) |
| 43.0 | C0504A430(1)2GA(2) |
| 47.0 | C0504A470(1)2GA(2) |
| 51.0 | C0504A510(1)2GA(2) |
| 56.0 | C0504A560(1)2GA(2) |
| 62.0 | C0504A620(1)2GA(2) |
| 75.0 | C0504A750(1)2GA(2) |
| 82.0 | C0504A820(1)2GA(2) |
| 100 V | OLT - BP |
| 91.0 | C0504A910(1)1GA(2) |
| 100 | C0504A101(1)1GA(2) |
| 110 | C0504A111(1)1GA(2) |
| 120 | C0504A121(1)1GA(2) |
| 130 | DIT-BP |
| 150 | C0504A151(1)5GA(2) |
| 160 | C0504A161(1)5GA(2) |
| 180 | C0504A181(1)5GA(2) |
| | |
| CAPACITANCE | KEMET |
| pF | PART NUMBER |
| 200 V | OLT - BX |
| 220 | C0504A221(1)2XA(2) |
| 270 | C0504A271(1)2XA(2) |
| 330 | C0504A331(1)2XA(2) |
| 100 V | OLT - BX |
| 360 | C0504A361(1)1XA(2) |

360 390

470

560

680 820

1000 1200 C0504A391(1)1XA(2)

C0504A471(1)1XA(2)

C0504A561(1)1XA(2) C0504A681(1)1XA(2)

C0504A821(1)1XA(2) C0504A102(1)1XA(2)

C0504A122(1)1XA(2)



CERAMIC CHIPS HIGH RELIABILITY GR 900 SERIES (BP/BX DIELECTRIC)

RATINGS AND PART NUMBER REFERENCE STYLE C1005

| CAPACITANCE | KEMET | | | | | | |
|---------------|--------------------|--|--|--|--|--|--|
| pF | PART NUMBER | | | | | | |
| 200 VOLT - BP | | | | | | | |
| 1.0 | C1005A109(1)2GA(2) | | | | | | |
| 1.1 | C1005A119(1)2GA(2) | | | | | | |
| 1.2 | C1005A129(1)2GA(2) | | | | | | |
| 1.5 | C1005A159(1)2GA(2) | | | | | | |
| 1.6 | C1005A169(1)2GA(2) | | | | | | |
| 1.8 | C1005A189(1)2GA(2) | | | | | | |
| 2.0 | C1005A209(1)2GA(2) | | | | | | |
| 2.2 | C1005A229(1)2GA(2) | | | | | | |
| 2.4 | C1005A249(1)2GA(2) | | | | | | |
| 2.7 | C1005A279(1)2GA(2) | | | | | | |
| 3.0 | C1005A309(1)2GA(2) | | | | | | |
| 3.3 | C1005A339(1)2GA(2) | | | | | | |
| 3.6 | C1005A369(1)2GA(2) | | | | | | |
| 3.9 | C1005A399(1)2GA(2) | | | | | | |
| 4.3 | C1005A439(1)2GA(2) | | | | | | |
| 4.7 | C1005A479(1)2GA(2) | | | | | | |
| 5.1 | C1005A519(1)2GA(2) | | | | | | |
| 5.6 | C1005A569(1)2GA(2) | | | | | | |
| 6.8 | C1005A689(1)2GA(2) | | | | | | |
| 7.5 | C1005A759(1)2GA(2) | | | | | | |
| 8.2 | C1005A829(1)2GA(2) | | | | | | |
| 9.1 | C1005A919(1)2GA(2) | | | | | | |
| 10.0 | C1005A100(1)2GA(2) | | | | | | |
| 11.0 | C1005A110(1)2GA(2) | | | | | | |
| 12.0 | C1005A120(1)2GA(2) | | | | | | |
| 13.0 | C1005A130(1)2GA(2) | | | | | | |
| 15.0 | C1005A150(1)2GA(2) | | | | | | |
| 16.0 | C1005A160(1)2GA(2) | | | | | | |
| 18.0 | C1005A180(1)2GA(2) | | | | | | |
| 20.0 | C1005A200(1)2GA(2) | | | | | | |
| 22.0 | C1005A220(1)2GA(2) | | | | | | |
| 24.0 | C1005A240(1)2GA(2) | | | | | | |
| 27.0 | C1005A270(1)2GA(2) | | | | | | |
| 30.0 | C1005A300(1)2GA(2) | | | | | | |
| 33.0 | C1005A330(1)2GA(2) | | | | | | |
| 36.0 | C1005A360(1)2GA(2) | | | | | | |
| 39.0 | C1005A390(1)2GA(2) | | | | | | |
| 43.0 | C1005A430(1)2GA(2) | | | | | | |
| 47.0 | C1005A470(1)2GA(2) | | | | | | |
| 51.0 | C1005A510(1)2GA(2) | | | | | | |
| 56.0 | C1005A560(1)2GA(2) | | | | | | |
| 62.0 | C1005A620(1)2GA(2) | | | | | | |
| 75.0 | C1005A750(1)2GA(2) | | | | | | |
| 82.0 | C1005A820(1)2GA(2) | | | | | | |
| 91.0 | C1005A910(1)2GA(2) | | | | | | |
| 100 | C1005A101(1)2GA(2) | | | | | | |
| 110 | C1005A111(1)2GA(2) | | | | | | |
| 120 | C1005A121(1)2GA(2) | | | | | | |
| 130 | C1005A131(1)2GA(2) | | | | | | |
| 150 | C1005A151(1)2GA(2) | | | | | | |
| 160 | C1005A161(1)2GA(2) | | | | | | |
| 100 | | | | | | | |

| CADACITANCE | KEMET |
|-------------|--------------------|
| CAPACITANCE | |
| рг 200 У | PART NUMBER |
| 200 | |
| 180 | C1005A181(1)2GA(2) |
| 200 | C1005A201(1)2GA(2) |
| 220 | C1005A221(1)2GA(2) |
| 240 | C1005A241(1)2CA(2) |
| 270 | C1005A271(1)2GA(2) |
| 300 | C1005A301(1)2GA(2) |
| 330 | C1005A351(1)2GA(2) |
| 300 | C1005A301(1)2GA(2) |
| 430 | C1005A331(1)2GA(2) |
| 430 | C1005A451(1)2GA(2) |
| 4/0 | |
| 510 | |
| 510 | |
| 500 | C1005A561(1)1GA(2) |
| 620 | |
| 680 | |
| 750 | |
| 620 50 \ | |
| 50 V | |
| 910 | C1005A911(1)5GA(2) |
| 1000 | C1005A102(1)5GA(2) |
| 1100 | C1005A112(1)5GA(2) |
| 1200 | |
| 200 | |
| 330 | C1005A331(1)2XA(2) |
| 390 | C1005A391(1)2XA(2) |
| 470 | |
| 560 | C1005A561(1)2XA(2) |
| 080 | |
| 820 | C1005A821(1)2XA(2) |
| 1200 | C1005A102(1)2XA(2) |
| 1200 | |
| 1900 | |
| 1000 | |
| 2200 | |
| 2200 | |
| 2700 | |
| 3300 | |
| 3900 | |
| 4700 | |
| 6800 | |
| 8200 | |
| 10,000 | |
| 50 V | |
| 12,000 | |
| 12,000 | |
| 18,000 | |
| 22,000 | |
| 22,000 | C TOUSAZZS(HSAAKZ) |

RATINGS AND PART NUMBER REFERENCE STYLE C1206

| CAPACITANCE pF | KEMET PART NUMBER | |
|-------------------|----------------------|--|
| 200 VOLT - BP | | |
| 10.0 | C1206A100(1)2GA(2) | |
| 11.0 | C1206A110(1)2GA(2) | |
| 12.0 | C1206A120(1)2GA(2) | |
| 13.0 | C1206A130(1)2GA(2) | |
| 15.0 | C1206A150(1)2GA(2) | |
| 16.0 | C1206A160(1)2GA(2) | |
| 18.0 | C1206A180(1)2GA(2) | |
| 20.0 | C1206A200(1)2GA(2) | |
| 22.0 | C1206A220(1)2GA(2) | |
| 24.0 | C1206A240(1)2GA(2) | |

| CAPACITANCE pF | KEMET PART NUMBER | | |
|-------------------|----------------------|--|--|
| 200 | 200 VOLT - BP | | |
| 27.0 | C1206A270(1)2GA(2) | | |
| 30.0 | C1206A300(1)2GA(2) | | |
| 33.0 | C1206A330(1)2GA(2) | | |
| 36.0 | C1206A360(1)2GA(2) | | |
| 39.0 | C1206A390(1)2GA(2) | | |
| 43.0 | C1206A430(1)2GA(2) | | |
| 47.0 | C1206A470(1)2GA(2) | | |
| 51.0 | C1206A510(1)2GA(2) | | |
| 56.0 | C1206A560(1)2GA(2) | | |
| 62.0 | C1206A620(1)2GA(2) | | |

(1) Complete KEMET part number by inserting capacitance tolerance, as applicable as shown in ordering information on page 17. BP CAPACITANCE TOLERANCE: ±1%, ±2%, ±5%, ±10%, ±20% (±0.5pF & ±0.25pF tolerances available 1.0 thru 10pF only) TEMPERATURE CHARACTERISTIC "G" BX CAPACITANCE TOLERANCE: ±1%, ±10%, ±20% (±0.5pF & ±0.25pF tolerances available 1.0 thru 10pF only) TEMPERATURE CHARACTERISTIC "G" (2) Complete part number by inserting end Metallization, as applicable as shown in ordering information on page 17.



RATINGS AND PART NUMBER REFERENCE STYLE C1206 (continued)

| CAPACITANCE | KEMET | |
|---------------|--------------------|--|
| pF | PART NUMBER | |
| 200 VOLT - BP | | |
| 68.0 | C1206A680(1)2GA(2) | |
| 75.0 | C1206A750(1)2GA(2) | |
| 82.0 | C1206A820(1)2GA(2) | |
| 91.0 | C1206A910(1)2GA(2) | |
| 100 | C1206A101(1)2GA(2) | |
| 110 | C1206A111(1)2GA(2) | |
| 120 | C1206A121(1)2GA(2) | |
| 130 | C1206A131(1)2GA(2) | |
| 150 | C1206A151(1)2GA(2) | |
| 160 | C1206A161(1)2GA(2) | |
| 180 | C1206A181(1)2GA(2) | |
| 200 | C1206A201(1)2GA(2) | |
| 220 | C1206A221(1)2GA(2) | |
| 240 | C1206A241(1)2GA(2) | |
| 270 | C1206A271(1)2GA(2) | |
| 300 | C1206A301(1)2GA(2) | |
| 330 | C1206A331(1)2GA(2) | |
| 360 | C1206A361(1)2GA(2) | |
| 390 | C1206A391(1)2GA(2) | |
| 430 | C1206A431(1)2GA(2) | |
| 470 | C1206A471(1)2GA(2) | |
| 100 \ | /OLT - BP | |
| 510 | C1206A511(1)1GA(2) | |
| 560 | C1206A561(1)1GA(2) | |
| 620 | C1206A621(1)1GA(2) | |
| 680 | C1206A681(1)1GA(2) | |
| 750 | C1206A751(1)1GA(2) | |
| 820 | C1206A821(1)1GA(2) | |
| 910 | C1206A911(1)1GA(2) | |
| 1000 | C1206A102(1)1GA(2) | |
| 1100 | C1206A112(1)1GA(2) | |
| 1200 | C1206A122(1)1GA(2) | |
| 1300 | C1206A132(1)1GA(2) | |
| 1500 | C1206A152(1)1GA(2) | |
| 1600 | C1206A162(1)1GA(2) | |

| CAPACITANCE | KEMET |
|-------------|--------------------|
| pF | PART NUMBER |
| 50 V | OLT - BP |
| 1800 | C1206A182(1)5GA(2) |
| 2000 | C1206A202(1)5GA(2) |
| 16 V | OLT - BP |
| 4700 | C1206A472(1)4GA(2) |
| 5600 | C1206A562(1)4GA(2) |
| 200 V | OLT - BX |
| 470 | C1206A471(1)2XA(2) |
| 560 | C1206A561(1)2XA(2) |
| 680 | C1206A681(1)2XA(2) |
| 820 | C1206A821(1)2XA(2) |
| 1000 | C1206A102(1)2XA(2) |
| 1200 | C1206A122(1)2XA(2) |
| 1500 | C1206A152(1)2XA(2) |
| 1800 | C1206A182(1)2XA(2) |
| 2200 | C1206A222(1)2XA(2) |
| 2700 | C1206A272(1)2XA(2) |
| 3300 | C1206A332(1)2XA(2) |
| 3900 | C1206A392(1)2XA(2) |
| 4700 | C1206A472(1)2XA(2) |
| 100 V | OLT - BX |
| 5600 | C1206A562(1)1XA(2) |
| 6800 | C1206A682(1)1XA(2) |
| 8200 | C1206A822(1)1XA(2) |
| 10,000 | C1206A103(1)1XA(2) |
| 12,000 | C1206A123(1)1XA(2) |
| 15,000 | C1206A153(1)1XA(2) |
| 50 V | OLT - BX |
| 18,000 | C1206A183(1)5XA(2) |
| 22,000 | C1206A223(1)5XA(2) |
| 27,000 | C1206A273(1)5XA(2) |
| 33,000 | C1206A333(1)5XA(2) |
| 39,000 | C1206A393(1)5XA(2) |
| 47,000 | C1206A473(1)5XA(2) |
| 150,000 | C1206A154(1)5XA(2) |

RATINGS AND PART NUMBER REFERENCE STYLE C1210

| CAPACITANCE | KEMET PART NUMBER | |
|---------------|----------------------|--|
| 200 VOLT - BP | | |
| 10.0 | C1210A100(1)2GA(2) | |
| 11.0 | C1210A110(1)2GA(2) | |
| 12.0 | C1210A120(1)2GA(2) | |
| 13.0 | C1210A130(1)2GA(2) | |
| 15.0 | C1210A150(1)2GA(2) | |
| 16.0 | C1210A160(1)2GA(2) | |
| 18.0 | C1210A180(1)2GA(2) | |
| 20.0 | C1210A200(1)2GA(2) | |
| 22.0 | C1210A220(1)2GA(2) | |
| 24.0 | C1210A240(1)2GA(2) | |
| 27.0 | C1210A270(1)2GA(2) | |
| 30.0 | C1210A300(1)2GA(2) | |
| 33.0 | C1210A330(1)2GA(2) | |
| 36.0 | C1210A360(1)2GA(2) | |
| 39.0 | C1210A390(1)2GA(2) | |
| 43.0 | C1210A430(1)2GA(2) | |
| 47.0 | C1210A470(1)2GA(2) | |
| 51.0 | C1210A510(1)2GA(2) | |
| 56.0 | C1210A560(1)2GA(2) | |
| 62.0 | C1210A620(1)2GA(2) | |
| 68.0 | C1210A680(1)2GA(2) | |
| 75.0 | C1210A750(1)2GA(2) | |
| 82.0 | C1210A820(1)2GA(2) | |
| 91.0 | C1210A910(1)2GA(2) | |
| 100 | C1210A101(1)2GA(2) | |
| 110 | C1210A111(1)2GA(2) | |
| 120 | C1210A121(1)2GA(2) | |

| DF | KEMET PART NUMBER | |
|---------------|----------------------|--|
| 200 VOLT - BP | | |
| 130 | C1210A131(1)2GA(2) | |
| 150 | C1210A151(1)2GA(2) | |
| 160 | C1210A161(1)2GA(2 | |
| 180 | C1210A181(1)2GA(2) | |
| 200 | C1210A201(1)2GA(2 | |
| 220 | C1210A221(1)2GA(2 | |
| 240 | C1210A241(1)2GA(2 | |
| 270 | C1210A271(1)2GA(2) | |
| 300 | C1210A301(1)2GA(2 | |
| 330 | C1210A331(1)2GA(2) | |
| 360 | C1210A361(1)2GA(2 | |
| 390 | C1210A391(1)2GA(2 | |
| 430 | C1210A431(1)2GA(2 | |
| 470 | C1210A471(1)2GA(2 | |
| 510 | C1210A511(1)2GA(2) | |
| 560 | C1210A561(1)2GA(2) | |
| 620 | C1210A621(1)2GA(2 | |
| 680 | C1210A681(1)2GA(2 | |
| 750 | C1210A751(1)2GA(2 | |
| 820 | C1210A821(1)2GA(2) | |
| 910 | C1210A911(1)2GA(2) | |
| 1000 | C1210A102(1)2GA(2) | |

Comprete REME: I part number by inserting capacitance tolerance, as applicable as shown in ordering information on page 17. BP CAPACITANCE TOLERANCE: ±1%, ±2%, ±5%, ±10%, ±20% (±0.5pF & ±0.25pF tolerances available 1.0 thru 10pF only) TEMPERATURE CHARACTERISTIC "G" BX CAPACITANCE TOLERANCE: ±5%, ±10%, ±20% TEMPERATURE CHARACTERISTIC "X"

Complete part number by inserting end Metallization, as applicable as shown in ordering information on page 17. C—Tin-Coated, Final (SolderGuard II) H—Solder-Coated, Final (SolderGuard I) L—70/30 Tin/Lead Plated G—Gold Plated

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CERAMIC CHIPS HIGH RELIABILITY GR 900 SERIES (BP/BX DIELECTRIC)



RATINGS AND PART NUMBER REFERENCE STYLE C1210 (continued)

| 112(1)1GA(2) 122(1)1GA(2) 132(1)1GA(2) 152(1)1GA(2) 162(1)1GA(2) 162(1)1GA(2) |
|--|
| 112(1)1GA(2) 122(1)1GA(2) 132(1)1GA(2) 152(1)1GA(2) 162(1)1GA(2) 162(1)1GA(2) |
| 122(1)1GA(2) 132(1)1GA(2) 152(1)1GA(2) 162(1)1GA(2) 182(1)1GA(2) |
| 132(1)1GA(2) 152(1)1GA(2) 162(1)1GA(2) 182(1)1GA(2) |
| 152(1)1GA(2) 162(1)1GA(2) 182(1)1GA(2) |
| 162(1)1GA(2) 182(1)1GA(2) |
| 162(1)1GA(2) |
| 189(1)1(GA(2) |
| 102111 OALEI |
| 202(1)1GA(2) |
| 222(1)1GA(2) |
| 242(1)1GA(2) |
| 272(1)1GA(2) |
| 302(1)1GA(2) |
| 332(1)1GA(2) |
| |
| 362(1)5GA(2) |
| |
| 103(1)4GA(2) |
| |
| 471(1)2XA(2) |
| 561(1)2XA(2) |
| 681(1)2XA(2) |
| 821(1)2XA(2) |
| 102(1)2XA(2) |
| 122(1)2XA(2) |
| 152(1)2XA(2) |
| 100(1)0VA(2) |
| |

| pF | KEMET PART NUMBER |
|---------|----------------------|
| 200 V | OLT - BX |
| 2200 | C1210A222(1)2XA(2) |
| 2700 | C1210A272(1)2XA(2) |
| 3300 | C1210A332(1)2XA(2) |
| 3900 | C1210A392(1)2XA(2) |
| 4700 | C1210A472(1)2XA(2) |
| 5600 | C1210A562(1)2XA(2) |
| 6800 | C1210A682(1)2XA(2) |
| 8200 | C1210A822(1)2XA(2) |
| 10,000 | C1210A103(1)2XA(2) |
| 100 V | OLT - BX |
| 12,000 | C1210A123(1)1XA(2) |
| 15,000 | C1210A153(1)1XA(2) |
| 18,000 | C1210A183(1)1XA(2) |
| 22,000 | C1210A223(1)1XA(2) |
| 27,000 | C1210A273(1)1XA(2) |
| 33.000 | C1210A333(1)1XA(2) |
| 100,000 | C1210A104(1)1XA(2) |
| 50 VC | OLT - BX |
| 39,000 | C1210A393(1)5XA(2) |
| 47,000 | C1210A473(1)5XA(2) |
| 56,000 | C1210A563(1)5XA(2) |
| 68,000 | C1210A683(1)5XA(2) |
| 82,000 | C1210A823(1)5XA(2) |
| 100,000 | C1210A104(1)5XA(2) |
| 25 VC | DLT - BX |
| 330,000 | C1210A334(1)3XA(2) |
| 16 VC | DLT - BX |
| 470,000 | C1210A474(1)4XA(2) |

RATINGS AND PART NUMBER REFERENCE STYLE C1805

| CAPACITANCE | KEMET |
|-------------|--------------------|
| pF | PART NUMBER |
| 200 V | OLT - BP |
| 220 | C1805A221(1)2GA(2) |
| 240 | C1805A241(1)2GA(2) |
| 270 | C1805A271(1)2GA(2) |
| 300 | C1805A301(1)2GA(2) |
| 330 | C1805A331(1)2GA(2) |
| 360 | C1805A361(1)2GA(2) |
| 390 | C1805A391(1)2GA(2) |
| 430 | C1805A431(1)2GA(2) |
| 470 | C1805A471(1)2GA(2) |
| 100 V | OLT - BP |
| 510 | C1805A511(1)1GA(2) |
| 560 | C1805A561(1)1GA(2) |
| 620 | C1805A621(1)1GA(2) |
| 680 | C1805A681(1)1GA(2) |
| 750 | C1805A751(1)1GA(2) |
| 820 | C1805A821(1)1GA(2) |
| 910 | C1805A911(1)1GA(2) |
| 1000 | C1805A102(1)1GA(2) |
| 1100 | C1805A112(1)1GA(2) |
| 1200 | C1805A122(1)1GA(2) |
| 1300 | C1805A132(1)1GA(2) |
| 1500 | C1805A152(1)1GA(2) |
| 50 VC | OLT - BP |
| 1600 | C1805A162(1)5GA(2) |
| 1800 | C1805A182(1)5GA(2) |
| 2000 | C1805A202(1)5GA(2) |
| 2200 | C1805A222(1)5GA(2) |

| DF | KEMET PART NUMBER |
|--------|----------------------|
| 200 V | OLT - BX |
| 1200 | C1805A122(1)2XA(2) |
| 1500 | C1805A152(1)2XA(2) |
| 1800 | C1805A182(1)2XA(2) |
| 2200 | C1805A222(1)2XA(2) |
| 2700 | C1805A272(1)2XA(2) |
| 3300 | C1805A332(1)2XA(2) |
| 3900 | C1805A392(1)2XA(2) |
| 100 V | OLT - BX |
| 4700 | C1805A472(1)1XA(2) |
| 5600 | C1805A562(1)1XA(2) |
| 6800 | C1805A682(1)1XA(2) |
| 8200 | C1805A822(1)1XA(2) |
| 10,000 | C1805A103(1)1XA(2) |
| 12,000 | C1805A123(1)1XA(2) |
| 15,000 | C1805A153(1)1XA(2) |
| 18,000 | C1805A183(1)1XA(2) |
| 50 V | OLT - BX |
| 18,000 | C1805A183(1)5XA(2) |
| 22,000 | C1805A223(1)5XA(2) |
| 27,000 | C1805A273(1)5XA(2) |
| 33,000 | C1805A333(1)5XA(2) |
| 39,000 | C1805A393(1)5XA(2) |
| 47,000 | C1805A473(1)5XA(2) |

(1) Complete KEMET part number by inserting capacitance tolerance, as applicable as shown in ordering information on page 17.

BP CAPACITANCE TOLERANCE: ±1%, ±2%, ±5%, ±10%, ±20% (±0.5pF & ±0.25pF tolerances available 1.0 thru 10pF only) TEMPERATURE CHARACTERISTIC "G"

BX CAPACITANCE TOLERANCE: ±5%, ±10%, ±20% TEMPERATURE CHARACTERISTIC "X"

(2) Complete part number by inserting end Metallization, as applicable as shown in ordering information on page 17.

C-Tin-Coated, Final (SolderGuard II) H-Solder-Coated, Final (SolderGuard I)

L-70/30 Tin/Lead Plated G-Gold Plated



CERAMIC CHIPS HIGH RELIABILITY GR 900 SERIES (BP/BX DIELECTRIC)

RATINGS AND PART NUMBER REFERENCE STYLE C1808

| CAPACITANCE | KEMET |
|-------------|--------------------|
| pF | PART NUMBER |
| 200 | VOLT - BP |
| 330 | C1808A331(1)2GA(2) |
| 360 | C1808A361(1)2GA(2) |
| 390 | C1808A391(1)2GA(2) |
| 430 | C1808A431(1)2GA(2) |
| 470 | C1808A471(1)2GA(2) |
| 510 | C1808A511(1)2GA(2) |
| 560 | C1808A561(1)2GA(2) |
| 620 | C1808A621(1)2GA(2) |
| 680 | C1808A681(1)2GA(2) |
| 750 | C1808A751(1)2GA(2) |
| 820 | C1808A821(1)2GA(2) |
| 910 | C1808A911(1)2GA(2) |
| 1000 | C1808A102(1)2GA(2) |
| 1100 | C1808A112(1)2GA(2) |
| 1200 | C1808A122(1)2GA(2) |
| 1300 | C1808A132(1)2GA(2) |
| 1500 | C1808A152(1)2GA(2) |
| 100 \ | VOLT - BP |
| 1600 | C1808A162(1)1GA(2) |
| 1800 | C1808A182(1)1GA(2) |
| 2000 | C1808A202(1)1GA(2) |
| 2200 | C1808A222(1)1GA(2) |
| 2400 | C1808A242(1)1GA(2) |
| 2700 | C1808A272(1)1GA(2) |
| 3000 | C1808A302(1)1GA(2) |
| 3300 | C1808A332(1)1GA(2) |
| 3600 | C1808A362(1)1GA(2) |
| 3900 | C1808A392(1)1GA(2) |
| 4300 | C1808A432(1)1GA(2) |
| 4700 | C1808A472(1)1GA(2) |

| | KEMET PART NUMBER |
|---------|----------------------|
| 50 V | /OLT - BP |
| 5100 | C1808A512(1)5GA(2) |
| 5600 | C1808A562(1)5GA(2) |
| 200 \ | VOLT - BX |
| 2200 | C1808A222(1)2XA(2) |
| 2700 | C1808A272(1)2XA(2) |
| 3300 | C1808A332(1)2XA(2) |
| 3900 | C1808A392(1)2XA(2) |
| 4700 | C1808A472(1)2XA(2) |
| 5600 | C1808A562(1)2XA(2) |
| 6800 | C1808A682(1)2XA(2) |
| 8200 | C1808A822(1)2XA(2) |
| 10,000 | C1808A103(1)2XA(2) |
| 100 ' | VOLT - BX |
| 12,000 | C1808A123(1)1XA(2) |
| 15,000 | C1808A153(1)1XA(2) |
| 18,000 | C1808A183(1)1XA(2) |
| 22,000 | C1808A223(1)1XA(2) |
| 27,000 | C1808A273(1)1XA(2) |
| 33,000 | C1808A333(1)1XA(2) |
| 39,000 | C1808A393(1)1XA(2) |
| 47,000 | C1808A473(1)1XA(2) |
| 50 V | /OLT - BX |
| 39,000 | C1808A393(1)5XA(2) |
| 47,000 | C1808A473(1)5XA(2) |
| 56,000 | C1808A563(1)5XA(2) |
| 68,000 | C1808A683(1)5XA(2) |
| 82,000 | C1808A823(1)5XA(2) |
| 100,000 | C1808A104(1)5XA(2) |

RATINGS AND PART NUMBER REFERENCE STYLE C1812

| CAPACITANCE | KEMET | |
|---------------|--------------------|--|
| pF | PART NUMBER | |
| 200 | VOLT - BP | |
| 330 | C1812A331(1)2GA(2) | |
| 360 | C1812A361(1)2GA(2) | |
| 390 | C1812A391(1)2GA(2) | |
| 430 | C1812A431(1)2GA(2) | |
| 470 | C1812A471(1)2GA(2) | |
| 510 | C1812A511(1)2GA(2) | |
| 560 | C1812A561(1)2GA(2) | |
| 620 | C1812A621(1)2GA(2) | |
| 680 | C1812A681(1)2GA(2) | |
| 750 | C1812A751(1)2GA(2) | |
| 820 | C1812A821(1)2GA(2) | |
| 910 | C1812A911(1)2GA(2) | |
| 1000 | C1812A102(1)2GA(2) | |
| 1100 | C1812A112(1)2GA(2) | |
| 1200 | C1812A122(1)2GA(2) | |
| 1300 | C1812A132(1)2GA(2) | |
| 1500 | C1812A152(1)2GA(2) | |
| 1600 | C1812A162(1)2GA(2) | |
| 1800 | C1812A182(1)2GA(2) | |
| 2000 | C1812A202(1)2GA(2) | |
| 2200 | C1812A222(1)2GA(2) | |
| 2400 | C1812A242(1)2GA(2) | |
| 2700 | C1812A272(1)2GA(2) | |
| 100 VOLT - BP | | |
| 3000 | C1812A302(1)1GA(2) | |
| 3300 | C1812A332(1)1GA(2) | |
| 3600 | C1812A362(1)1GA(2) | |
| 3900 | C1812A392(1)1GA(2) | |
| 4300 | C1812A432(1)1GA(2) | |
| 4700 | C1812A472(1)1GA(2) | |
| 5100 | C1812A512(1)1GA(2) | |

| CAPACITANCE | KEMET |
|-------------|--------------------|
| pF | PART NUMBER |
| 100 |) VOLT - BP |
| 5600 | C1812A562(1)1GA(2) |
| 6200 | C1812A622(1)1GA(2) |
| 6800 | C1812A682(1)1GA(2) |
| 50 | VOLT - BP |
| 7500 | C1812A752(1)5GA(2) |
| 8200 | C1812A822(1)5GA(2) |
| 9100 | C1812A912(1)5GA(2) |
| 10,000 | C1812A103(1)5GA(2) |
| 200 | O VOLT - BX |
| 6800 | C1812A682(1)2XA(2) |
| 8200 | C1812A822(1)2XA(2) |
| 10,000 | C1812A103(1)2XA(2) |
| 12,000 | C1812A123(1)2XA(2) |
| 15,000 | C1812A153(1)2XA(2) |
| 18,000 | C1812A183(1)2XA(2) |
| 100 |) VOLT - BX |
| 22,000 | C1812A223(1)1XA(2) |
| 27,000 | C1812A273(1)1XA(2) |
| 33,000 | C1812A333(1)1XA(2) |
| 39,000 | C1812A393(1)1XA(2) |
| 47,000 | C1812A473(1)1XA(2) |
| 56,000 | C1812A563(1)1XA(2) |
| 68,000 | C1812A683(1)1XA(2) |
| 82,000 | C1812A823(1)1XA(2) |
| 50 | VOLT - BX |
| 82,000 | C1812A823(1)5XA(2) |
| 100,000 | C1812A104(1)5XA(2) |
| 120,000 | C1812A124(1)5XA(2) |
| 150,000 | C1812A154(1)5XA(2) |
| 180,000 | C1812A184(1)5XA(2) |



CERAMIC CHIPS HIGH RELIABILITY GR 900 SERIES (BP/BX DIELECTRIC)

RATINGS AND PART NUMBER REFERENCE STYLE C1825

| | CAPACITANCE | KEMET |
|---------------|-------------|--------------------|
| | pF | PART NUMBER |
| 200 VOLT - BP | | |
| | 2700 | C1825A272(1)2GA(2) |
| | 3000 | C1825A302(1)2GA(2) |
| | 3300 | C1825A332(1)2GA(2) |
| | 3600 | C1825A362(1)2GA(2) |
| | 3900 | C1825A392(1)2GA(2) |
| | 4300 | C1825A432(1)2GA(2) |
| | 4700 | C1825A472(1)2GA(2) |
| | 5100 | C1825A512(1)2GA(2) |
| | 5600 | C1825A562(1)2GA(2) |
| | 100 | VOLT - BP |
| | 6200 | C1825A622(1)1GA(2) |
| | 6800 | C1825A682(1)1GA(2) |
| | 7500 | C1825A752(1)1GA(2) |
| | 8200 | C1825A822(1)1GA(2) |
| | 9100 | C1825A912(1)1GA(2) |
| | 10,000 | C1825A103(1)1GA(2) |
| | 11,000 | C1825A113(1)1GA(2) |
| | 12,000 | C1825A123(1)1GA(2) |
| | 13,000 | C1825A133(1)1GA(2) |
| | 15,000 | C1825A153(1)1GA(2) |
| | 16,000 | C1825A163(1)1GA(2) |
| | 18,000 | C1825A183(1)1GA(2) |
| | 50 V | OLT - BP |
| | 20,000 | C1825A203(1)5GA(2) |
| | 22 000 | C1825A223(1)5GA(2) |

| CAPACITANCE | KEMET |
|---------------|--------------------|
| pF | PART NUMBER |
| 200 | VOLT - BX |
| 10,000 | C1825A103(1)2XA(2) |
| 12,000 | C1825A123(1)2XA(2) |
| 15,000 | C1825A153(1)2XA(2) |
| 18,000 | C1825A183(1)2XA(2) |
| 22,000 | C1825A223(1)2XA(2) |
| 33,000 | C1825A333(1)2XA(2) |
| 39,000 | C1825A393(1)2XA(2) |
| 47,000 | C1825A473(1)2XA(2) |
| 100 VOLT - BX | |
| 56,000 | C1825A563(1)1XA(2) |
| 68,000 | C1825A683(1)1XA(2) |
| 82,000 | C1825A823(1)1XA(2) |
| 100,000 | C1825A104(1)1XA(2) |
| 120,000 | C1825A124(1)1XA(2) |
| 150,000 | C1825A154(1)1XA(2) |
| 180,000 | C1825A184(1)1XA(2) |
| 50 VOLT - BX | |
| 180,000 | C1825A184(1)5XA(2) |
| 220,000 | C1825A224(1)5XA(2) |
| 270,000 | C1825A274(1)5XA(2) |
| 330,000 | C1825A334(1)5XA(2) |
| 390,000 | C1825A394(1)5XA(2) |
| 470,000 | C1825A474(1)5XA(2) |

RATINGS AND PART NUMBER REFERENCE STYLE C2225

| CAPACITANCE | KEMET |
|-------------|--------------------|
| pF | PART NUMBER |
| 200 | VOLT - BP |
| 2700 | C2225A272(1)2GA(2) |
| 3000 | C2225A302(1)2GA(2) |
| 3300 | C2225A332(1)2GA(2) |
| 3600 | C2225A362(1)2GA(2) |
| 3900 | C2225A392(1)2GA(2) |
| 4300 | C2225A432(1)2GA(2) |
| 4700 | C2225A472(1)2GA(2) |
| 5100 | C2225A512(1)2GA(2) |
| 5600 | C2225A562(1)2GA(2) |
| 6200 | C2225A622(1)2GA(2) |
| 6800 | C2225A682(1)2GA(2) |
| 7500 | C2225A752(1)2GA(2) |
| 8200 | C2225A822(1)2GA(2) |
| 100 | VOLT - BP |
| 9100 | C2225A912(1)1GA(2) |
| 10,000 | C2225A103(1)1GA(2) |
| 11,000 | C2225A113(1)1GA(2) |
| 12,000 | C2225A123(1)1GA(2) |
| 13,000 | C2225A133(1)1GA(2) |
| 15,000 | C2225A153(1)1GA(2) |
| 16,000 | C2225A163(1)1GA(2) |
| 18,000 | C2225A183(1)1GA(2) |
| 20,000 | C2225A203(1)1GA(2) |
| 22,000 | C2225A223(1)1GA(2) |
| 50 \ | /OLT - BP |
| 24,000 | C2225A243(1)5GA(2) |
| 27,000 | C2225A273(1)5GA(2) |
| 33,000 | C2225A333(1)5GA(2) |

| CAPACITANCE | KEMET |
|-------------|--------------------|
| pF | PART NUMBER |
| 200 | VOLT - BX |
| 18,000 | C2225A183(1)2XA(2) |
| 22,000 | C2225A223(1)2XA(2) |
| 27,000 | C2225A273(1)2XA(2) |
| 33,000 | C2225A333(1)2XA(2) |
| 39,000 | C2225A393(1)2XA(2) |
| 47,000 | C2225A473(1)2XA(2) |
| 100 | VOLT - BX |
| 56,000 | C2225A563(1)1XA(2) |
| 68,000 | C2225A683(1)1XA(2) |
| 82,000 | C2225A823(1)1XA(2) |
| 100,000 | C2225A104(1)1XA(2) |
| 120,000 | C2225A124(1)1XA(2) |
| 150,000 | C2225A154(1)1XA(2) |
| 180,000 | C2225A184(1)1XA(2) |
| 50 \ | /OLT - BX |
| 220,000 | C2225A224(1)5XA(2) |
| 270,000 | C2225A274(1)5XA(2) |
| 330,000 | C2225A334(1)5XA(2) |
| 390,000 | C2225A394(1)5XA(2) |
| 470,000 | C2225A474(1)5XA(2) |
| 560,000 | C2225A564(1)5XA(2) |
| 680,000 | C2225A684(1)5XA(2) |
| 820,000 | C2225A824(1)5XA(2) |
| 1,000,000 | C2225A105(1)5XA(2) |

(1) Complete KEMET part number by inserting capacitance tolerance, as applicable as shown in ordering information on page 17. **BP CAPACITANCE TOLERANCE:** ±1%, ±2%, ±5%, ±10%, ±20% (±0.5pF & ±0.25pF tolerances available 1.0 thru 10pF only) TEMPERATURE CHARACTERISTIC "G" **BX CAPACITANCE TOLERANCE:** ±5%, ±10%, ±20% TEMPER-ATURE CHARACTERISTIC "X"

(2) Complete part number by inserting end Metallization, as applicable as shown in ordering information on page 17.



Overview

KEMET's High Temperature surface mount COG Multilayer Ceramic Capacitors (MLCCs) are constructed of a robust and proprietary COG/NPO base metal electrode (BME) dielectric system that offers industry-leading performance at extreme temperatures up to 200°C. These devices are specifically designed to withstand the demands of harsh industrial environments such as down-hole oil exploration and automotive/avionics engine compartment circuitry.

KEMET's High Temperature COG capacitors are temperature compensating and are well suited for resonant circuit applications or those where Q and stability of capacitance characteristics are required. They exhibit no change in capacitance with respect to time and voltage and boast a negligible change in capacitance with reference to ambient temperature. Capacitance change is limited to ±30ppm/°C from -55°C to +200°C. In addition, these capacitors exhibit high insulation resistance with low dissipation factor at elevated temperatures up to 200°C. They also exhibit low ESR at high frequencies and offer greater volumetric efficiency over competitive high temperature precious metal electrode (PME) and BME ceramic capacitor devices.

These devices are Lead (Pb)-Free, RoHS and REACH compliant without the need of any exemptions.



Ordering Information

| С | 1210 | Н | 124 | J | 5 | G | Α | С | TU |
|---------|--|------------------------------------|---|---|--|------------|-------------------------|---|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance ¹ | Voltage | Dielectric | Failure Rate/ Design | Termination Finish ² | Packaging/ Grade (C-Spec) |
| | 0402 0603 0805 1206 1210 1812 2220 | H = High temperature (200°C) | Two significant digits + number of zeros. Use 9 for 1.0 – 9.9 pF Use 8 for 0.5 – 0.99 pF e.g., 2.2 pF = 229 e.g., 0.5 pF = 508 | $B = \pm 0.10 \text{ pF}$ $C = \pm 0.25 \text{ pF}$ $D = \pm 0.5 \text{ pF}$ $F = \pm 1\%$ $G = \pm 2\%$ $J = \pm 5\%$ $K = \pm 10\%$ $M = \pm 20\%$ | 8 = 10 V 4 = 16 V 3 = 25 V 5 = 50 V 1 = 100 V 2 = 200 V | G = COG | A = N/A | C = 100% Matte Sn L = SnPb (5% Pb minimum) E = Gold (Au) 1.97 - 11.8 µin F = Gold (Au) 30 - 70 µin G = Gold (Au) 100 µin minimum | See "Packaging C-Spec Ordering Options Table" below |

¹ Additional capacitance tolerance offerings may be available. Contact KEMET for details.

² Additional termination finish options may be available. Contact KEMET for details.

Built Into Tomorrow



Benefits

- -55°C to +200°C operating temperature range
- Lead (Pb)-free, RoHS and REACH compliant
- EIA 0402, 0603, 0805, 1206, 1210, 1812, and 2220 case sizes
- DC voltage ratings of 10 V, 16 V, 25 V, 50 V, 100 V, and 200 V
- · Capacitance offerings ranging from 0.5 pF up to 470 nF
- Available capacitance tolerances of ±0.10 pF, ±0.25 pF, ±0.5 pF, ±1%, ±2%, ±5%, ±10% or ±20%
- No piezoelectric noise
- Extremely low ESR and ESL
- · High thermal stability
- · High ripple current capability

- Preferred capacitance solution at line frequencies and into the MHz range
- No capacitance change with respect to applied rated DC voltage
- Negligible capacitance change with respect to temperature from -55°C to +200°C
- No capacitance decay with time
- Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish allowing for excellent solderability
- Gold (Au), Tin/Lead (Sn/Pb) and 100% pure matte Tin (Sn) termination finishes available

Applications

Typical applications include critical timing, tuning, circuits requiring low loss, circuits with pulse, high current, decoupling, bypass, filtering, transient voltage suppression, blocking and energy storage for use in extreme environments such as downhole exploration, aerospace engine compartments and geophysical probes.



Packaging C-Spec Ordering Options Table

| Termination Finish Options | Packaging Type/Options | Packaging Ordering Code (C-Spec) |
|---|--|---|
| | Standard Packaging – Unmarked ³ | |
| | Bulk Bag | Blank ¹ |
| | Waffle Tray ² | 7292 |
| | 7" Tape & Reel | TU |
| C = 100% Matte Sn | 13" Reel | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) |
| L = SnPb (5% Pb min.) | 7" Tape & Reel/2 mm pitch ⁴ | 7081 |
| $F = Gold (Au) 30 - 70 \mu minimum G = Gold (Au) 100 uin minimum$ | 7" Tape & Reel – 50 pieces | T050 |
| | 7" Tape & Reel – 100 pieces | T100 |
| | 7" Tape & Reel – 250 pieces | T250 |
| | 7" Tape & Reel – 500 pieces | T500 |
| | 7" Tape & Reel – 1,000 pieces | Т1К0 |
| Ν | Aoisture Sensitive Packaging⁵ – Unmarked | 3 |
| | Waffle Tray ² | 7282 |
| | 7" Tape & Reel | 7130 |
| F = Gold (Au) 1 97 – 11 8 uin | 7" Tape & Reel – 50 pieces | |
| $F = Gold (Au) 30 - 70 \mu in$ | 7" Tape & Reel – 100 pieces | |
| G = Gold (Au) 100 µin minimum | 7" Tape & Reel – 250 pieces | Contact KEMET ⁶ |
| | 7" Tape & Reel – 500 pieces | |
| | 7" Tape & Reel – 1,000 pieces | |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ "Bulk Bag" packaging option is not available for Gold (Au) termination finish options and case sizes larger than 2225 (5664 Metric).

² "Waffle Tray" packaging option is not available for case sizes larger than 2225 (5664 Metric).

³ The terms "Marked" and "Unmarked" pertain to laser marking option of components. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices.

³ Reeling quantities are dependent upon chip size and thickness dimension. When ordering using the "T1K0" packaging option, 1812 through 2225 case size devices with chip thickness of ≥ 1.9 mm (nominal) may be shipped on multiple 7" reels or a single 13" reel. Additional reeling or packaging options may be available. Contact KEMET for details.

⁴ The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

 $^{\rm 5}$ Moisture sensitive packaging is required for Gold (Au) termination option "E" (1.97 – 11.8 $\mu in)$

⁶ Additional reeling or packaging options may be available. Contact KEMET for details.



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|----------------------------|---------------------------------|
| 0402 | 1005 | 1.00 (0.040) ±0.05 (0.002) | 0.50 (0.020) ±0.05 (0.002) | | 0.30 (0.012) ±0.10 (0.004) | 0.30 (0.012) | Solder Reflow Only |
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | |
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave or Solder Reflow |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | See Table 2 for Thickness | 0.50 (0.02) ±0.25 (0.010) | | |
| 1210 | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | N / A | |
| 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | | 0.60 (0.024) ±0.35 (0.014) | N/A | Solder Reflow Only |
| 2220 | 5650 | 5.70 (0.224) ±0.40 (0.016) | 5.00 (0.197) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | |



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +200°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±30 ppm/°C (up to 200°C) |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 0% |
| ¹ Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5±1 seconds and charge/discharge not exceeding 50 mA) |
| ² Dissipation Factor (DF) Maximum Limit at 25°C | 0.1% |
| ³ Insulation Resistance (IR) Minimum Limit at 25°C | 1,000 megohm microfarads or 100 GΩ (Rated voltage applied for 120±5 seconds at 25°C) |

¹ DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

² Capacitance and dissipation factor (DF) measured under the following conditions:

1 MHz ±100 kHz and 1.0 ±0.2 Vrms if capacitance ≤ 1,000 pF

1 kHz ±50 Hz and 1.0 ±0.2 Vrms if capacitance > 1,000 pF

³ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 & Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

Post Environmental Limits

| High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | | | |
|---|---------------------|----------------------|-----------------------------------|----------------------|--------------------------|--|--|--|--|--|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | | | | | |
| COG | All | All | 0.5 | 0.3% or ±0.25 pF | 10% of Initial Limit | | | | | |



Electrical Characteristics

Delta Cap vs. Temperature (Typical)



Capacitance vs. Temperature with 25 V DC Bias (Rated Voltage)



IR vs. Temperature with 25 V DC Bias (Rated Voltage)



C1210H104J1GAC - Life Test IR Distribution (Lognormal)



DF vs. Temperature without DC Bias.



BME vs. PME/IR vs. Temperature with 25 V DC Bias (Rated Voltage)





Table 1A - Capacitance Range/Selection Waterfall (0402 - 1206 Case Sizes)

| | | 0 | Case Size / Series | | | | C |)40 | 2H | | | (| C06 | 03 | н | | | (| C08 | 05ł | ł. | | | (| C12 | 06H | I | | | | | |
|--------------------------------|--------------------------|---|--------------------|-------|-------|-------|------|-----|----|---------------------------------------|---------------------------------------|----------|-----|-----|----|-----|-----|-------|------------|---------|-------|--------|------|------|------|-----|----|----|----------|-----|-----|-----|
| Canacitanco | Сар | | | Vo | oltag | je Co | de | | | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 2 | 8 | 4 | 3 | 5 | 1 | 2 | 8 | 4 | 3 | 5 | 1 | 2 |
| Capacitance | Code | | R | ated | Vol | tage | (VD | C) | | 9 | 16 | 25 | 50 | 100 | 9 | 16 | 25 | 50 | 100 | 200 | 9 | 16 | 25 | 50 | 100 | 200 | 10 | 16 | 25 | 50 | 100 | 200 |
| | | | Cap | oacit | and | e To | oler | anc | е | | | | | | | Pro | duc | t Ava | ilabi | ility a | and (| Chip ' | Thic | knes | s Co | des | | | | | | |
| 0.5 & 0.75 pF | 508 & 758 | В | C | D | | | | | | BB | BB | BB | BB | | CF | CF | CF | CF | 2 10 CF | CF | DN | DN | DN | DN | DN | DN | | | | | | |
| 1.0 - 9.0 pF* | 109 - 919* | В | С | D | | | | | | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB |
| 10 - 91 pF* | 100 - 910* | | | | F | G | J | K | M | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB |
| 100 - 180 pF* 200 - 430 pF* | 101 - 181* 201 - 431* | | | | F | G | J | ĸ | M | BB | BB | BB | BB | BB | | | CF | CF | CF | CF | | | | | | | EB | EB | EB | EB | EB | EB |
| 470 pF | 471 | | | | F | G | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DN | DP | EB | EB | EB | EB | EB | EB |
| 510 pF | 511 | | | | F | G | J | к | м | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB |
| 560 pF | 561 | | | | F | G | J | к | М | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB |
| 620 pF | 621 | | | | F | G | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB |
| 680 pF | 681 751 | | | | F | G | J | ĸ | M | BB | BB | BB | BB | BB | | CF | CF | CF | CF | | | DN | DN | | | DN | EB | EB | EB | EB | EB | EB |
| 820 nF | 821 | | | | F | G | J | ĸ | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | | | DN | | | | | FB | FB | FB | FB | FB | FB |
| 910 pF | 911 | | | | F | G | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DP | DP | EB | EB | EB | EB | EB | EB |
| 1,000 pF | 102 | | | | F | G | J | к | М | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DP | DP | EB | EB | EB | EB | EB | EE |
| 1,100 pF | 112 | | | | F | G | J | Κ | М | BB | BB | BB | BB | | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DN | | EB | EB | EB | EB | EB | EB |
| 1,200 pF | 122 | | | | F | G | J | K | M | BB | BB | BB | BB | | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DN | | EB | EB | EB | EB | EB | EB |
| 1,300 pF | 132 | | | | | G | J | ĸ | M | B B B B B B B B B B B B B B B B B B B | B B B B B B B B B B B B B B B B B B B | RR RR | BB | | | | | | | | | | | | | | EB | EB | EB | EB | EC | EC |
| 1,500 pF | 162 | | | | F | G | J | ĸ | M | | | | | | CF | CF | CF | CF | CF | | DP | DP | DP | DP | | | FB | FB | FB | FB | FD | FD |
| 1,800 pF | 182 | | | | F | G | J | ĸ | M | | | | | | CF | CF | CF | CF | CF | | DP | DP | DP | DP | DP | | EB | EB | EB | EB | ED | ED |
| 2,000 pF | 202 | | | | F | G | J | Κ | М | | | | | | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DN | | EB | EB | EB | EB | ED | ED |
| 2,200 pF | 222 | | | | F | G | J | К | М | | | | | | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DN | | EB | EB | EB | EB | EE | EE |
| 2,400 pF | 242 | | | | F | G | J | K | M | | | | | | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DN | | EB | EB | EB | EB | EC | EC |
| 2,700 pF | 2/2 | | | | | G | J | ĸ | M | | | | | | | | | | | | | | | | | | EB | EB | EB | EC | EC | EC |
| 3,300 pF | 302 | | | | F | G | J | K | M | | | | | | CF | CF | CF | CF | CF | | DP | DP | DP | DP | DN | | EC | EC | EC | EC | EE | |
| 3,600 pF | 362 | | | | F | G | J | ĸ | M | | | | | | CF | CF | CF | CF | CF | | DP | DP | DP | DP | DN | | EC | EC | EC | EC | EE | |
| 3,900 pF | 392 | | | | F | G | J | К | М | | | | | | CF | CF | CF | CF | CF | | DE | DE | DE | DE | DN | | EC | EC | EC | EC | EF | |
| 4,300 pF | 432 | | | | F | G | J | К | М | | | | | | CF | CF | CF | CF | CF | | DE | DE | DE | DE | DN | | EC | EC | EC | EC | EC | |
| 4,700 pF | 472 | | | | F | G | J | K | M | | | | | | CF | CF | CF | CF | CF | | DE | DE | DE | DE | DN | | EC | EC | EC | EC | EC | |
| 5,100 pF | 512 | | | | F | G | J | ĸ | M | | | | | | | CF | CF | CF | | | | | | | | | | ED | ED | ED | ED | |
| 6.200 pF | 622 | | | | F | G | J | ĸ | M | | | | | | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | | EB | EB | EB | EB | EB | |
| 6,800 pF | 682 | | | | F | G | J | K | M | | | | | | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | | EB | EB | EB | EB | EB | |
| 7,500 pF | 752 | | | | F | G | J | К | М | | | | | | CF | CF | CF | | | | DN | DN | DN | DN | DN | | EB | EB | EB | EB | EB | |
| 8,200 pF | 822 | | | | F | G | J | K | M | | | | | | CF | CF | CF | | | | DN | DN | DN | DN | DN | | EC | EC | EC | EC | EB | |
| 9,100 pF | 912 | | | | F | G | J | K | M | | | | | | CF | CF | CF | | | | DN | DN | DN | | DN | | EC | EC | EC | EC | EB | |
| 10,000 pF 12 000 pF | 103 | | | | F | G | J | ĸ | M | | | | | | UF | UF | UF | | | | | | | | DF | | FR | FR | FR | FR | FR | |
| 15,000 pF | 153 | | | | F | G | J | ĸ | M | | | | | | | | | | | | DN | DN | DN | DP | DG | | EB | EB | EB | EB | EB | |
| 18,000 pF | 183 | | | | F | G | J | К | М | | | | | | | | | | | | DN | DN | DN | DP | | | EB | EB | EB | EB | EB | |
| 22,000 pF | 223 | | | | F | G | J | К | М | | | | | | | | | | | | DP | DP | DP | DF | | | EB | EB | EB | EB | EC | |
| 27,000 pF | 273 | | | | F | G | J | K | M | | | | | | | | | | | | DF | DF | DF | | | | EB | EB | EB | EB | EE | |
| 33,000 pF 39,000 pF | 333 | | | | F | G | J | ĸ | M | | | | | | | | | | | | | | DG | | | | EB | EB | EB | EB | EE | |
| 47,000 pF | 473 | | | | F | G | J | K | M | | | | | | | | | | | | DG | DG | DG | | | | EC | EC | EC | EE | EH | |
| 56,000 pF | 563 | | | | F | G | J | K | M | | | | | | | | | | | | | | - | | | | ED | ED | ED | EF | | |
| 68,000 pF | 683 | | | | F | G | J | K | М | | | | | | | | | | | | | | | | | | EF | EF | EF | EH | | |
| 82,000 pF | 823 | | | | F | G | J | K | M | | | | | | | | | | | | | | | | | | EH | EH | EH | EH | | |
| 0.10 μF | 104 | | | | F | G | J | K | M | | | 10 | _ | - | | | 10 | - | - | - | | | | - | - | 0 | | EH | EH 10 | _ | | - |
| | | | F | ated | Vol | tage | (VD | C) | | μĔ | 1 | 5 | 50 | 9 | μ¥ | ž | 5 | 50 | 9 | 20 | 12 | 1 | 5 | 5(| 9 | 20 | Ĕ | 1 | 5 | 5(| 9 | 20 |
| Capacitance | Cap Code | | | Vo | oltag | je Co | de | | | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 2 | 8 | 4 | 3 | 5 | 1 | 2 | 8 | 4 | 3 | 5 | 1 | 2 |
| | | | (| ase | Siz | e / S | Seri | es | | | C | 0402 | 2H | | | | C06 | 03H | | | | | C08 | 05H | | | | | C12 | 06H | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).

These products are protected under US Patents 7,172,985 and 7,670,981, other patents pending, and any foreign counterparts.



Table 1B - Capacitance Range/Selection Waterfall (1210 - 2220 Case Sizes)

| Capacitance Cap (and voltage (VDC)) Value (Value (Val | | | | Case Size / Series | | | | | C1210H | | | | | C1812H | | | | | С2220Н | | | | | | | | | |
|--|---------------|--------------------|----------|---------------------|------|--------|-------|------|--------|-----|----|--------|----|--------|--------|-----------------------|------------------|-----------------|-----------------|-----------------|----------------|-------------------|----------------|----------|----|----|--------|-----|
| Capacitance Code Rated Voltage (VDC) P < | Conscitones | Сар | | | v | oltag | e Co | de | | | 8 | 4 | 3 | 5 | 1 | 2 | 8 | 4 | 3 | 5 | 1 | 2 | 8 | 4 | 3 | 5 | 1 | 2 |
| Capacitance Tolerance Capacitance Tolerance Product Availability | Capacitance | Code | | | Rate | d Volt | tage | (VDC |) | | 5 | 16 | 25 | 50 | 100 | 200 | 10 | 16 | 25 | 50 | 100 | 200 | 10 | 16 | 25 | 50 | 100 | 200 |
| 0.58.075pf 508.275p 508.275p 60.2 0 <th0< th=""> <th0< t<="" th=""><th></th><th></th><th></th><th>C</th><th>apac</th><th>itanc</th><th>e Tol</th><th>eran</th><th>ce</th><th></th><th></th><th>,</th><th></th><th></th><th>Pr</th><th>oduci</th><th>t Avai ahle 2</th><th>labili for (</th><th>ty an Chin 1</th><th>d Chij Chick</th><th>p Thio</th><th>knes Dime</th><th>s Coo nsion</th><th>les s</th><th></th><th></th><th></th><th></th></th0<></th0<> | | | | C | apac | itanc | e Tol | eran | ce | | | , | | | Pr | oduci | t Avai ahle 2 | labili for (| ty an Chin 1 | d Chij Chick | p Thio | knes Dime | s Coo nsion | les s | | | | |
| 10.0.91 pF* 100.919* 10 10.0.91 pF* 100.919 F 6 J K M F8 | 0.5 & 0.75 pF | 508 & 758 | В | С | D | | | | | | | | | | | | | | | | | | | <u> </u> | | | | |
| 100-910 pF* 100-910 pF 100-910 pF 100-910 pF 100-910 pF 100 pF | 1.0 - 9.1 pF* | 109 - 919* | В | C | D | | | | | | FB | FB | FB | FB | FB | FB | | | | | | | | | | | | |
| 100-910 pF* 101-911* F G J K M FB FB <td>10 - 91 pF*</td> <td>100 - 910*</td> <td></td> <td></td> <td></td> <td>F</td> <td>G</td> <td>J</td> <td>K</td> <td>M</td> <td>FB</td> <td>FB</td> <td>FB</td> <td>FB</td> <td>FB</td> <td>FB</td> <td></td> | 10 - 91 pF* | 100 - 910* | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | | | | | | | | | | | | |
| 1.000 pF 102 Image: book product of the state of the | 100 - 910 pF* | 101 - 911* | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | | | | | | | | | | | | |
| 1,000 pF 112 F G J K M FB < | 1,000 pF | 102 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | | | | | | | | | | | | |
| 1,200 pF 122 122 F 6 J K M P8 | 1,100 pF | 112 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | | | | | | | | | | | | |
| 1.300 pF 132 132 F G J K M F8 | 1,200 pF | 122 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | | | | | | | | | | | | |
| 1.300 pF 152 F 6 J K M FB FB FB FE F | 1,300 pF | 132 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FC | | | | | | | | | | | | |
| 1.000 pF 162 Image: Free G image: Free | 1,500 pF | 152 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FE | | | | | | | | | | | | |
| 1,200 pF 102 F 6 J K M FB < | 1,600 pF | 162 | | - | | F | G | J | K | M | FB | FB | FB | FB | FB | FE | | | | | | | | | | | | |
| 2.000 pF 2.02 F G J K M PB PB PB PE FE | 1,800 pF | 182 | | | | | G | J | K | M | FR | FR | FB | FR | FB | FE | | | | | | | | | | | | |
| 2.400 pF 2.22 F G J K M P8 P8 P6 | 2,000 pF | 202 | | | | | G | J | K | M | FR | FR | FB | FR | FC | FE | | | | | | | | | | | | |
| 2,400 pF 242 PF G J K M PB PB PB PB PB PE | 2,200 pF | 222 | | | | | G | J | K | M | FR | FR | FB | FR | FC | FG | | | | | | | | | | | | |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $ | 2,400 pF | 242 | | | | | 6 | J | K | IM | FB | FB | FB | FB | FC | FC | | | | | | | | | | | | |
| 3.000 μF 3.32 F G J K M Fb | 2,700 pF | 2/2 | | | | F | G | J | N K | IVI | | FD | FD | FD | FC | FU | | | | | | | | | | | | |
| 3.500 µF 3.32 F G J K M Fb | 3,000 pF | 302 | | | | | C | J | | | | | | | | | | | | | | | | | | | | |
| 3,000 pF 302 F G J K M PB PB PB PB PF FF < | 3,300 µF | 332 | | | | | C | J | | | | | | | | | | | | | | | | | | | | |
| 3,500 μ ¹ 322 i < | 3,000 pF | 202 | | | | | G | J | R R | M | | | | | | | | | | | | | | | | | | |
| 4,300 µr 432 Fr 6 3 K M FF FF FF F6 | 3,900 pF | 122 | | | | | G | J | | M | | | | | | | | | | | | | | | | | | |
| 47.00 µL 47.2 F G J K M F <th< td=""><td>4,300 pF</td><td>432</td><td></td><td></td><td></td><td>F</td><td>G</td><td>J</td><td>K</td><td>M</td><td>FE</td><td>FE</td><td>FE</td><td>FE</td><td>FG</td><td>FG</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></th<> | 4,300 pF | 432 | | | | F | G | J | K | M | FE | FE | FE | FE | FG | FG | | | | | | | | | | | | |
| 5,000 pF 552 F G J K M FB < | 5 100 pF | 512 | | | | F | G | 1 | ĸ | M | FR | FR | FR | FR | FG | FG | | | | | | | | | | | | |
| 6,000 pF 622 6 0 K M PB FB | 5,600 pF | 562 | | | | F | G | 1 | K | M | FR | FR | FR | FR | FG | FG | | | | | | | | | | | | |
| 6,800 pF 682 7 6 3 K M FB FC < | 6 200 pF | 622 | | | | F | G | Ĭ | ĸ | M | FR | FR | FR | FR | FG | 10 | | | | | | | | | | | | |
| 3.000 pF 752 752 F 6 J K M FC | 6 800 pF | 682 | | | | F | G | J | ĸ | M | FR | FR | FR | FR | FG | | | | | | | | | | | | | |
| 8,200 pF 822 F G J K M FC | 7,500 pF | 752 | | _ | | F | G | J | ĸ | M | FC | FC | FC | FC | FC | | | | | | | | | | | | | |
| 9,100 pF 9,100 pF 10,000 pF 123 12,000 pF 123 15 12,000 pF 123 15 15 15 15 12,000 pF 153 15 15 15 15 15 15 15 15 15 15 | 8 200 pF | 822 | | | | F | G | J | ĸ | м | FC | FC | FC | FC | FC | | | | | | | | | | | | | |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $ | 9.100 pF | 912 | | | | F | G | J | ĸ | M | FE | FE | FE | FE | FE | | | | | | | | | | | | | |
| 12.000 pF 123 Image: constraint of the state of | 10.000 pF | 103 | | | | F | G | J | K | M | FF | FF | FF | FF | FF | | | | | | | | | | | | | |
| 15,000 pF 153 F G J K M FG | 12.000 pF | 123 | | | | F | G | J | K | M | FG | FG | FG | FG | FB | | | | | | | | | | | | | |
| 18,000 pF 183 F G J K M FB FB FB FB FB FB FB FB GB | 15,000 pF | 153 | | | | F | G | J | K | М | FG | FG | FG | FG | FB | | GB | GB | GB | GB | GB | | | | | | | |
| 22,000 pF 223 F G J K M FB FB FB FB FB FB GB | 18,000 pF | 183 | | | | F | G | J | К | М | FB | FB | FB | FB | FB | | GB | GB | GB | GB | GB | | | | | | | |
| 27,000 pF 273 S F G J K M FB FB FB FB FB FB FB FB GB | 22,000 pF | 223 | | | | F | G | J | К | М | FB | FB | FB | FB | FB | | GB | GB | GB | GB | GB | | | | | | | |
| 33,000 pF 333 Image: Find the f | 27,000 pF | 273 | | | | F | G | J | К | М | FB | FB | FB | FB | FB | | GB | GB | GB | GB | GB | | | | | | | |
| 39,000 pF 393 4 F G J K M FB | 33,000 pF | 333 | | | | F | G | J | K | М | FB | FB | FB | FB | FB | | GB | GB | GB | GB | GB | | | | | | | |
| 47,000 pF 473 F G J K M FB | 39,000 pF | 393 | | | | F | G | J | K | M | FB | FB | FB | FB | FE | | GB | GB | GB | GB | GB | | | | | | | |
| 56,000 pF 563 F G J K M FB | 47,000 pF | 473 | | | | F | G | J | K | M | FB | FB | FB | FB | FE | | GB | GB | GB | GB | GB | | | | | | | |
| 68,000 pF 683 F G J K M FB FB FC FG GB | 56,000 pF | 563 | | | | F | G | J | K | M | FB | FB | FB | FB | FF | | GB | GB | GB | GB | GB | | | | | | | |
| 82,000 pF 823 i F G J K M FC FC FC FF FH GB | 68,000 pF | 683 | | | | F | G | J | K | M | FB | FB | FB | FC | FG | | GB | GB | GB | GB | GB | | | | | | | |
| $ \begin{array}{ c c c c c c c c c c c c c c c c c c c$ | 82,000 pF | 823 | | | | F | G | J | K | М | FC | FC | FC | FF | FH | | GB | GB | GB | GB | GB | | | | | | | |
| 0.12 μF 124 F G J K M FG FG FG FG FG FH < | 0.10 µF | 104 | | | | F | G | J | K | M | FE | FE | FE | FG | FM | | GB | GB | GB | GB | GD | | | | | | | |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $ | 0.12 μF | 124 | | | | F | G | J | K | М | FG | FG | FG | FH | | | GB | GB | GB | GB | GH | | | | | | | |
| 0.18 μF 184 F G J K M J K M K K M K | 0.15 μF | 154 | | | | F | G | J | K | M | FH | FH | FH | FM | | | GD | GD | GD | GD | GN | | | | | | | |
| 0.22 μF 224 F G J K M | 0.18 µF | 184 | | | | F | G | J | K | M | | | | | | | GH | GH | GH | GH | | | | | | | | |
| 0.47 µr 4/4 r 6 3 K M r 6 7 6 3 K M r 6 7 6 3 5 7 7 7 3 | 0.22 µF | 224 | | | | F | G | J | K | M | | | | | | | GK | GK | GK | GK | | | | | | | | |
| Capacitance Cap Code Voltage Code 8 4 3 5 1 2 8 4 3 5 1 2 8 4 3 5 1 2 8 4 3 5 1 2 8 4 3 5 1 2 8 4 3 5 1 2 8 4 3 5 1 2 8 4 3 5 1 2 8 4 3 5 1 2 8 4 3 5 1 2 8 4 3 5 1 2 8 4 3 5 1 2 8 4 3 5 1 2 8 4 3 5 1 2 8 4 3 5 1 2 8 4 3 5 1 2 8 4 3 5 1 2 8 4 3 5 1 2 8 4 3 5 1 2 <t< td=""><td>U.4/ µF</td><td>4/4</td><td>\vdash</td><td colspan="4">Rated Voltage (VDC)</td><td>0</td><td>9</td><td>5</td><td>0</td><td>8</td><td>8</td><td>0</td><td>9</td><td>5</td><td>0</td><td>0</td><td>8</td><td>0</td><td>0 11</td><td>11</td><td>11</td><td>8</td><td>00</td></t<> | U.4/ µF | 4/4 | \vdash | Rated Voltage (VDC) | | | | 0 | 9 | 5 | 0 | 8 | 8 | 0 | 9 | 5 | 0 | 0 | 8 | 0 | 0 11 | 1 1 | 11 | 8 | 00 | | | |
| | Canacitance | Can Code | - | | V | oltan | e Co | de | , | | 8 | - | 3 | 5 | ₩ 1 | 7 2 | 8 | - | 3 | 5 | ₩ 1 | م 2 | 8 | - | 3 | 5 | ₩ 1 | 5 |
| Case Size / Series C1210H C1812H C2220H | | Case Size / Series | | | | ۴° | - | C12 | 10H | | - | C1812H | | | | 8 4 3 5 I 2 C2220H | | | | | | | | | | | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).

These products are protected under US Patents 7,172,985 and 7,670,981, other patents pending, and any foreign counterparts.



| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic (| Quantity |
|-----------|-------------------|-------------|---------|----------------------|-----------|----------|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| BB | 0402 | 0.50±0.05 | 10,000 | 50,000 | 0 | 0 |
| CF | 0603 | 0.80±0.07 | 4,000 | 15,000 | 0 | 0 |
| DN | 0805 | 0.78±0.10 | 4,000 | 15,000 | 0 | 0 |
| DP | 0805 | 0.90±0.10 | 4,000 | 15,000 | 0 | 0 |
| DE | 0805 | 1.00±0.10 | 0 | 0 | 2,500 | 10,000 |
| DF | 0805 | 1.10±0.10 | 0 | 0 | 2,500 | 10,000 |
| DG | 0805 | 1.25±0.15 | 0 | 0 | 2,500 | 10,000 |
| EB | 1206 | 0.78±0.10 | 4,000 | 10,000 | 4,000 | 10,000 |
| EC | 1206 | 0.90±0.10 | 0 | 0 | 4,000 | 10,000 |
| ED | 1206 | 1.00±0.10 | 0 | 0 | 2,500 | 10,000 |
| EE | 1206 | 1.10±0.10 | 0 | 0 | 2,500 | 10,000 |
| EF | 1206 | 1.20±0.15 | 0 | 0 | 2,500 | 10,000 |
| EH | 1206 | 1.60±0.20 | 0 | 0 | 2,000 | 8,000 |
| FB | 1210 | 0.78±0.10 | 0 | 0 | 4,000 | 10,000 |
| FC | 1210 | 0.90±0.10 | 0 | 0 | 4,000 | 10,000 |
| FE | 1210 | 1.00±0.10 | 0 | 0 | 2,500 | 10,000 |
| FF | 1210 | 1.10±0.10 | 0 | 0 | 2,500 | 10,000 |
| FG | 1210 | 1.25±0.15 | 0 | 0 | 2,500 | 10,000 |
| FH | 1210 | 1.55±0.15 | 0 | 0 | 2,000 | 8,000 |
| FM | 1210 | 1.70±0.20 | 0 | 0 | 2,000 | 8,000 |
| GB | 1812 | 1.00±0.10 | 0 | 0 | 1,000 | 4,000 |
| GD | 1812 | 1.25±0.15 | 0 | 0 | 1,000 | 4,000 |
| GH | 1812 | 1.40±0.15 | 0 | 0 | 1,000 | 4,000 |
| GK | 1812 | 1.60±0.20 | 0 | 0 | 1,000 | 4,000 |
| GN | 1812 | 1.70±0.20 | 0 | 0 | 1,000 | 4,000 |
| JJ | 2220 | 2.20±0.15 | 0 | 0 | 500 | 2,000 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic | Quantity |

Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2mm pitch option see "Tape & Reel Packaging Information".



Table 2B – Bulk Packaging Quantities

| | | | Loose Pa | ackaging | Secure P | ackaging |
|----------|------------------------|-----------------------|-----------|-----------------|------------------|--------------------|
| | Packaging ⁻ | Гуре | Bulk Bag | (default) | 2" x 2" Wa Tr | affle Pack/ ay³ |
| | Packaging C-S | Spec ¹ | N | /A ² | 7282 | /7292 |
| Case | e Size | Chip Thickness | Packaging | Quantities (| pieces/unit | packaging) |
| EIA (in) | Metric (mm) | (mm) | Minimum | Maximum | Minimum | Maximum |
| 0402 | 1005 | | | | | 368 |
| 0603 | 1608 | All | | | | 368 |
| 0805 | 2012 | - | | E0 000 | | 100 |
| 1206 | 3216 | ≤ 1.25 (nominal) | | 50,000 | | 126 |
| 1206 | 3216 | > 1.25 (nominal) | | | | 50 |
| 1210 | 3225 | | 1 | | 1 | 80 |
| 1808 | 4520 | | | | | 50 |
| 1812 | 4532 | | | | | 42 |
| 1825 | 4564 | | | 20,000 | | 20 |
| 2220 | 5650 | | | | | 20 |
| 2225 | 5664 | | | | | 20 |

¹ The "Packaging C-Spec" is a 4-digit code which identifies the packaging type. When ordering, the proper code must be included in the 15th through 18th character positions of the ordering code. See "Ordering Information" section of this document for further details. Product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.

² A packaging C-Spec (see note 1 above) is not required For "Bulk Bag" packaging (excluding Anti-Static Bulk Bag). The 15th through 18th character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.
³ Also commonly referred to as "Chip Carrier" or "Molded Tray". All tray packaging options offer static protection.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size Code | Metric Size | | Dens Maxi Land Pr | sity Lev mum (I rotrusio | rel A: Most) on (mm |) | | Dens Media Land Pr | sity Lev an (Nor rotrusic | rel B: ninal) on (mm |) | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | |
|---------------------|----------------|------|-------------------------|--------------------------------|---------------------------|------|------|--------------------------|---------------------------------|----------------------------|------|---|------|------|------|------|--|--|
| ooue | ooue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | С | Y | X | V1 | V2 | | |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 | | |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 | | |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 | | |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 | | |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 | | |
| 1210 ¹ | 3225 | 1.50 | 1.60 | 2.90 | 5.60 | 3.90 | 1.40 | 1.40 | 2.80 | 4.70 | 3.30 | 1.30 | 1.20 | 2.70 | 4.00 | 3.00 | | |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 | | |
| 2220 | 5650 | 2.75 | 1.70 | 5.50 | 8.20 | 6.50 | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | 2.55 | 1.30 | 5.30 | 6.60 | 5.60 | | |

¹ Only for capacitance values \geq 22 μ F

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/ J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Terminati | ion Finish |
|--|-----------------------|-----------------------|
| Trome reature | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate (T_L to T_P) | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T _L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Product Qualification Test Plan | | | | | | | |
|---------------------------------|---|--|--|--|--|--|--|
| Reliability/I | Environmental Tests per MIL-STD-202//JESD22 | | | | | | |
| High Temperature Life | 200°C rated voltage 1,000 hours | | | | | | |
| Load Humidity | 85°C/85%RH rated voltage 1,000 hours | | | | | | |
| Low Voltage Humidity | 85°C/85%RH, 1.5 V, 1,000 hours | | | | | | |
| Temperature Cycling | -55°C to +200°C, 50 Cycles | | | | | | |
| Thermal Shock | -55°C to +150°C, 20 seconds transfer, 15 minute dwell, 300 cycles | | | | | | |
| Moisture Resistance | Cycled Temp/RH 0 V, 10 cycles at 24 hours each | | | | | | |
| Physical, Mecha | nical & Process Tests per MIL-STD 202/JIS-C-6429 | | | | | | |
| Resistance to Solvents | Include Aqueous wash chemical, OKEM Clean or equivalent | | | | | | |
| Mechanical Shock and Vibration | Method 213: Figure 1, Condition F Method 204: 5 gs for 20 minutes 12 cycles | | | | | | |
| Resistance to Soldering Heat | Condition B, no per-heat of samples, Single Wave Solder | | | | | | |
| Terminal Strength | Force of 1.8 kg for 60 seconds | | | | | | |
| Board Flex | Appendix 2, Note: 3.0 mm (minimum) | | | | | | |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. In addition, temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within the time frame outlined in the table below:

| Termination Finish | Termination Finish Ordering Code ¹ | Storage Life |
|----------------------------|---|------------------------------------|
| 100% Matte Tin (Sn) | С | 1.5 years upon receipt |
| SnPb (5% Pb min.) | L | 1.5 years upon receipt |
| Gold (Au) 1.97 – 11.8 µin² | E | 6 months upon receipt ² |
| Gold (Au) 30 – 70 µin | F | 1.5 years upon receipt |
| Gold (Au) 100 µin min. | G | 1.5 years upon receipt |

¹ The fourteenth (14th) character position of the KEMET part number is assigned to identify and/or define the termination finish. For more information, see "Ordering Information" section of this document.

² Gold plating option "E" devices should remain in its factory sealed moisture sensitive packaging during storage. If the factory sealed packaging is disturbed please store any remaining packaged components in a dry box container to prevent oxidation of the termination finish.



Construction



Capacitor Marking (Optional):

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punche | d Paper |
|-------------------|------|---------|--------------------|---------|--------------------|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| | (W)* | Pitch | (P ₁)* | Pitch | (P ₁)* |
| 01005 - 0402 | 8 | | | 2 | 2 |
| 0603 | 8 | | | 2/4 | 2/4 🦯 |
| 0805 | 8 | 4 | 4 | 4 | 4 |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 |
| 1805 - 1808 | 12 | 4 | 4 | | |
| ≥ 1812 | 12 | 8 | 8 | | |
| KPS 1210 | 12 | 8 | 8 | | |
| KPS 1812 & 2220 | 16 | 12 | 12 | | |
| Array 0508 & 0612 | 8 | 4 | 4 | | |

*Refer to Figures 1 & 2 for W and P, carrier tape reference locations. *Refer to Tables 6 & 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs
- Double the parts on each reel results in fewer reel changes and increased efficiency
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|-----------|--|----------------------------------|----------------------------|---------------------------|----------------------------|---------------------------|----------------------------------|-------------------|---------------------------------|--|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T₁ Maximum | | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | | |
| 12 mm | 1.5+0.10 -0.0 (0.059+0.004 -0.0) | 1.5 | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.05 (0.079±0.002) |) 30 (1.181) | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | |
| 16 mm | | (0.059) | | | | | | | | | |
| | | Va | ariable Dimer | nsions — Milli | meters (Inch | es) | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,E | β ₀ & Κ ₀ | | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5±0.05 (0.138±0.002) | 4.0±0.10 (0.157±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | | |
| 12 mm | Single (4 mm) & Double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5±0.05 (0.217±0.002) | 8.0±0.10 (0.315±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | ote 5 | | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5±0.05 (0.138±0.002) | 12.0±0.10 (0.157±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6).

3. If S₁ < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Standard 481 paragraph 4.3 section b).

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3).

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape

(See Figure 4).

(e) for KPS Series product, A_0 and B_0 are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.

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Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|-----------|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|--|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) Maximum | 0.75 (0.030) | 25 (0.984) | | | | |
| | | Variable D | imensions – M | illimeters (Inche | es) | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | | | |

1. The cavity defined by A_{ρ} , B_{ρ} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3).

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4).

e) see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6).



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 Kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 Newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 Newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|-----------|--|--|--|--|--|--|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | | | | |
| 8 mm | 178 ±0.20 | | | | | | | | | |
| 12 mm | Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | | | | |
| 16 mm | (13.000 ±0.008) | | | | | | | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) ((| | | | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Waffle Tray Packaging Information – 2" x 2" w/ Static Protection

Figure 9 – Waffle Tray Dimensions – Inches (Millimeters)





| Cas | o Ciro | | 2" x 2" Waffle Tray Dimensions – Inches | | | | | | | Packaging Quantity | |
|---------------------|-------------|--------|---|--------|--------|--------|--------|--------|--------|--------------------|------------|
| Cas | e Size | М | M1 | M2 | M3 | Х | Y | Z | A° | MATRIX | (pcs/unit |
| EIA (in) | Metric (mm) | ±0.003 | ±0.003 | ±0.002 | ±0.002 | ±0.002 | ±0.002 | ±0.003 | ± 1/2° | (X x Y) | packaging) |
| 0402 | 1005 | 0.175 | 0.153 | 0.077 | 0.110 | 0.073 | 0.042 | 0.041 | 7 | 16 X 23 | 368 |
| 0504 | 1210 | 0.235 | 0.226 | 0.172 | 0.170 | 0.080 | 0.090 | 0.055 | 5 | 10 X 10 | 100 |
| 0603 | 1608 | 0.175 | 0.153 | 0.077 | 0.110 | 0.073 | 0.042 | 0.041 | 7 | 16 X 23 | 368 |
| 0805 | 2012 | 0.232 | 0.186 | 0.181 | 0.171 | 0.062 | 0.092 | 0.036 | 10 | 10 X 10 | 100 |
| 1005 | 2512 | 0.230 | 0.240 | 0.190 | 0.140 | 0.060 | 0.110 | 0.075 | 5 | 12 X 9 | 108 |
| 1206 ^{1,2} | 3216 | 0.194 | 0.228 | 0.193 | 0.124 | 0.067 | 0.130 | 0.065 | 5 | 14 X 9 | 126 |
| 1206 ^{1,3} | 3216 | 0.250 | 0.250 | 0.375 | 0.167 | 0.100 | 0.200 | 0.070 | 5 | 10 X 5 | 50 |
| 1210 | 3225 | 0.217 | 0.244 | 0.215 | 0.174 | 0.110 | 0.145 | 0.080 | 5 | 10 X 8 | 80 |
| 1808 | 4520 | 0.271 | 0.285 | 0.286 | 0.243 | 0.150 | 0.200 | 0.075 | 5 | 7 X 6 | 42 |
| 1812 | 4532 | 0.271 | 0.285 | 0.286 | 0.243 | 0.150 | 0.200 | 0.075 | 5 | 7 X 6 | 42 |
| 1825 | 4564 | 0.318 | 0.362 | 0.424 | 0.34 | 0.24 | 0.32 | 0.032 | 5 | 5 X 4 | 20 |
| 2220 | 5650 | 0.318 | 0.362 | 0.424 | 0.34 | 0.24 | 0.32 | 0.032 | 5 | 5 X 4 | 20 |
| 2225 | 5664 | 0.318 | 0.362 | 0.424 | 0.34 | 0.24 | 0.32 | 0.032 | 5 | 5 X 4 | 20 |

Table 9A – Waffle Tray Dimensions – Inches

¹ Packaging of 1206 (3216 metric) case size capacitors is dependent upon the nominal chip thickness of the device. See "Capacitance Range/Selection Waterfall" and "Chip Thickness/Tape & Reel Packaging Quantities" to identify the nominal chip thickness of the capacitor.

² Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of \leq 1.25mm (0.049 inches).

³ Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of > 1.25mm (0.049 inches).

Table 9B – Waffle Tray Dimensions – Millimeters

| Coo | o Ciro | 2" x 2" Waffle Tray Dimensions – Millimeters | | | | | | | | | Packaging Quantity |
|---------------------|-------------|--|-------|-------|-------|-------|-------|-------|--------|---------|---------------------------|
| Cas | e 512e | М | M1 | M2 | M3 | Х | Y | Z | A° | MATRIX | (pcs/unit |
| EIA (in) | Metric (mm) | ±0.08 | ±0.08 | ±0.05 | ±0.05 | ±0.05 | ±0.05 | ±0.08 | ± 1/2° | (X x Y) | packaging) |
| 0402 | 1005 | 4.45 | 3.89 | 1.96 | 2.79 | 1.85 | 1.07 | 1.04 | 7 | 16 X 23 | 368 |
| 0504 | 1210 | 5.97 | 5.74 | 4.37 | 4.32 | 2.03 | 2.29 | 1.40 | 5 | 10 X 10 | 100 |
| 0603 | 1608 | 4.45 | 3.89 | 1.96 | 2.79 | 1.85 | 1.07 | 1.04 | 7 | 16 X 23 | 368 |
| 0805 | 2012 | 5.89 | 4.72 | 4.60 | 4.34 | 1.57 | 2.34 | 0.91 | 10 | 10 X 10 | 100 |
| 1005 | 2512 | 5.84 | 6.10 | 4.83 | 3.56 | 1.52 | 2.79 | 1.91 | 5 | 12 X 9 | 108 |
| 1206 ^{1,2} | 3216 | 4.93 | 5.79 | 4.90 | 3.15 | 1.70 | 3.30 | 1.65 | 5 | 14 X 9 | 126 |
| 1206 ^{1,3} | 3216 | 6.35 | 6.35 | 9.53 | 4.24 | 2.54 | 5.08 | 1.78 | 5 | 10 X 5 | 50 |
| 1210 | 3225 | 5.51 | 6.20 | 5.46 | 4.42 | 2.79 | 3.68 | 2.03 | 5 | 10 X 8 | 80 |
| 1808 | 4520 | 6.88 | 7.24 | 7.26 | 6.17 | 3.81 | 5.08 | 1.91 | 5 | 7 X 6 | 42 |
| 1812 | 4532 | 6.88 | 7.24 | 7.26 | 6.17 | 3.81 | 5.08 | 1.91 | 5 | 7 X 6 | 42 |
| 1825 | 4564 | 8.08 | 9.19 | 10.77 | 8.64 | 6.10 | 8.13 | 0.81 | 5 | 5 X 4 | 20 |
| 2220 | 5650 | 8.08 | 9.19 | 10.77 | 8.64 | 6.10 | 8.13 | 0.81 | 5 | 5 X 4 | 20 |
| 2225 | 5664 | 8.08 | 9.19 | 10.77 | 8.64 | 6.10 | 8.13 | 0.81 | 5 | 5 X 4 | 20 |

¹ Packaging of 1206 (3216 metric) case size capacitors is dependent upon the nominal chip thickness of the device. See "Capacitance Range/Selection Waterfall" and "Chip Thickness/Tape & Reel Packaging Quantities" to identify the nominal chip thickness of the capacitor.

² Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of \leq 1.25mm (0.049 inches).

³ Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of > 1.25mm (0.049 inches).

High Temperature 150°C, Ultra-Stable X8R Dielectric, 10 – 100 VDC (Commercial & Automotive Grade)



Overview

KEMET's Ultra-Stable X8R dielectric features a 150°C maximum operating temperature, offering the latest in high temperature dielectric technology and reliability for extreme temperature applications. It offers the same temperature capability as conventional X8R, but without the capacitance loss due to applied DC voltage. Ultra-Stable X8R exhibits no change in capacitance with respect to voltage and boasts a minimal change in capacitance with reference to ambient temperature. It is a suitable replacement for higher capacitance and larger footprint devices that fail to offer capacitance stability. Capacitance change with respect to temperature is limited to $\pm 15\%$ from -55° C to $+150^{\circ}$ C.

Driven by the demand for a more robust and reliable component, Ultra-Stable X8R dielectric capacitors were developed for critical applications where reliability and capacitance stability at higher operating temperatures are a concern.These capacitors are widely used in automotive circuits as well as general high temperature applications. In addition to commercial grade, automotive grade devices are available and meet the demanding Automotive Electronics Council's AEC-Q200 gualification requirements.



| Ordering | Information |
|----------|-------------|
|----------|-------------|

| C | 1210 | С | 184 | K | 3 | Н | Α | C | AUTO |
|---------|--|---------------------------------------|--|--|---|-------------------------|------------------------|---|--|
| Ceramic | Case Size (L" x W") | Specification/ Series ¹ | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/Design | Termination Finish ² | Packaging/ Grade (C-Spec) |
| | 0402 0603 0805 1206 1210 1812 | C = Standard | Two significant digits and number of zeros | $B = \pm 0.10 \text{ pF}$ $C = \pm 0.25 \text{ pF}$ $D = \pm 0.5 \text{ pF}$ $F = \pm 1\%$ $G = \pm 2\%$ $J = \pm 5\%$ $K = \pm 10\%$ $M = \pm 20\%$ | 8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 | H = Ultra Stable X8R | A = N/A | C = 100% Matte Sn L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ Flexible termination option is available. Please see FT-CAP product bulletin C1013_X8R_FT-CAP_SMD.

² Additional termination finish options may be available. Contact KEMET for details.

² SnPb termination finish option is not available on automotive grade product.



Packaging C-Spec Ordering Options Table

| Packaging Type | Packaging/Grade Ordering Code (C-Spec) | | | |
|---|---|--|--|--|
| Commerc | ial Grade ¹ | | | |
| Bulk Bag | Not Required (Blank) | | | |
| 7" Reel/Unmarked | TU | | | |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) | | | |
| 7" Reel/Unmarked/2 mm pitch ² | 7081 | | | |
| 13" Reel/Unmarked/2 mm pitch ² | 7082 | | | |
| Automoti | ve Grade ³ | | | |
| 7" Reel | AUTO | | | |
| 13" Reel/Unmarked | AUT07411 (EIA 0603 and smaller case sizes) AUT07210 (EIA 0805 and larger case sizes) | | | |
| 7" Reel/Unmarked/2 mm pitch ² | 3190 | | | |
| 13" Reel/Unmarked/2 mm pitch ² | 3191 | | | |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked.

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

³ Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information".

³ For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information".

³ All Automotive packaging C-Specs listed exclude the option to laser mark components. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking".

Benefits

- -55°C to +150°C operating temperature range
- · Lead (Pb)-Free, RoHS and REACH compliant
- EIA 0402, 0603, 0805, 1206, 1210, and 1812 case sizes
- DC voltage ratings of 10 V, 16 V, 25 V, 50 V and 100 V
- Capacitance offerings ranging from 0.5 pF to 0.22 µF
- Available capacitance tolerances of ±0.10 pF, ±0.25 pF, ±0.5 pF, ±1%, ±2%, ±5%, ±10%, and ±20%
- Extremely low ESR and ESL
- High thermal stability
- High ripple current capability

- No capacitance change with respect to applied rated DC voltage
- · Non-polar device, minimizing installation concerns
- · Offered in both commercial and automotive grades
- 100% pure matte tin-plated termination finish that allowing for excellent solderability.
- SnPb plated termination finish option available upon request

(5% Pb minimum)

Applications

Typical applications include decoupling, bypass and filtering in extreme environments such as down-hole oil exploration, under-hood automotive, military and aerospace.



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | tion Due To: | Days Prior To |
|-----------------------------|----------------------------------|---------------|------------------|
| C-Spec | Process/Product change | Obsolescence* | Implementation |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum |
| AUTO | Yes (without approval) | Yes | 90 days minimum |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | | PPAP (Product | Part Approval | Process) Leve | I |
|-----------------------------|---|---------------|---------------|---------------|---|
| C-Spec | 1 | 2 | 3 | 4 | 5 |
| KEMET assigned ¹ | • | • | • | • | • |
| AUTO | | | 0 | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|---------------|---------------------|-------------------------------|-------------------------------|-----------------|-------------------------------|----------------------------|---------------------------------|
| 0402 | 1005 | 1.00 (0.040) ±0.05 (0.002) | 0.50 (0.020) ±0.05 (0.002) | | 0.30 (0.012) ±0.10 (0.004) | 0.30 (0.012) | Solder Reflow Only |
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | - | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | |
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | See Table 2 for | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave or Solder Reflow |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | Thickness | 0.50 (0.02) ±0.25 (0.010) | | |
| 1210 | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | - | 0.50 (0.02) ±0.25 (0.010) | N/A | Solder Reflow |
| 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | | 0.60 (0.024) ±0.35 (0.014) | | Only |



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|--|
| Operating Temperature Range | -55°C to +150°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±15% |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 0% |
| Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA) |
| Dissipation Factor (DF) Maximum Limit at 25°C | 2.5% |
| Insulation Resistance (IR) Limit at 25°C | 1,000 MΩ μF or 100 GΩ (Rated voltage applied for 120 ±5 seconds at 25°C) |

To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Capacitance and dissipation factor (DF) measured under the following conditions:

1 MHz ±100 kHz and 1.0 ±0.2 V_{rms} if capacitance \leq 1,000 pF.

1 kHz ±50 Hz and 1.0 ±0.2 V_{rms} if capacitance > 1,000 pF.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

Post Environmental Limits

| | High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | | | |
|------------------|---|----------------------|-----------------------------------|----------------------|--------------------------|--|--|--|--|--|--|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | | | | | | |
| Ultra-Stable X8R | All | All | 3.0 | 0.3% or ±0.25 pf | 10% of Initial Limit | | | | | | |



Table 1 – Capacitance Range/Selection Waterfall (0402 – 1812 Case Sizes)

| | Con | Case S | Size/ | Seri | es | | CO |)40 | 2C | | | C | 060 | 3C | | | C | 080 | 5C | | | C 1 | 20 | 6C | | | C | 121 | OC | | C18 | 12C |
|--------------------------|-------------------|----------|---------|--------|-----|---|------------|------------|---------------------------------------|----------|----|----|------|----------|--------------|---------------|---------------|-----------------|------------|-------------|--------------|---------------|-------------|--------------|---------|-----|----|------|----|-----|-----|-----|
| Capacitance | Code | Volt | tage Co | ode | | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 5 | 1 |
| | oouc | Rated V | /oltage | e (VDC | C) | 9 | 16 | 25 | 50 | 100 | 2 | 16 | 25 | 50 | 100 | 9 | 16 | 25 | 50 | 100 | 9 | 16 | 25 | 20 | 10 | 9 | 16 | 25 | 50 | 100 | 50 | 100 |
| | | Capacita | nce To | olerar | ice | | | | | | | | | Pro S | oduc ee T | t Ava able | ailat 2 fo | oility or Ch | and and | Chi hick | p Th ness | ickn 5 Din | ess nens | Cod sions | es S | | | | | | | |
| 0.50 & 0.75 pF | 508 & 758 | B C D | | | | BB | BB | BB | BB | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | | | | | | | | | | | | |
| 0.75 pF 1.0 - 9.1 pF* | /58 109 - 919* | BCD | | | | BB | BB | BB | BB | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 10 pF | 100 | | FG | JK | М | BB | BB | BB | BB | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 11 pF | 110 | | FG | JK | M | BB | BB | BB | BB | | CF | CF | CF | CF | CF | | DN | | DN | | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 13 pF | 130 | | FG | JK | M | BB | BB | BB | BB | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 15 pF | 150 | | FG | JK | м | BB | BB | BB | BB | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 16 pF | 160 | | FG | JK | M | BB | BB | BB | BB | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 18 pF | 180 | | FG | JK | M | BB | BB | BB | BB | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 20 pF 22 nF | 200 | | FG | JK | M | BB | BB | BB | BB | | CF | CF | CF | CF | CF | | | | | | FB | FB | FB | FB | FB | FB | FB | FB | FB | FB | | |
| 24 pF | 240 | | FG | JK | M | BB | BB | BB | BB | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 27 pF | 270 | | FG | JK | М | BB | BB | BB | BB | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 30 pF | 300 | | FG | JK | M | BB | BB | BB | BB | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 33 pF 36 nF | 330 | | FG | JK | M | BB | BB | BB | BB | | | CF | | CF | CF | | | | | | EB | EB | FR | FR | FR | FB | FB | FB | FB | FB | | |
| 39 pF | 390 | | FG | JK | м | BB | BB | BB | BB | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 43 pF | 430 | | FG | JK | м | BB | BB | BB | BB | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 47 pF | 470 | | FG | JK | М | BB | BB | BB | BB | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 51 pF | 510 | | FG | JK | M | BB | BB | BB | BB | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 62 nF | 620 | | FG | JK | M | BB | BB | BB | BB | | CF | CF | CF | CF | CF | | | | | | FB | FB | FB | FB | FB | FB | FB | FB | FB | FB | | |
| 68 pF | 680 | | F G | JK | M | BB | BB | BB | BB | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 75 pF | 750 | | FG | JK | М | BB | BB | BB | BB | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 82 pF | 820 | | FG | JK | M | BB | BB | BB | BB | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 91 pF 100 pE | 910 | | FG | JK | M | BB | BB | BB BB | BB | BB | | | | | | | | | | | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 110 pF | 111 | | FG | JK | м | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 120 pF | 121 | | F G | JK | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 130 pF | 131 | | FG | JK | М | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 150 pF | 151 | | FG | JK | М | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 160 pF | 161 | | FG | JK | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 180 pF 200 pF | 181 | | FG | JK | M | BB | BB RR | BB RR | BB | BB | | CF | CF | CF | CF | | | | | | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 200 pF | 201 | | FG | JK | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 240 pF | 241 | | F G | JK | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 270 pF | 271 | | FG | JK | м | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 300 pF | 301 | | FG | JK | М | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 330 pF | 331 | | FG | JK | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | | |
| 360 pF | 361 | | FG | JK | M | B B B B B B B B B B B B B B B B B B B | B B R R | DD RR | B B B B B B B B B B B B B B B B B B B | RR RR | | CF | CF | | CF | | | | | | EB | EB | EB | EB | EB | L P | FR | FR | FB | FB | | |
| 430 nF | 431 | | FG | JK | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | | | DN | DN | | FB | FB | FB | FB | FB | FB | FB | FB | FB | FB | | |
| 470 pF | 471 | | F G | JK | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | GB | GB |
| 510 pF | 511 | | FG | JK | М | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | GB | GB |
| 560 pF | 561 | | FG | JK | М | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | GB | GB |
| 620 pF | 621 | | FG | JK | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | GB | GB |
| 680 pF | 68 I 75 1 | | FG | JK | M | DD RR | DD RR | RR RR | B B B B B B B B B B B B B B B B B B B | RR | | | | CF | CF | | | | | | EB | EB | EB | EB | EB | L B | FR | FB | FR | FB | GB | GB |
| 820 pF | 821 | | FG | JK | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | | | | | | FB | FB | FB | FB | FB | FB | FB | FB | FB | FB | GB | GB |
| 910 pF | 911 | | FG | JK | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | DN | DN | DN | DN | DP | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | GB | GB |
| 1,000 pF | 102 | | FG | JK | М | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | DN | DN | DN | DN | DP | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | GB | GB |
| 1,100 pF | 112 | | FG | JK | М | BB | BB | BB | BB | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DP | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | GB | GB |
| 1,200 pF | 122 | | FG | JK | M | BB | BB | BB | BB | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DP | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | GB | GB |
| 1,300 pF | 132 | | FG | JK | M | BD RR | BD RR | B D R R | B D RR | | | CF | | | | | DP | DP | DP | UP PD | EB | EB | EB | EB | EC | FB | FB | FB | FB | FB | GB | GB |
| 1.600 pF | 162 | | FG | JK | M | 00 | טט | סט | | | CF | CF | CF | CF | CF | DP | DP | DP | DP | DP | EB | EB | EB | ER | ED | FR | FR | FR | FR | FR | GB | GB |
| 1,800 pF | 182 | | FG | JK | M | | | | | | CF | CF | CF | CF | CF | DP | DP | DP | DP | DP | EB | EB | EB | EB | ED | FB | FB | FB | FB | FB | GB | GB |
| | 0 | Rated V | /oltage | e (VD | C) | 10 | 16 | 25 | 50 | 100 | 5 | 16 | 25 | 50 | 100 | 5 | 16 | 25 | 50 | 100 | 5 | 16 | 25 | 50 | 100 | 5 | 16 | 25 | 50 | 100 | 50 | 100 |
| Capacitance | Cap Code | Volt | tage Co | ode | | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 5 | 1 |
| | | Case | Size/S | Serie | s | | C | 0402 | 2C | | | C | 0603 | BC | | | C | 0805 | 5C | | | C | 1206 | 5C | | | С | 1210 | C | ľ | C18 | 12C |



Table 1 – Capacitance Range/Selection Waterfall (0402 – 1812 Case Sizes) cont.

| | Can | Case Size/Series | | C | 040 | 2C | | | CO |)60 | 3C | | | C |)80 | 5C | | | C 1 | 20 | 6C | | C1210C | | | | | C1812C | |
|-------------|------|-----------------------|-----|----|------|----|-----|--------|----|--------|----------|-------------|--------------|---------------|-----------------|-----|-------------|--------------|---------------|-------------|-----|-----|--------|----|----|------|-----|--------|-----|
| Capacitance | Codo | Voltage Code | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 5 | 1 |
| | Coue | Rated Voltage (VDC) | 10 | 16 | 25 | 50 | 100 | 10 | 16 | 25 | 50 | 100 | 10 | 16 | 25 | 50 | 100 | 10 | 16 | 25 | 50 | 100 | 10 | 16 | 25 | 50 | 100 | 50 | 100 |
| | | Capacitance Tolerance | | | | | | | | | Pro S | duc ee T | t Av able | ailab 2 fo | oility or Ch | and | Chi hick | p Th ness | ickn s Din | ess nens | Cod | es | | | | | | | |
| 2,000 pF | 202 | F G J K M | | | | | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | ED | FB | FB | FB | FB | FC | GB | GB |
| 2,200 pF | 222 | F G J K M | | | | | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EE | FB | FB | FB | FB | FC | GB | GB |
| 2,400 pF | 242 | F G J K M | | | | | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EC | FB | FB | FB | FB | FC | | |
| 2,700 pF | 272 | F G J K M | | | | | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EB | EB | EB | EB | EC | FB | FB | FB | FB | FC | GB | GB |
| 3,000 pF | 302 | F G J K M | | | | | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EC | EC | EC | EC | EC | FB | FB | FB | FB | FC | | |
| 3,300 pF | 332 | F G J K M | | | | | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EC | EC | EC | EC | EE | FB | FB | FB | FB | FF | GB | GB |
| 3,600 pF | 362 | F G J K M | | | | | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EC | EC | EC | EC | EE | FB | FB | FB | FB | FF | | |
| 3,900 pF | 392 | F G J K M | | | | | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EC | EC | EC | EC | EF | FB | FB | FB | FB | FF | GB | GB |
| 4,300 pF | 432 | F G J K M | 1 | | 1 | | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EC | EC | EC | EC | EC | FB | FB | FB | FB | FF | | |
| 4,700 pF | 472 | F G J K M | 1 | | 1 | | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | EC | EC | EC | EC | EC | FF | FF | FF | FF | FG | GB | GB |
| 5.100 pF | 512 | F G J K M | 1 | | | | | CF | CF | CF | CF | | DN | DN | DN | DN | DN | ED | ED | ED | ED | ED | FB | FB | FB | FB | FG | | |
| 5.600 pF | 562 | FGJKM | 1 | | | | | CF | CF | CF | CF | | DN | DN | DN | DN | DN | ED | ED | ED | ED | ED | FB | FB | FB | FB | FG | GB | GB |
| 6.200 pF | 622 | FGJKM | | | | | | CF | CF | CF | CF | | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FG | | |
| 6.800 pF | 682 | FGJKM | i i | | | | | CF | CF | CF | CF | | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FG | GB | GB |
| 7 500 pF | 752 | FGJKM | i i | | | | | CF | CF | CF | | | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FC | FC | FC | FC | FC | | |
| 8 200 pF | 822 | FGJKM | | | | | | CF | CF | CF | | | DN | DN | DN | DN | DN | FB | FB | FB | FB | FB | FC | FC | FC | FC | FC | GB | GH |
| 9 100 pF | 912 | FGJKM | | | | | | CF | CF | CF | | | DN | DN | DN | DN | DN | FR | FR | FR | FB | FR | FF | FF | FF | FF | FF | 0.5 | 0 |
| 10 000 pF | 103 | F G J K M | | _ | | | | CF | CF | CF | | | DN | DN | DN | DN | DP | FR | FR | FB | FR | FB | FF | FF | FF | FE | FF | GB | GH |
| 12 000 pF | 123 | FGJKM | | | | | | Ŭ. | 0. | 0. | | | DN | DN | DN | | DF | FR | FR | FR | FR | FR | FR | FB | FR | FB | FB | GB | GG |
| 15,000 pF | 153 | FGIKM | | | | | | | | | | | ПМ | | DN | DP | DG | FR | FR | FR | FR | FR | FR | FR | FR | FR | FR | GB | GR |
| 18,000 pF | 183 | FGIKM | | | | | | | | | | | | | | | 00 | FR | FR | FR | FR | FR | FR | FR | FR | FR | FR | GB | GB |
| 22 000 pF | 223 | F G J K M | | | | | | | | | | | | | | | | FR | FR | FR | FR | FC | FR | FR | FR | FR | FR | GB | GB |
| 27,000 pF | 223 | E G J K M | | | | | | | | | | | | | | DI | | | ED | ED | ED | EE | | ED | ED | EB | EP | GR | GR |
| 22,000 pF | 273 | ECIKM | | | | | | | | | | | | DC | | | | | | | ED | | | ED | ED | ED | ED | GR | GB |
| 20,000 pF | 202 | E C I K M | | | | | | | | | | | 00 | 00 | 00 | | | | | EC | | | | | | | | | |
| 39,000 pF | 393 | | | | | | | | | | | | | | | | | | EC | EC | | | | | | | | | CD |
| 47,000 pF | 4/3 | FGJKM | | | | | | | | | | | | | | | | | EU | EU | | ЕП | | | FD | FD | | GB | GB |
| 56,000 pF | 503 | FGJKM | | | | | | | | | | | | | | | | ED | ED | ED | EF | | FB | FB | FB | FB | FF | GB | GB |
| 68,000 pF | 083 | FGJKM | | | | | | | | | | | | | | | | | EF | EF | EH | | FB | FB | FB | FU | FG | GB | GB |
| 82,000 pF | 823 | FGJKM | | | | | | | | | | | | | | | | EH | EH | EH | EH | | FC | FC | FC | FF F | FH | GB | GB |
| 100,000 pF | 104 | FGJKM | | | | | | | | | | | | | | | | EH | EH | EH | | | FE | FE | FE | FG | FM | GB | GD |
| 120,000 pF | 124 | FGJKM | | | | | | | | | | | | | | | | | | | | | FG | FG | FG | FH | | GB | GH |
| 150,000 pF | 154 | FGJKM | | | | | | | | | | | | | | | | | | | | | FH | FH | FH | FM | | GD | GN |
| 180,000 pF | 184 | FGJKM | | | | | | | | | | | | | | | | | | | | | FJ | FJ | FJ | | | GH | |
| 220,000 pF | 224 | F G J K M | | | | | - | | | | | - | | | | | - | | | | | - | | | | | - | GK | - |
| | Can | Rated Voltage (VDC) | 9 | 16 | 25 | 20 | 100 | 9 | 16 | 25 | 50 | 100 | 2 | 16 | 25 | 50 | 100 | 2 | 16 | 25 | 50 | 100 | 9 | 16 | 25 | 50 | 100 | 50 | 100 |
| Capacitance | Code | Voltage Code | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 5 | 1 |
| | | Case Size/Series | | C | 0402 | 2C | | C0603C | | C0805C | | | C1206C | | | | | C1210C | | | | | C1812C | | | | | | |



| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic (| Quantity | | |
|-----------|-------------------|-------------|---------|----------------------|------------------|----------|--|--|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | |
| BB | 0402 | 0.50 ±0.05 | 10,000 | 50,000 | 0 | 0 | | |
| CF | 0603 | 0.80 ±0.07* | 4,000 | 15,000 | 0 | 0 | | |
| DN | 0805 | 0.78 ±0.10* | 4,000 | 15,000 | 0 | 0 | | |
| DP | 0805 | 0.90 ±0.10* | 4,000 | 15,000 | 0 | 0 | | |
| DE | 0805 | 1.00 ±0.10 | 0 | 0 | 2,500 | 10,000 | | |
| DF | 0805 | 1.10 ±0.10 | 0 | 0 | 2,500 | 10,000 | | |
| DG | 0805 | 1.25 ±0.15 | 0 | 0 | 2,500 | 10,000 | | |
| EB | 1206 | 0.78 ±0.10 | 0 | 0 | 4,000 | 10,000 | | |
| EC | 1206 | 0.90 ±0.10 | 0 | 0 | 4,000 | 10,000 | | |
| ED | 1206 | 1.00 ±0.10 | 0 | 0 | 2,500 | 10,000 | | |
| EE | 1206 | 1.10 ±0.10 | 0 | 0 | 2,500 | 10,000 | | |
| EF | 1206 | 1.20 ±0.15 | 0 | 0 | 2,500 | 10,000 | | |
| EH | 1206 | 1.60 ±0.20 | 0 | 0 | 2,000 | 8,000 | | |
| FB | 1210 | 0.78 ±0.10 | 0 | 0 | 4,000 | 10,000 | | |
| FC | 1210 | 0.90 ±0.10 | 0 | 0 | 4,000 | 10,000 | | |
| FE | 1210 | 1.00 ±0.10 | 0 | 0 | 2,500 | 10,000 | | |
| FF | 1210 | 1.10 ±0.10 | 0 | 0 | 2,500 | 10,000 | | |
| FG | 1210 | 1.25 ±0.15 | 0 | 0 | 2,500 | 10,000 | | |
| FH | 1210 | 1.55 ±0.15 | 0 | 0 | 2,000 | 8,000 | | |
| FM | 1210 | 1.70 ±0.20 | 0 | 0 | 2,000 | 8,000 | | |
| FJ | 1210 | 1.85 ±0.20 | 0 | 0 | 2,000 | 8,000 | | |
| GB | 1812 | 1.00 ±0.10 | 0 | 0 | 1,000 | 4,000 | | |
| GD | 1812 | 1.25 ±0.15 | 0 | 0 | 1,000 | 4,000 | | |
| GH | 1812 | 1.40 ±0.15 | 0 | 0 | 1,000 | 4,000 | | |
| GG | 1812 | 1.55 ±0.10 | 0 | 0 | 1,000 | 4,000 | | |
| GK | 1812 | 1.60 ±0.20 | 0 | 0 | 1,000 | 4,000 | | |
| GN | 1812 | 1.70 ±0.20 | 0 | 0 | 1,000 | 4,000 | | |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic Quantity | | | |

Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".



Table 2B – Bulk Packaging Quantities

| Deeke | ning Tuno | Loose Pa | ackaging | | | | | | | |
|----------|------------------------|---|-----------------|--|--|--|--|--|--|--|
| Раска | Jing Type | Bulk Bag | (default) | | | | | | | |
| Packagi | ng C-Spec ¹ | N, | /A ² | | | | | | | |
| Cas | e Size | Packaging Quantities (pieces/unit packaging | | | | | | | | |
| EIA (in) | Metric (mm) | Minimum | Maximum | | | | | | | |
| 0402 | 1005 | | | | | | | | | |
| 0603 | 1608 | | | | | | | | | |
| 0805 | 2012 | | 50,000 | | | | | | | |
| 1206 | 3216 | | | | | | | | | |
| 1210 | 3225 | 1 | | | | | | | | |
| 1808 | 4520 | | | | | | | | | |
| 1812 | 4532 | | | | | | | | | |
| 1825 | 4564 | | 20,000 | | | | | | | |
| 2220 | 5650 | | | | | | | | | |
| 2225 | 5664 | | | | | | | | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial Grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive Grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size Code | Metric Size Code | | Dens Maxi Land Pi | sity Lev mum (I rotrusio | vel A: Most) on (mm |) | | Dens Media Land Pi | sity Lev an (Nor rotrusio | vel B: ninal) on (mm |) | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | | | |
|---------------------|------------------------|------|-------------------------|--------------------------------|---------------------------|------|------|--------------------------|---------------------------------|----------------------------|------|---|------|------|------|------|--|--|--|--|
| ooue | ooue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | | | | |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 | | | | |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 | | | | |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 | | | | |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 | | | | |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 | | | | |
| 1210 ¹ | 3225 | 1.50 | 1.60 | 2.90 | 5.60 | 3.90 | 1.40 | 1.40 | 2.80 | 4.70 | 3.30 | 1.30 | 1.20 | 2.70 | 4.00 | 3.00 | | | | |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 | | | | |

¹ Only for capacitance values \geq 22 μ F.

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.



Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Terminat | ion Finish |
|--|-----------------------|-----------------------|
| Tomeredure | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate (T _L to T _P) | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T _L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T_p to T_L)$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.






Table 4 – Performance & Reliability: Test Methods & Conditions

| Stress | Reference | Test or Inspection Method |
|------------------------|---------------------------------------|--|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds. |
| Board Flex | JIS-C-6429 | Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm for COG. Flexible termination system – 3.0 mm (minimum). |
| | | Magnification 50 X. Conditions: |
| Solderability | I-STD-002 | a) Method B, 4 hours at 155°C, dry heat at 235°C |
| Solderability | 5 510 002 | b) Method B at 215°C category 3 |
| | | c) Method D, category 3 at 260°C |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to +150°C). Measurement at 24 hours \pm 4 hours after test conclusion. |
| Biased Humidity | MIL-STD-202 Method | Load Humidity: 1,000 hours 85°C/85%RH and rated voltage. Add 100K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. |
| Diabea Haimarty | 103 | Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours +4 hours after test conclusion. |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours. ±4 hours after test conclusion. |
| Thermal Shock | MIL-STD-202 Method 107 | -55°C/+150. Note: Number of cycles required – 300. Maximum transfer time – 20 seconds. Dwell time – 15 minutes. Air – Air. |
| High Temperature Life | MIL-STD-202 Method 108 /EIA-198 | 1,000 hours at 150°C with 2 X rated voltage applied. |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC for 1,000 hours. |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 min., 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz. |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Condition F. |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction



Capacitor Marking (Optional)

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punched Paper | | |
|----------------------|------|---------|--------------------|---------------|--------------------|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | (W)* | Pitch | (P ₁)* | Pitch | (P ₁)* | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 | |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | |
| Array 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | | | |
|--|---------------------------------------|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 16 mm | | (0.059) | | | | (1.181) | | | |
| | | , | Variable Dime | ensions – Mil | limeters (Incl | nes) | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | Note 5 | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | | |
|--|---------------------------------------|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | |
| | | Variable D | imensions – M | illimeters (Inche | es) | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | Note I | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | |
|--|----------------------|---------------------------------------|--|--|--|--|--|
| Tape Size | А | A B Minimum | | D Minimum | | | |
| 8 mm | 178 ±0.20 | | | | | | |
| 12 mm | (7.008 ±0.008) Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0 521 +0 02/-0 008) | 20.2 (0.795) | | | |
| 16 mm | (13.000 ±0.008) | | | | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Overview

KEMET's X8L dielectric features a 150°C maximum operating temperature and is considered "general purpose high temperature." These components are fixed, ceramic dielectric capacitors suited for high temperature bypass and decoupling applications or frequency discriminating circuits where Q and stability of capacitance characteristics are not critical. X8L exhibits a predictable change in capacitance with respect to time and voltage and boasts a minimal change in capacitance with reference to ambient temperature up to 125°C. Beyond 125°C X8L displays a wider variation in capacitance. Capacitance change is limited to ±15% from -55°C to +125°C and +15, -40% from 125°C to 150°C.

Driven by the demand for a more robust and reliable component, X8L dielectric capacitors were developed for critical applications where reliability at higher operating temperatures are a concern. These capacitors are widely used in automotive circuits as well as general high temperature applications. Concerned with flex cracks resulting from excessive tensile and shear stresses produced during board flexure and thermal cycling? These devices are available with KEMET's Flexible termination technology which inhibits the transfer of board stress to the rigid ceramic body, therefore mitigating flex cracks which can result in low IR or short circuit failures. Although flexible termination technology does not eliminate the potential for mechanical damage that may propagate during extreme environmental and handling conditions, it does provide superior flex performance over standard termination systems.

In addition to commercial grade, automotive grade devices are available and meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.



| С | 1210 | X | 106 | K | 8 | N | Α | C | TU |
|---------|--------------------------------------|---|--|---------------------------------|---|------------|----------------------------|---|---|
| Ceramic | Case Size (L" x W") | Specification/ Series ¹ | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ² | Packaging/Grade (C-Spec) |
| | 0402 0603 0805 1206 1210 | C = Standard X = Flexible termination | Two significant digits and number of zeros | J = ±5% K = ±10% M = ±20% | 9 = 6.3 8 = 10 4 = 16 3 = 25 5 = 50 | N = X8L | A = N/A | C = 100% Matte Sn L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

Ordering Information

¹ The flexible termination option is not available on EIA 0402 case size product. "C" must be used in the 6th character position when ordering this case size.

²Additional termination finish options may be available. Contact KEMET for details.

² SnPb termination finish option is not available on Automotive Grade product.



Packaging C-Spec Ordering Options Table

| Packaging Type | Packaging/Grade Ordering Code (C-Spec) | | | | | | |
|---|---|--|--|--|--|--|--|
| Commercial Grade ¹ | | | | | | | |
| Bulk Bag | Not Required (Blank) | | | | | | |
| 7" Reel/Unmarked | TU | | | | | | |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) | | | | | | |
| 7" Reel/Marked | ТМ | | | | | | |
| 13" Reel/Marked | 7040 (EIA 0603) 7215 (EIA 0805 and larger case sizes) | | | | | | |
| 7" Reel/Unmarked/2 mm pitch ² | 7081 | | | | | | |
| 13" Reel/Unmarked/2 mm pitch ² | 7082 | | | | | | |
| Automotiv | ve Grade ³ | | | | | | |
| 7" Reel | AUTO | | | | | | |
| 13" Reel/Unmarked | AUT07411 (EIA 0603 and smaller case sizes) AUT07210 (EIA 0805 and larger case sizes) | | | | | | |
| 7" Reel/Unmarked/2 mm pitch ² | 3190 | | | | | | |
| 13" Reel/Unmarked/2 mm pitch ² | 3191 | | | | | | |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked.

- ² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".
- ³ Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information".

³ For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information".

³ All Automotive packaging C-Specs listed exclude the option to laser mark components. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking".

Benefits

- -55°C to +150°C operating temperature range
- · Lead (Pb)-free, RoHS and REACH compliant
- EIA 0402, 0603, 0805, 1206, and 1210 case sizes
- DC voltage ratings of 10 V, 16 V, 25 V, and 50 V
- Capacitance offerings ranging from 0.012 μ F to 10 μ F
- Available capacitance tolerances of ±5%, ±10%, and ±20%
- · Commercial and Automotive (AEC-Q200) grades available
- · Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish allowing for excellent solderability
- SnPb termination finish option available upon request (5% Pb minimum)
- · Flexible termination option available upon request

Applications

Typical applications include use in extreme environments such as down-hole oil exploration, under-hood automotive, military and aerospace.



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | Days Prior To | |
|-----------------------------|----------------------------------|---------------|------------------|
| C-Spec | Process/Product change | Obsolescence* | Implementation |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum |
| AUTO | Yes (without approval) | Yes | 90 days minimum |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | PPAP (Product Part Approval Process) Level | | | | | | | |
|-----------------------------|--|---|---|---|---|--|--|--|
| C-Spec | 1 | 2 | 3 | 4 | 5 | | | |
| KEMET assigned ¹ | • | • | • | • | • | | | |
| AUTO | | | 0 | | | | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only

3



Dimensions – Standard Termination – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|---------------|---------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|----------------------------|---------------------------------|
| 0402 | 1005 | 1.00 (0.040) ±0.05 (0.002) | 0.50 (0.020) ±0.05 (0.002) | See Table 2 for Thickness | 0.30 (0.012) ±0.10 (0.004) | 0.30 (0.012) | Solder Reflow Only |
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | Solder Wave or Solder Reflow |
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) N/A | |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | | |
| 1210 | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | | Solder Reflow Only |

Dimensions – Flexible Termination – Millimeters (Inches)

| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|---------------|---------------------|-------------------------------|-------------------------------|-----------------|-------------------------------|----------------------------|---------------------------|
| 0603 | 1608 | 1.60 (0.063) ±0.17 (0.007) | 0.80 (0.032) ±0.15 (0.006) | | 0.45 (0.018) ±0.15 (0.006) | 0.58 (0.023) | Calder Wave |
| 0805 | 2012 | 2.00 (0.079) ±0.30 (0.012) | 1.25 (0.049) ±0.30 (0.012) | See Table 2 for | 0.50 (0.020) ±0.25 (0.010) | 0.75 (0.030) | Or Of Solder Poflow |
| 1206 | 3216 | 3.30 (0.130) ±0.40 (0.016) | 1.60 (0.063) ±0.35 (0.013) | Thickness | 0.60 (0.024) ±0.25 (0.010) | N1/A | Soluel Reliow |
| 1210 | 3225 | 3.30 (0.130) ±0.40 (0.016) | 2.60 (0.102) ±0.30(0.012) | | 0.60 (0.024) ±0.25 (0.010) | IN/A | Solder Reflow Only |

4



Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions (excluding SnPb termination finish option).

Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|--|
| Operating Temperature Range | -55°C to +150°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±15% (-55°C to 125°C), +15, -40% (125°C to 150°C) |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| ² Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5±1 seconds and charge/discharge not exceeding 50 mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | 3.5% (≤ 16V) and 2.5% (≥ 25V) |
| ⁴ Insulation Resistance (IR) Minimum Limit at 25°C | 500 megohm microfarads or 10 GΩ (Rated voltage applied for 120±5 seconds at 25°C) |

¹Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours.

²DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

³ Capacitance and dissipation factor (DF) measured under the following conditions:

1kHz ± 50Hz and 1.0 ± 0.2 Vrms if capacitance \leq 10 μ F

120Hz ± 10Hz and 0.5 ± 0.1 Vrms if capacitance >10µF

⁴ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 & Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON".

Post Environmental Limits

| High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | | | | | |
|---|--|------|-----|------|----------------|--|--|--|--|--|--|--|
| Dielectric | DielectricRated DC VoltageCapacitance ValueDissipation Factor (Maximum %)Capacitance ShiftInsulation Resistance | | | | | | | | | | | |
| VOL | ≥ 25 | A 11 | 3.0 | 120% | 10% of Initial | | | | | | | |
| XOL | ≤ 16 | All | 5.0 | 120% | Limit | | | | | | | |



Table 1 – Capacitance Range/Selection Waterfall (0402 – 1210 Case Sizes)

| | Can | Ca | se Si Serie | ze/ s | | C04 | 02C | 2C | | |)603 | BC | | | C |)80 | 5C | | | C | 1206 | 5C | | | C 1 | 1210 | C | |
|---------------|----------|------------------|----------------|--------------------------------|-----|-----|----------|------|-------|--------|--------|-------|--------|-------|---------|------|-------|--------|--------|-------|-------|-------|-------|-------|------------|------|------|----|
| Сар | Code | Va | ltage Co | ode | 9 | 8 | 4 | 3 | 9 | 8 | 4 | 3 | 5 | 9 | 8 | 4 | 3 | 5 | 9 | 8 | 4 | 3 | 5 | 9 | 8 | 4 | 3 | 5 |
| | | Rated | Voltage | (VDC) | 6.3 | 10 | 16 | 25 | 6.3 | 10 | 16 | 25 | 50 | 6.3 | 10 | 16 | 25 | 50 | 6.3 | 10 | 16 | 25 | 50 | 6.3 | 10 | 16 | 25 | 50 |
| | | Capaci | tance To | lerance | | | | Prod | uct A | vailal | bility | and (| Chip 1 | Thick | ness | Code | es Se | e Tab | le 2 f | or Ch | ip Th | ickne | ess D | imens | sions | | | |
| 12,000 pF | 123 | J | K | М | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | |
| 15,000 pF | 153 | J | K | M | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | |
| 18,000 pF | 183 | J | ĸ | M | BB | BB | DD BB | BB | | | | | | | | | | | | | | | | | | | | |
| 22,000 pF | 223 | J | ĸ | M | | BB | BB | DD | | | | | | | | | | | | | | | | | | | | |
| 33 000 pF | 333 | J | K | M | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 39.000 pF | 393 | Ĵ | ĸ | M | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 47,000 pF | 473 | J | к | м | BB | BB | BB | | CF | CF | CF | CF | CF | | | | | | | | | | | | | | | |
| 56,000 pF | 563 | J | к | м | BB | BB | | | | | | | | | | | | | | | | | | | | | | |
| 68,000 pF | 683 | J | K | М | BB | BB | | | | | | | | | | | | | | | | | | | | | | |
| 82,000 pF | 823 | J | K | M | BB | BB | | | | | | | | | | | | | | | | | | | | | | |
| 0.10 µF | 104 | J | K | M | BB | BB | | | CF | CF | CF | CF | | | | | | | | | | | | | | | | |
| 0.12 µF | 124 | J | K | M | | | | | CF | CF | CF | CF | | | | | | | | | | | | | | | | |
| 0.15 µF | 154 | J | K | M | | | | | CF | CF | CF | CF | | DG | DG | DG | DG | DG | | | | | | | | | | |
| 0.18 µF | 184 | J | K | M | | | | | CF | CF | CF | | | DG | DG | DG | DG | DG | | | | | | | | | | |
| 0.22 µF | 224 | J | ĸ | M | | | | | UF | LF | UF. | | | | ע קע | | | DG | | | | | | | | | | |
| 0.27 µF | 274 | J | ĸ | M | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.33 µF | 304 | 1 | K | M | | | | | | | | | | | | | | | | | | | | FD | FD | FD | FD | FD |
| 0.47 uF | 474 | Ĵ | ĸ | M | | | | | | | | | | DE | DE | DE | DE | | EG | EG | EG | EG | EG | FD | FD | FD | FD | FD |
| 0.56 µF | 564 | J | K | M | | | | | | | | | | DG | DG | DH | DH | | | | 20 | | | FF | FF | FF | FF | FF |
| 0.68 µF | 684 | J | к | м | | | | | | | | | | DG | DG | DH | DH | | | | | | | FG | FG | FG | FG | FG |
| 0.82 µF | 824 | J | К | м | | | | | | | | | | DG | DG | DG | | | | | | | | FL | FL | FL | FL | FL |
| 1.0 μF | 105 | J | K | M | | | | | | | | | | DG | DG | DG | | | ED | ED | ED | ED | | FM | FM | FM | FM | FM |
| 1.2 µF | 125 | J | K | M | | | | | | | | | | | | | | | EH | EH | EH | EH | | FG | FG | FG | FG | |
| 1.5 μF | 155 | J | K | M | | | | | | | | | | | | | | | EH | EH | EH | EH | | FG | FG | FG | FG | |
| 1.8 µF | 185 | J | K | M | | | | | | | | | | | | | | | EF | EF | EH | EH | | FG | FG | FG | FG | |
| 2.2 µF | 225 | J | K | M | | | | | | | | | | | | | | | | EF | EH | EH | | FG | FG | FG | FG | |
| ∠./μ⊦ 2.2⊑ | 2/5 | J | K V | M | | | | | | | | | | | | | | | | EH | EH | | | FG | FG | FH | FH | |
| 3.3 µF | 335 | J | K | M | | | | | | | | | | | _ | | | | | EH | EH | | | FIVI | FIVI | FIV | FIVI | |
| 4.7 μF | 475 | .1 | ĸ | M | | | | | | | | | | | | | | | FH | FH | FH | | | FG | FG | FS | ES | |
| 5.6 uF | 565 | J | K | M | | | | | | | | | | | | | | | | 2 | | | | FH | FH | FH | . 0 | |
| 6.8 µF | 685 | J | K | M | | | | | | | | | | | | | | | | | | | | FM | FM | FM | | |
| 8.2 µF | 825 | J | к | м | | | | | | | | | | | | | | | | | | | | FK | FK | FK | | |
| 10 µF | 106 | J | K | М | | | | | | | | | | | | | | | | | | | | FS | FS | FS | | |
| | | Rated | Voltage | (VDC) | 6.3 | 10 | 16 | 25 | 6.3 | 10 | 16 | 25 | 50 | 6.3 | 10 | 16 | 25 | 50 | 6.3 | 10 | 16 | 25 | 50 | 6.3 | 10 | 16 | 25 | 50 |
| Cap | Cap Code | Va | ltage Co | ode | 9 | 8 | 4 | 3 | 9 | 8 | 4 | 3 | 5 | 9 | 8 | 4 | 3 | 5 | 9 | 8 | 4 | 3 | 5 | 9 | 8 | 4 | 3 | 5 |
| | | Case Size/Series | | Case Size/Series C0402C C0603C | | | | | C | :0805 | C | | | C | C1206 | C | | C1210C | | | | | | | | | | |



| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic | Quantity |
|-----------|-------------------|-------------|---------|----------------------|---------|----------|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| BB | 0402 | 0.50 ± 0.05 | 10,000 | 50,000 | 0 | 0 |
| CF | 0603 | 0.80 ± 0.07 | 4,000 | 15,000 | 0 | 0 |
| DP | 0805 | 0.90 ± 0.10 | 4,000 | 15,000 | 0 | 0 |
| DE | 0805 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| DH | 0805 | 1.25 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| ED | 1206 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EG | 1206 | 1.60 ± 0.15 | 0 | 0 | 2,000 | 8,000 |
| EH | 1206 | 1.60 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FD | 1210 | 0.95 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| FF | 1210 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FG | 1210 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| FL | 1210 | 1.40 ± 0.15 | 0 | 0 | 2,000 | 8,000 |
| FH | 1210 | 1.55 ± 0.15 | 0 | 0 | 2,000 | 8,000 |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FK | 1210 | 2.10 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1,000 | 4,000 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic | Quantity |

Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

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Table 2B – Bulk Packaging Quantities

| Deeke | aing Tune | Loose P | ackaging | | | | |
|----------|------------------------|----------------------|-------------------------|--|--|--|--|
| Раска | Jing Type | Bulk Bag (default) | | | | | |
| Packagi | ng C-Spec ¹ | N | /A ² | | | | |
| Cas | e Size | Packaging Quantities | (pieces/unit packaging) | | | | |
| EIA (in) | Metric (mm) | Minimum | Maximum | | | | |
| 0402 | 1005 | | | | | | |
| 0603 | 1608 | | | | | | |
| 0805 | 2012 | | 50,000 | | | | |
| 1206 | 3216 | | | | | | |
| 1210 | 3225 | 1 | | | | | |
| 1808 | 4520 | | | | | | |
| 1812 | 4532 | | | | | | |
| 1825 | 4564 | | 20,000 | | | | |
| 2220 | 5650 | | | | | | |
| 2225 | 5664 | | | | | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial Grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive Grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3A – Land Pattern Design Recommendations per IPC-7351 – Standard Termination

| EIA Size Code | Metric Size Code | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | | | Dens Media Land Pi | sity Lev an (Nor rotrusio | vel B: minal) on (mm |) | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | |
|---------------------|------------------------|--|-------------|------|------|------|------|--------------------------|---------------------------------|----------------------------|------|---|------|------|------|------|--|
| | | C | C Y X V1 V2 | | | | | | X | V1 | V2 | C | Y | X | V1 | V2 | |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 | |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 | |
| 0805 | 2012 | 0.99 | 1.44 | 1.66 | 4.47 | 2.71 | 0.89 | 1.24 | 1.56 | 3.57 | 2.11 | 0.79 | 1.04 | 1.46 | 2.42 | 1.81 | |
| 1206 | 3216 | 1.59 | 1.62 | 2.06 | 5.85 | 3.06 | 1.49 | 1.42 | 1.96 | 4.95 | 2.46 | 1.39 | 1.22 | 1.86 | 4.25 | 2.16 | |
| 1210 | 3225 | 1.59 | 1.62 | 3.01 | 5.90 | 4.01 | 1.49 | 1.42 | 2.91 | 4.95 | 3.41 | 1.39 | 1.22 | 2.81 | 4.25 | 3.11 | |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





Table 3B - Land Pattern Design Recommendations per IPC-7351 - Flexible Termination

| EIA Size Code | Metric Size Code | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | | | Dens Media Land Pi | sity Lev an (Nor rotrusio | vel B: minal) on (mm |) | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | |
|---------------------|------------------------|--|-------------|------|------|------|------|--------------------------|---------------------------------|----------------------------|------|---|------|------|------|------|
| ooue | 0040 | C | C Y X V1 V2 | | | | | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0603 | 1608 | 0.85 | 1.25 | 1.10 | 4.00 | 2.10 | 0.75 | 1.05 | 1.00 | 3.10 | 1.50 | 0.65 | 0.85 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.65 | 1.90 | 5.90 | 2.90 | 1.50 | 1.45 | 1.80 | 5.00 | 2.30 | 1.40 | 1.25 | 1.70 | 4.30 | 2.00 |
| 1210 | 3225 | 1.60 | 1.65 | 2.80 | 5.90 | 3.80 | 1.50 | 1.45 | 2.70 | 5.00 | 3.20 | 1.40 | 1.25 | 2.60 | 4.30 | 2.90 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/ J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Terminat | ion Finish |
|--|-----------------------|-----------------------|
| Tomeredure | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate (T_L to T_p) | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T _L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T_p to T_L)$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method | | | | | |
|------------------------|---------------------------------------|---|--|--|--|--|--|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds. | | | | | |
| Board Flex | JIS-C-6429 | Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm for COG. Flexible termination system – 3.0 mm (minimum). | | | | | |
| | | Magnification 50 X. Conditions: | | | | | |
| Solderability | I-STD-002 | a) Method B, 4 hours at 155°C, dry heat at 235°C | | | | | |
| Solderability | J-31D-002 | b) Method B at 215°C category 3 | | | | | |
| | | c) Method D, category 3 at 260°C | | | | | |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to +150°C). Measurement at 24 hours +/- 4 hours after test conclusion. | | | | | |
| MIL-STD-202 Method | | Load Humidity: 1,000 hours 85°C/85%RH and rated voltage. Add 100K ohm resistor. Measurement at 24 hours +/- 4 hours after test conclusion. | | | | | |
| Blased Humidity | 103 | Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours +/- 4 hours after test conclusion. | | | | | |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours. +/- 4 hours after test conclusion. | | | | | |
| Thermal Shock | MIL-STD-202 Method 107 | -55°C/+150. Note: Number of cycles required – 300. Maximum transfer time – 20 seconds. Dwell time – 15 minutes. Air – Air. | | | | | |
| High Temperature Life | MIL-STD-202 Method 108 /EIA-198 | 1,000 hours at 150°C with 2 X rated voltage applied. | | | | | |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC for 1,000 hours. | | | | | |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 min., 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz | | | | | |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Condition F. | | | | | |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. | | | | | |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction – Standard Termination



Construction – Flexible Termination





Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a "K" to identify KEMET, followed by two characters (per EIA–198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the "K" character only.

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.
- X7R dielectric products in capacitance values outlined below.

| EIA Case Size | Metric Size Code | Capacitance |
|---------------|------------------|-------------|
| 0603 | 1608 | ≤ 170 pF |
| 0805 | 2012 | ≤ 150 pF |
| 1206 | 3216 | ≤ 910 pF |
| 1210 | 3225 | ≤ 2,000 pF |
| 1808 | 4520 | ≤ 3,900 pF |
| 1812 | 4532 | ≤ 6,700 pF |
| 1825 | 4564 | ≤ 0.018 µF |
| 2220 | 5650 | ≤ 0.027 µF |
| 2225 | 5664 | ≤ 0.033 µF |

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 μ F. Orientation of marking is vendor optional.





Capacitor Marking (Optional) cont.

| | Capacitance (pF) For Various Alpha/Numeral Identifiers | | | | | | | | | | | | |
|-----------|--|-----|----|-----|-------|----------|---------|-----------|------------|-------------|--|--|--|
| Alaba | | | | | | Numera | al | | | | | | |
| Alpila | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | |
| Character | | | | | Сара | acitance | e (pF) | | | | | | |
| А | 0.10 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 | | | |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 | | | |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 | | | |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 | | | |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 | | | |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 | | | |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 | | | |
| Н | 0.20 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 | | | |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 | | | |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 | | | |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 | | | |
| М | 0.30 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 | | | |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 | | | |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 | | | |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 | | | |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 | | | |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 | | | |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 | | | |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 | | | |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 | | | |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 | | | |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 | | | |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 | | | |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 | | | |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 | | | |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 | | | |
| d | 0.40 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 | | | |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 | | | |
| f | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 | | | |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 | | | |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 | | | |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 | | | |
| у | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 | | | |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punche | d Paper |
|----------------------|------|---------|--------------------|---------|--------------------|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| | (W)* | Pitch | (P ₁)* | Pitch | (P ₁)* |
| 01005 - 0402 | 8 | | | 2 | 2 |
| 0603 | 8 | | | 2/4 | 2/4 |
| 0805 | 8 | 4 | 4 | 4 | 4 |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 |
| 1805 - 1808 | 12 | 4 | 4 | | |
| ≥ 1812 | 12 | 8 | 8 | | |
| KPS 1210 | 12 | 8 | 8 | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | |
| Array 0612 | 8 | 4 | 4 | | |

*Refer to Figures 1 and 2 for W and P₁ carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | | (| Constant Dim | ensions – Mil | limeters (Inc | hes) | | | |
|-----------|---------------------------------------|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 16 mm | | (0.059) | | | | (1.181) | | | |
| | | , | Variable Dime | ensions – Mil | limeters (Incl | nes) | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | te 5 |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | | Constant [|)imensions — M | lillimeters (Inch | es) | | |
|-----------|---------------------------------------|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) |
| | | Variable D | imensions — M | illimeters (Inch | es) | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant | Dimensions — Millimete | rs (Inches) | |
|-----------|----------------------|---------------------------------------|--|--|
| Tape Size | A | B Minimum | С | D Minimum |
| 8 mm | 178 ±0.20 | | | |
| 12 mm | (7.008 ±0.008) Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) |
| 16 mm | (13.000 ±0.008) | | | |
| | Variable | Dimensions — Millimete | rs (Inches) | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber



Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs) **High Voltage COG Dielectric, 500 – 10,000 VDC** (Commercial Grade)



Overview

KEMET's High Voltage surface mount MLCCs in COG dielectric are temperature compensating and are suited for resonant circuit applications or those where Q and stability of capacitance characteristics are required. COG exhibits no change in capacitance with respect to time and voltage and boasts a negligible change in capacitance with reference to ambient temperature. Capacitance change is limited to ±30ppm/°C from -55°C to +125°C.

These devices exhibit low ESR at high frequencies and find conventional use as snubbers or filters in applications such as switching power supplies and lighting ballasts. Their exceptional performance at high frequencies has made COG high voltage the preferred dielectric choice of design engineers worldwide. In addition to Commercial Grade, Automotive Grade devices are available which meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.

Benefits

- Operating temperature range of -55°C to +125°C
- Capacitance offerings ranging from 1 pF to 0.15 μF
- DC voltage ratings of 500 V, 630 V, 1 KV, 1.5 KV, 2 KV, 2.5 KV, 3 KV and 10KV
- EIA 0402, 0603, 0805, 1206, 1210, 1808, 1812, 1825, 2220, 2225, 2824, 3040, 3640 and 4540 case sizes
- Extremely low ESR and ESL
- High ripple current capability
- No capacitance shift with voltage
- Negligible capacitance shift with respect to temperature
- · No piezoelectric noise
- · Lead (Pb)-Free, RoHS and REACH compliant

Applications

- High frequency power converters
- Wide bandgap (WBG), silicon carbide (SiC) and gallium nitride (GaN) systems
- Snubber (high dV/dT)
- Resonant circuits (LLC, Wireless Charging, etc)
- Timing
- Filtering



Ordering Information

| С | 1210 | C | 332 | J | C | G | Α | С | TU |
|---------|--|--------------------------|---|---|---|------------|-------------------------|--|--|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance ¹ | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ² | Packaging/ Grade (C-Spec) |
| | 0402 0603 0805 1206 1210 1808 1812 1825 2220 2225 2824 3040 3640 4540 | C = Standard | Two significant digits and number of zeros. | $B = \pm 0.10 \text{ pF}$ $C = \pm 0.25 \text{ pF}$ $D = \pm 0.5 \text{ pF}$ $F = \pm 1\%$ $G = \pm 2\%$ $J = \pm 5\%$ $K = \pm 10\%$ $M = \pm 20\%$ | C = 500 B = 630 D = 1,000 F = 1,500 G = 2,000 Z = 2,500 H = 3,000 K = 10,000 | G = COG | A = N/A | C = 100% Matte Sn L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ Additional capacitance tolerance offerings may be available. Contact KEMET for details.

² Additional termination finish options may be available. Contact KEMET for details.

Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) |
|---|---|
| Bulk Bag/Unmarked | Not required (Blank) |
| 7" Reel/Unmarked | TU |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2 mm pitch ² | 7081 |
| 13" Reel/Unmarked/2 mm pitch ² | 7082 |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ "Bulk Bag" packaging option is not available for case sizes larger than 2225 (5664 Metric).

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices. For more information see "Capacitor Marking".

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|--------------------------------|--------------------------------|-----------------|-------------------------------|----------------------------|---------------------------------|
| 0402 | 1005 | 1.00 (0.040) ±0.05 (0.002) | 0.50 (0.020) ±0.05 (0.002) | | 0.30 (0.012) ±0.10 (0.004) | 0.30 (0.012) | Solder Reflow Only |
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | |
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave or Solder Reflow |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | | |
| 1210 | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | | |
| 1808 | 4520 | 4.70 (0.185) ±0.50 (0.020) | 2.00 (0.079) ±0.20 (0.008) | | 0.60 (0.024) ±0.35 (0.014) | | |
| 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | See Table 2 for | 0.60 (0.024) ±0.35 (0.014) | | |
| 1825 | 4564 | 4.50 (0.177) ±0.30 (0.012) | 6.40 (0.252) ±0.40 (0.016) | Thickness | 0.60 (0.024) ±0.35 (0.014) | | |
| 2220 | 5650 | 5.70 (0.224) ±0.40 (0.016) | 5.00 (0.197) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | N/A | Solder Reflow |
| 2225 | 5664 | 5.60 (0.220) ±0.40 (0.016) | 6.40 (0.248) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | Only |
| 2824 | 7260 | 7.10 (0.280) ±0.40 (0.016) | 6.10 (0.240) ±0.40 (0.016) | | 1.27 (0.050) ±0.40 (0.016) | - | |
| 3040 | 7610 | 7.60 (0.300) ±0.40 (0.016) | 10.20 (0.402) ±0.40 (0.016) | | 1.27 (0.050) ±0.40 (0.016) | | |
| 3640 | 9210 | 9.10 (0.358) ±0.40 (0.016) | 10.20 (0.402) ±0.40 (0.016) | - | 1.27 (0.050) ±0.40 (0.016) | | |
| 4540 | - | 11.40 (0.449) ±0.40 (0.016) | 10.20 (0.402) ±0.40 (0.016) | | 1.27 (0.050) ±0.40 (0.016) | | |



Qualification/Certification

Commercial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance & Reliability.

Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions (excluding SnPb termination finish option).

Table 1A – Capacitance Range/Selection Waterfall (0402 – 1808 Case Sizes)

| | | Ca | as | se Size/Series C | | | | | C0402C | CC |)6(|)3 | C | C0 | 80 | 5C | | C 1 | 20 | 6C | | | C 1 | 21 | 0C | | | | C 1 | 80 | 8C | | | |
|--------------------------------|------------|----|--------------|------------------|-------------------|-----|------|----|--------|--------|-----|-----|-------|------|-----|------|-------------|------------|--------|--------|-------|------|------------|------|-----------|------|------|-----|------------|------|------|------|------|------|
| | | | | Vol | ltag | e C | ode | 9 | | С | C | В | | D | C | В | D | C | В | D | F | G | C | В | D | F | G | С | В | D | F | G | z | н |
| Capacitance | Cap Code | | Rat | ed ' | Vol | tag | e (V | DC |) | 500 | 500 | 630 | 000 | 1000 | 500 | 630 | 1000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| | | | | Ca | pac | ita | nce | e | | | | | | | | Pro | duc | t Av | ailal | oility | / and | l Ch | ip Th | nick | ness | s Co | des | | | | | | | |
| 10.01-5* | 100 010+ | | 0 | | ole | ran | ce | | _ | | - | | | _ | DO. | S | <u>ee 1</u> | able | e 2 fo | or Cl | nip T | hick | nes | s Di | men | sion | S | | | | | | | |
| 1.0 - 9.1 µF* 10 nF - 47nF* | 109 - 919* | Р | U | U | F | G | | ĸ | м | | | | | | | | | FD | FD | FD | FD | FD | FM | FM | FM | FM | FM | IB | LD | LD | LD | LD | LD | |
| 11 pF | 110 | | | | F | G | J | ĸ | M | | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 12 pF | 120 | | | | F | G | J | K | M | | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 13 pF | 130 | | | | F | G | J | K | М | | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 15 pF | 150 | | | | F | G | J | K | М | | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 16 pF | 160 | | | | F | G | J | K | Μ | | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FΜ | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 18 pF | 180 | | | | F | G | J | K | M | | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 20 pF | 200 | | | | | G | J | K | M | | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | | LB | |
| 22 pF 24 nF | 220 | | | | F | G | J | K | M | | | | | | DG | | DG | | ED | ED | ED | ED | FM | FM | FM | FM | FM | | LD | LD | LD | LD | LD | |
| 27 pF | 270 | | | | F | G | J | ĸ | M | | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 30 pF | 300 | | | | F | G | J | K | M | | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 33 pF | 330 | | | | F | G | J | К | М | | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FΜ | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 36 pF | 360 | | | | F | G | J | K | Μ | | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 39 pF | 390 | | | | F | G | J | K | M | | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FΜ | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 43 pF | 430 | | | | F | G | J | K | M | | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 47 pF | 470 | | | | F | G | J | K | M | | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 51 pF | 510 | | | | | G | J | K | M | | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | |
| 50 µF | 620 | | | | F | G | J | K | M | | | | | | DG | | DG | FD | FD | FD | ED | FD | FM | FM | FM | FM | FM | | LD | LD | LD | LD | LD | |
| 68 pF | 680 | | | | F | G | J | ĸ | M | | | | | | DG | DG | DG | FD | FD | FD | FD | FD | FM | FM | FM | FM | FM | IB | IB | IB | IB | IB | IB | IB |
| 75 pF | 750 | | | | F | G | J | K | M | | | | | | DG | DG | DG | ED | ED | ED | ED | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 82 pF | 820 | | | | F | G | J | К | м | | | | | | DG | DG | DG | ED | ED | ED | ED | EF | FΜ | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 91 pF | 910 | | | | F | G | J | K | М | | | | | | DG | DG | DG | ED | ED | ED | ED | EF | FΜ | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 100 pF | 101 | | | | F | G | J | K | Μ | BB | CG | CG | 6 0 | CG | DG | DG | DG | ED | ED | ED | ED | EF | FΜ | FM | FM | FM | FM | LB | LB | LB | LB | LB | LC | LB |
| 110 pF | 111 | | | | F | G | J | K | M | BB | CG | CO | 6 0 | CG | DG | DG | DG | ED | ED | ED | ED | EG | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LC | LB |
| 120 pF | 121 | | | | F | G | J | K | M | BB | CG | CO | 6 0 | CG | DG | DG | DG | ED | ED | ED | ED | EG | FG | FG | FG | FM | FM | | LA | LA | | LB | LC | LB |
| 130 pF | 131 | | | | | 6 | J | K | M | BB | | | | 26 | | | | | ED | ED | ED | EG | | FG | FG | FM | EM | | | | | | | |
| 160 pF | 161 | | | | F | G | J | K | M | BB | CG | | | 2G | DG | DG | DG | FD | FD | ED | FF | EG | FG | FG | FG | FM | FM | | IA | IA | ΙA | | | |
| 180 pF | 181 | | | | F | G | J | ĸ | м | BB | CG | CG | | G | DG | DG | DG | ED | ED | ED | EF | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LC | LC | LC |
| 200 pF | 201 | | | | F | G | J | к | м | BB | CG | CG | | G | DG | DG | DG | ED | ED | ED | EF | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LC | LC | |
| 220 pF | 221 | | | | F | G | J | К | М | BB | CG | CG | ; C | G | DG | DG | DG | ED | ED | ED | EG | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LC | LC | |
| 240 pF | 241 | | | | F | G | J | K | Μ | BB | CG | CG | ; | | DG | DG | DG | ED | ED | ED | EG | EG | FG | FG | FG | FM | FM | LA | LA | LA | LB | LC | LC | |
| | Con | | Rat | ed ' | Vol | tag | e (V | DC |) | 500 | 500 | 630 | | 1000 | 500 | 630 | 1000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| Capacitance | Code | | Voltage Code | | C | C | B | | D | C | В | D | С | В | D | F | G | C | В | D | F | G | C | В | D | F | G | Z | H | | | | | |
| | | | Ca | ise | e Size/Series C04 | | | | | C0402C | C | 060 | 30 | ; | C | 0805 | C | | C | 1206 | 5C | | | C | 121(| C | | | | C | 1808 | C | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82 and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).

These products are protected under US Patents 7,172,985 and 7,670,981, other patents pending, and any foreign counterparts.



Table 1A – Capacitance Range/Selection Waterfall (0402 – 1808 Case Sizes) cont.

| | | Case Size/Series | C0402C | CO | 60 | 3C | CO | 80 | 5C | | C 1 | 20 | 6C | | | C 1 | 21 | 0C | | | | C1 | 80 | BC | | |
|-------------|-------------|--------------------------|--------|-----|------|------|-----|------|------|--------------|------------|--------|-------|------|-------|---------------|-------|-----------|------|-----|-----|-----------|------|------|------|------|
| | | Voltage Code | С | С | В | D | С | В | D | С | В | D | F | G | C | В | D | F | G | С | В | D | F | G | z | Н |
| Capacitance | Cap Code | Rated Voltage (VDC) | 500 | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| | | Capacitance Tolerance | | | | - | | Pro | duc | t Av able | ailal | bility | y and | l Ch | ip Tl | nicki e Di | ness | S Coo | les | | | - | | | | |
| 270 pF | 271 | | BB | CG | CG | | DG | DG | DG | ED | ED | ED | EG | EG | FG | FG | FG | FK | FK | LA | LA | LA | LB | LC | LC | |
| 300 pF | 301 | F G J K M | BD | CG | CG | | DG | DG | DN | ED | ED | EF | EG | | FG | FG | FG | FK | FK | LA | LA | LA | LB | LC | LC | |
| 330 pF | 331 | F G J K M | BD | CG | CG | | DG | DG | DN | ED | ED | EF | EG | | FG | FG | FG | FK | FK | LA | LA | LA | LB | LC | LC | |
| 360 pF | 361 | F G J K M | | CG | CG | | DG | DG | DN | ED | ED | EF | EG | | FG | FG | FG | FK | FS | LA | LA | LA | LB | LA | LC | |
| 390 pF | 391 | F G J K M | | CG | CG | | DG | DG | DN | ED | ED | EF | EG | | FG | FG | FG | FK | FS | LA | LA | LA | LB | LA | LC | |
| 430 pF | 431 | F G J K M | | CG | CG | | DG | DG | DP | ED | ED | EF | EG | | FG | FΜ | FM | FS | FS | LA | LB | LB | LC | LA | | |
| 470 pF | 471 | F G J K M | | CG | CG | | DG | DG | DP | ED | ED | EG | EG | | FG | FΜ | FM | FS | FS | LA | LB | LB | LC | LA | | |
| 510 pF | 511 | F G J K M | | CG | CG | | DG | DG | DP | ED | ED | EG | EG | | FG | FΜ | FM | FS | FS | LA | LB | LB | LC | LB | | |
| 560 pF | 561 | F G J K M | | CG | CG | | DG | DG | DG | ED | ED | EG | EG | | FG | FΜ | FM | FS | FS | LA | LB | LB | LC | LB | | |
| 620 pF | 621 | F G J K M | | CG | CG | | DG | DG | DG | ED | ED | EG | | | FG | FM | FM | FS | FS | LA | LB | LB | LA | LC | | |
| 680 pF | 681 | F G J K M | | CG | CG | | DG | DG | DG | ED | ED | EG | | | FG | FM | FM | FS | FS | LB | LB | LB | LA | LC | | |
| 750 pF | 751 | F G J K M | | | | | DG | DG | DG | ED | EF | EG | | | FG | FM | FM | FM | | LB | LB | LB | LA | | | |
| 820 pF | 821 | F G J K M | | | | | DG | DG | DG | ED | EF | EG | | | FG | FM | FM | FM | | LB | LB | LB | LA | | | |
| 910 pF | 911 | F G J K M | | | | | DN | DN | | ED | EF | EG | | | FM | FM | FM | FY | | LB | LB | LB | LA | | | |
| 1,000 pF | 102 | F G J K M | | | | | DN | DN | | ED | EF | EG | | | FM | FΜ | FM | FY | | LB | LB | LB | LB | | | |
| 1,100 pF | 112 | F G J K M | | | | | DN | DN | | EF | EG | ED | | | FM | FK | FK | FS | | LC | LC | LC | LB | | | |
| 1,200 pF | 122 | F G J K M | | | | | DN | DN | | EF | EG | ED | | | FM | FK | FK | FS | | LC | LC | LC | LC | | | |
| 1,300 pF | 132 | F G J K M | | | | | DN | DN | | EF | EG | ED | | | FM | FS | FS | | | LC | LC | LC | LC | | | |
| 1,500 pF | 152 | F G J K M | | | | | DP | DP | | EF | EG | ED | | | FK | FS | FS | | | LC | LC | LC | LC | | | |
| 1,600 pF | 162 | F G J K M | | | | | DP | DP | | EF | EG | ED | | | FK | FS | FS | | | LC | LC | LC | | | | |
| 1,800 pF | 182 | F G J K M | | | | | DG | DG | | EF | EG | EF | | | FK | FS | FS | | | LC | LC | LC | | | | |
| 2,000 pF | 202 | F G J K M | | | | | DG | DG | | EG | EB | EF | | | FK | FL | FS | | | LC | LA | LB | | | | |
| 2,200 pF | 222 | F G J K M | | | | | DG | DG | | EG | EB | EF | | | FK | FL | FS | | | LC | LA | LB | | | | |
| 2,400 pF | 242 | F G J K M | | | | | DG | DG | | EG | EB | EG | | | FS | FL | FS | | | LC | LA | LB | | | | |
| 2,700 pF | 2/2 | F G J K M | | | | | DG | DG | | EG | EB | EG | | | FS | FL | FS | _ | | LC | LA | LC | | | _ | |
| 3,000 pF | 302 | FGJKM | | | | | | | | EB | EB | | | | FS | FL | FF FO | | | LA | LA | LA | | | | |
| 3,300 pF | 332 | FGJKM | | | | | | | | EB | EB | | | | FS | FM | FG | | | LA | LA | LA | | | | |
| 3,600 pF | 362 | FGJKM | | | | | | | | EC | EC | | | | I FL | FM | FG | | | LA | LB | LA | | | | |
| 3,900 pF | 392 | FGJKM | | | | | | | | EC | EC | | | | | FY | FL | | | | LB | LA | | | | |
| 4,300 pF | 432 | FGJKM | | | | | | | | ED | ED | | | | FM | FY | FL | | | | LU | | | | | |
| 4,700 pF | 472 | F G J K M | | | | | | | | ED | ED | | | | | FY | | | | | | | | | | |
| 5,100 pF | 512 | F G J K M | | | | | | | | | | | | | | 15 | | | | | LB | LB | | | | |
| 5,000 pF | 502 | | | | | | | | | | | | | | | F3 | | | | | | | | | | |
| 6,200pF | 682 | | | | | | | | | | EC | | | | | | | | | | | | | | | |
| 7.500pF | 752 | F G J K M | | | | | | | | FG | EG | | | | FS | FE | FS | | | | | LU | | | | |
| 8 200 pF | 822 | F G J K M | | | | | | | | FG | FG | | | | FS | FF | FS | | | | | | | | | |
| 9 100 pF | 912 | F G I K M | | | | | | | | FG | FG | | | | FF | FF | FS | | | | | | | | | |
| 10 000 pF | 103 | F G I K M | | | | | | | | FH | FH | | | | FG | FG | FS | | | | | | | | | |
| 12 000 pF | 123 | F G J K M | | | | | | | | FG | | | | | FG | FG | FM | | | | ΙΔ | | | | | |
| 15 000 pF | 153 | F G J K M | | | | | | | | FG | | | | | FM | FM | FS | | | I B | LB | | | | | |
| 18,000 pF | 183 | F G J K M | | | | | | | | 1 | | | | | FM | FM | FS | | | LC | LC | | | | | |
| 22.000 pF | 223 | F G J K M | | | | | | | | | | | | | FY | FY | FS | | | 1 | - • | | | | | |
| 27,000 pF | 273 | F G J K M | | | | | | | | | | | | | FS | FS | | | | 1 | | | | | | |
| 33,000 pF | 333 | F G J K M | | | | | | | | | | | | | FS | FS | | | | | | | | | | |
| | | Rated Voltage (VDC) | 500 | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| Capacitance | Cap Code | Voltage Code | С | c | В | D | С | В | D | c | В | D | F | G | c | В | D | F | G | c | В | D | F | G | Z | H |
| | | Case Size/Series | C0402C | C | 0603 | BC | C | 0805 | 5C | | C | 120 | 6C | | | C | 121(| oc | | | | C | 1808 | C | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82 and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).

These products are protected under US Patents 7,172,985 and 7,670,981, other patents pending, and any foreign counterparts.



Table 1B - Capacitance Range/Selection Waterfall (1812 - 2225 Case Sizes)

| | | Ca | se S | ize | /Se | ries | | | C1 | 81: | 2C | | | | | C1 | 82 | 5C | | | | | C2 | 22 | 0C | | | | | C | 22 | 25 | С | | |
|----------------|------------|----|------------------|-------|--------|------|----------|-----|--------|--------|--------|--------|--------|----------|----|-------------|-------------|----------------|---------------------|--------------|--------|--------------|-----------------|------------|------------|-------------------|---------|--------|----------|--------|---------|--------|--------|----------|-----------|
| Capacitance | Сар | | Volt | age C | ode | | С | В | D | F | G | z | H | С | В | D | F | G | z | н | C | В | D | F | G | z | н | C | В | D | F | G | z | н | К |
| | Code | Ra | ated V | oltag | e (VC |)C) | 8 | 30 | 000 | 500 | 000 | 500 | 000 | 00 | 30 | 000 | 500 | 000 | 500 | 000 | 00 | 30 | 000 | 500 | 000 | 500 | 000 | 00 | 30 | 000 | 500 | 000 | 500 | 000 | 000 |
| | | | Cap To | acita | nce | · · | | U | - | - | 7 | 7 | m | | Pr | rodu See | ct A Tab | raila Naila | ∾ abili for (| ty a Chin | nd (| Chip ickn | – Thi ess | ckn Dim | ess ens | ⊂∾ Cod ions | es s | | U | - | - | 0 | 0 | m | 1 |
| 10 pF - 47pF* | 100 - 470* | F | G | J | K | М | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 11 pF | 110 | F | G | J | K | M | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 12 pF | 120 | F | G | J | K | M | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 13 pF | 130 | | G | J | K | M | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 15 pF | 150 | | G | J | K | M | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 10 pF | 100 | | 6 | J | ĸ | | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | | | KF | |
| 20 pF | 200 | F | G | J | ĸ | M | GB | GB | GB | GB | GB | GB | GB | нс | нс | HC | HC | нс | HC | нс нс | JK | JK | JK | JK | JK | JK | JK | KE | | KE | | | | KE | |
| 20 pF 22 nF | 200 | F | G | J | ĸ | M | GB | GR | GB | GB | GB | GB | GR | HG | HG | HG | HG | HG | HG | HG | IK | IK | IK | IK | IK | IK | IK | KF | KF | KF | KF | KF | KF | KF | |
| 22 pr 24 nF | 240 | F | G | J | ĸ | M | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 27 pF | 270 | F | G | J | K | M | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 30 pF | 300 | F | G | J | K | M | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 33 pF | 330 | F | G | J | к | М | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 36 pF | 360 | F | G | J | К | М | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 39 pF | 390 | F | G | J | К | М | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 43 pF | 430 | F | G | J | K | M | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 47 pF | 470 | F | G | J | K | M | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | KE |
| 51 pF | 510 | F | G | J | K | M | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | KE |
| 56 pF | 560 | F | G | J | K | M | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | KE |
| 62 pF | 620 | F | G | J | K | M | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | KF |
| 68 pF | 680 | F | G | J | K | M | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | KF |
| 75 pF | 750 | F | G | J | K | M | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | KF |
| 82 pF | 820 | F | G | J | K | M | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | KF |
| 91 pF | 910 | F | G | J | K | M | GD | GD | GD | GD | GD | GD | GD | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | KH |
| 100 pF | 101 | F | G | J | K | M | GD | GD | GD | GD | GD | GD | GD | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | KH |
| 110 pF | 101 | | G | J | K | M | GD | GD | GD | GD | GD | GD | GD | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | KJ |
| 120 pF | 121 | | 6 | J | ĸ | M | | GD | GD | GD | GD | GD | GD | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | | | | KJ V I |
| 150 pF | 151 | | G | J | r v | M | | CD | CD | CD | CD | CD | GK | ПС | | | | по | по | пс | | | | | | | | | | | | | | | кJ |
| 160 pF | 161 | F | G | J | K | M | GD | GD | GD | GD | GD | GD | GK | HG | HG | HG | HG | HG | HG | HG | IK | IK | IK | IK | IK | IK | IK | KF | KF | KF | KF | KF | KF | KF | |
| 180 pF | 181 | F | G | J | K | M | GD | GD | GD | GD | GD | GD | GK | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 200 pF | 201 | F | G | J | ĸ | M | GD | GD | GD | GD | GD | GD | GM | HF | HF | HF | HF | HF | HF | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 220 pF | 221 | F | G | J | K | M | GB | GB | GB | GB | GB | GD | GM | HE | HE | HE | HE | HE | HE | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 240 pF | 241 | F | G | J | K | M | GB | GB | GB | GB | GB | GD | GM | HE | HE | HE | HE | HE | HE | HG | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KE | KE | KE | KF | |
| 270 pF | 271 | F | G | J | К | М | GB | GB | GB | GB | GB | GH | GM | HE | HE | HE | HE | ΗE | HE | HG | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KE | KE | KE | KF | |
| 300 pF | 301 | F | G | J | K | М | GB | GB | GB | GB | GB | GH | GM | HE | HE | HE | HE | HE | HE | HG | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KE | KE | KE | KF | |
| 330 pF | 331 | F | G | J | K | M | GB | GB | GB | GB | GB | GH | GO | HE | HE | HE | HE | HE | HE | HG | JE | JE | JE | JE | JE | JK | JK | KE | KE | KE | KE | KE | KE | KF | |
| 360 pF | 361 | F | G | J | K | M | GB | GB | GB | GB | GD | GK | GO | HE | HE | HE | HE | HE | HE | HG | JE | JE | JE | JE | JE | JK | JK | KE | KE | KE | KE | KE | KE | KF | |
| 390 pF | 391 | F | G | J | K | M | GB | GB | GB | GB | GD | GK | GO | HE | HE | HE | HE | HE | HE | HG | JE | JE | JE | JE | JE | JK | JK | KE | KE | KE | KE | KE | KE | KF | |
| 430 pF | 431 | F | G | J | K | М | GB | GB | GB | GB | GD | GK | | HE | HE | HE | HE | HE | HE | HJ | JE | JE | JE | JE | JE | JK | JE | KE | KE | KE | KE | KE | KE | KF | |
| 470 pF | 471 | F | G | J | K | М | GB | GB | GB | GB | GD | GK | | HE | HE | HE | HE | HE | HE | HJ | JE | JE | JE | JE | JE | JK | JK | KF | KF | KF | KF | KE | KE | KF | |
| 510 pF | 511 | F | G | J | K | M | GB | GB | GB | GD | GH | GM | | HE | HE | HE | HE | HE | HE | HJ | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KE | KE | KF | |
| 560 pF | 561 | F | G | J | K | M | GB | GB | GB | GD | GH | GM | | HE | HE | HE | HE | HG | HE | HJ | JK | JK | JK | JK | JK | JK | JL | KF | KF | KF | KF | KE | KE | KF | |
| 620 pF | 621 | F | G | J | K | M | GB | GB | GB | GD | GH | GM | | HE | HE | HE | HE | HG | HE | HK | JK | JK | JK | JK | JK | JK | JL | KF | KF | KF | KF | KE | KF | KH | |
| 080 pF | 081 | F | G | J | K | M | GB | GB | GB | GD | GH | 60 | | HE | HE | HE | HE | HG | HG | ΗK | JE | JE | JE | JK | JK | JK | JL | KF | KF | KF | KF | KE | KF | KH | |
| 750 pF | /51 | | C | J | K V | | СР СР | C P | CP | | GK | | | HE UE | | | нG | пс | по | | JE | JE | JE | JK | JK | JK | JL | | NE VE | | | | | KH KH | |
| 910 pF | 911 | | G | | ĸ | M | GB | GR | GR | GH | GM | | | HE | HE | HF | HG | HG | HG | | JE | JE | JE | JK | JK | JK | | KE | KE | KE | KF | KE | KF | KI | |
| 910 pi | | R | ated V | oltan | e (VI |)C) | 8 | 30 | 000 | 200 | 000 | 500 | 000 | 0 | 8 | 000 | 200 | 000 | 200 | ğ | 00 | 90 90 | 000 | 200 | 000 | 200 | 000 | 00 | 30 | 000 | 200 | 000 | 200 | 000 | 000 |
| Canacitanaa | Cap | | Volt | age (| ode | -, | C C | B | ≓ ₽ | ≓ F | 5 0 | з Z | ы Н | C C | B | ¥ ₽ | ≓≓ F | 5 0 | λ Ζ | ы Н | с С | ю В | ≓ ₽ | ≓ F | ы Б | ій Z | ы Н | C S | ю В | ¥ ₽ | ≓ F | ы Б | к Z | ы Н | K 5 |
| Capacitance | Code | | Case Size/Series | | | | | | `٦ | 1817 | 20 | _ | | | | ص | 1825 | 5C | - | | - | - | ^^ | |)C | | | | - | - | C22 | 250 | | | |
| | | | asec | 5120/ | Jen | -3 | | | | 1012 | | | | | | Ū | 1020 | | | | | 0 | | | | | | | | | | .230 | | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82 and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).

These products are protected under US Patents 7,172,985 and 7,670,981, other patents pending, and any foreign counterparts.

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Table 1B – Capacitance Range/Selection Waterfall (1812 – 2225 Case Sizes) cont.

| Capacitance | Cap Code | Case Size/Series | | | | C1812C | | | | | | | | C1825C | | | | | | | C2220C | | | | | | | C2225C | | | | | | | |
|----------------------|-------------|---------------------|---------------------|--------|--------|--------|-----|--------|-------|------|------|------|------|--------|-----|------------|------|------|------|------------|-------------|------|--------|------|------|------|------|--------|-----|--------|------|-----------|------|----------|------|
| | | Voltage Code | | | | С | В | D | F | G | z | н | С | В | D | F | G | z | н | C | В | D | F | G | z | н | С | В | D | F | G | z | н | К | |
| | | Rated Voltage (VDC) | | | | 500 | 630 | 000 | 500 | 000 | 500 | 000 | 500 | 630 | 000 | 1500 | 000 | 500 | 000 | 500 | 630 | 000 | 500 | 000 | 500 | 000 | 500 | 630 | 000 | 1500 | 000 | 500 | 000 | 0000 | |
| | | | Capacitance | | | | | - | - | - | 2 | 2 | m | | P | rodu | ct A | vail | abil | ity a | and | Chip | Thi | ckn | ess | Cod | es | | - | - | - | ~ | 2 | m | - |
| | | | Te | oleran | ce | | | | | | | | | | | <u>See</u> | Tab | le 2 | for | <u>Chi</u> | <u>p Th</u> | ickr | less | Din | nens | ion | s | | | | | | | | |
| 1,000 pF | 102 | F | G | J | K | M | GB | GB | GB | GH | GM | | | HE | HE | HE | HG | HG | HG | | JE | JK | JK | JK | JK | JK | JN | KE | KE | KE | KF | KE | KF | KJ | |
| 1,100 pF | 112 | | G | J | K | M | GB | GB | GB | GH | GO | | | HE | HE | HE | HG | HG | HJ | | JE | JK | JK | JK | JK | JK | | KE | KE | KE | KF | KF | KF | | |
| 1,200 pF | 122 | | G | J | K | M | GB | GB | GB | GH | GO | | | HE | HE | HE | HG | HG | HJ | | JE | JK | JK | JK | JK | JL | | KE | KE | KE | KF | KF | KF | | |
| 1,300 pF | 132 | | 6 | J | K | IVI | GB | GB | GB | GH | GU | | | HE | HE | HE | HG | HE | HJ | | JE | JK | JK | JK | JE | JL | | KE | KE | KE | KF | KF | KH | | |
| 1,500 pF | 152 | | 6 | J | K | IVI | GB | GB | GB | GK | GU | | | HE | HE | HE | HG | HE | HK | | JE | JK | JK | JK | JE | JL | | KE | KE | KE | KF | KF | KH | | |
| 1,600 pF | 102 | | 6 | J | K | IVI | GB | GD | GD | GK | | | | HE | HG | HG | HG | HG | нк | | JE | JK | JK | JK | JE | JL | | KE | KE | KE | KF | KE | KH | | |
| 1,800 pF | 182 | | 6 | J | ĸ | IM | GB | GD | GD | GM | | | | HE | HG | HG | HG | HG | | | JE | JK | JK | JK | JE | JN | | KE | KE | KE | KF | KE | KH | | |
| 2,000 pF | 202 | | G | J | K | M | GB | GH | GH | GM | | | | HE | HG | HG | HE | HJ | | | JE | JK | JK | JE | JK | | | KE | KE | KE | KF | KE | KJ | | |
| 2,200 pF | 222 | | 6 | J | K | M | GB | GH | GH | 60 | | | | HE | HG | HG | HE | HJ | | | JE | JK | JK | JE | JK | | | KE | KE | KE | KF | KF | KJ | | |
| 2,400 pF | 242 | | 6 | J | K | M | GB | GH | GK | 60 | | | | HE | HG | HG | HE | HJ | | | JK | JK | JK | JE | JL | | | KE | KE | KE | KE | KH | | | |
| 2,700 pF | 2/2 | | 6 | J | ĸ | M | GB | GH | GK | 60 | | | | HE | HG | HG | HE | HK | | | JK | JK | JK | JE | JL | | | KE | KE | KE | KE | KH | | | |
| 3,000 pF | 302 | | G | J | ĸ | IVI | GB | GH | GK | | | | | по | | HG | HE | пк | | | JK | JK | JK | JE | JL | | | KE | KE | KE | KE | KI | | | |
| 3,300 pr | 332 | | G | J | N K | IVI | | GH | GK | | | | | ПС | | HG | HG | | | | JK | JK | JK | | | | | KE | KE | KE | KE | KJ | | | |
| 3,000 pF | 302 | | G | J | ĸ | IVI | | GH | GIVI | | | | | по | | | ны | | | | JK | JK | JK | | | | | | | | | KJ V I | | | |
| 3,900 pF | 392 | | G | J | ĸ | IVI | | СП | GIVI | | | | | | | | пј | | | | | | | JK | JIN | | | | | | | RJ | | | |
| 4,300 pr 4,700 pE | 432 | | G | J | r v | M | СЦ | СЦ | 60 | | | | | | | | пJ | | | | | | | JK | | | | | | | | | | | |
| 4,700 pr | 512 | | G | J | K K | M | | GK | 60 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5,100 pF | 562 | | G | | R R | M | | GK | 60 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5,000 pr | 622 | | G | | R R | M | | GK | CU CU | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6,200pT | 682 | F | G | | ĸ | M | СН | GM | СН | | | | | нс | HE | н | | | | | | IF | | | | | | KE | KE | KE | K I | | | | |
| 7,500pF | 752 | F | G | 1 | ĸ | M | СН | GM | CK | | | | | нс | HE | н | | | | | IK | IF | IK | | | | | KE | KE | KE | KJ | | | | |
| 8 200 pF | 822 | F | G | 1 | K | M | CK | 60 | CK | | | | | нс | HE | HI | | | | | IK | IE | | | | | | KE | KE | KE | | | | | |
| 0,200 pr | 022 | F | G | 1 | ĸ | M | GM | 00 | GM | | | | | HE | нс | нк | | | | | | IF | | | | | | KE | KE | КН | | | | | |
| 10 000 pF | 103 | F | G | 1 | ĸ | M | GM | 00 | GM | | | | | HE | нс | нк | | | | | IF | IF | | | | | | KE | KE | КН | | | | | |
| 12 000 pF | 123 | F | G | Ĭ | ĸ | M | 60 | GH | GO | | | | | HE | HG | HE | | | | | IF | IK | IN | | | | | KE | KE | кн | | | | | |
| 15,000 pF | 153 | F | G | 1 | ĸ | M | 60 | GH | 60 | | | | | HE | ні | HE | | | | | IF | | IF | | | | | KE | KE | KI | | | | | |
| 18,000 pF | 183 | F | G | 1 | ĸ | M | GН | GH | 00 | | | | | НG | нк | HG | | | | | IF | | IF | | | | _ | KE | KH | KE | | | | | |
| 22 000 pF | 223 | F | G | J | ĸ | M | GH | GH | | | | | | H.I | HF | HJ | | | | | .IK | JN | JK | | | | | KF | K.I | KE | | | | | |
| 27,000 pF | 273 | F | G | J | ĸ | M | GK | GK | | | | | | H.I | HE | нк | | | | | | JN | | | | | | KF | K.I | КН | | | | | |
| 33 000 pF | 270 | F | G | Ĭ | ĸ | M | GM | GM | | | | | | нк | HE | нк | | | | | | IF | | | | | | кн | KE | кн | | | | | |
| 39 000 pF | 393 | F | G | . J | ĸ | M | GO | GO | | | | | | HF | HE | | | | | | JE | JE | | | | | | K.I | KF | K.I | | | | | |
| 47.000 pF | 473 | F | G | J | ĸ | M | GO | GO | | | | | | HE | HE | | | | | | JE | JE | | | | | | KF | KE | 110 | | | | | |
| 56 000 pF | 563 | F | G | J | ĸ | M | 00 | | | | | | | HG | HG | | | | | | JK | JK | | | | | | KF | KF | | | | | | |
| 68 000 pF | 683 | F | G | J | ĸ | M | | | | | | | | нJ | HJ | | | | | | JI | JI | | | | | | KF | KF | | | | | | |
| 82.000 pF | 823 | F | G | J | ĸ | M | | | | | | | | нк | НК | | | | | | JL | JL | | | | | | кн | КН | | | | | | |
| 0.1 µF | 104 | F | G | J | K | M | | | | | | | | ΗК | HK | | | | | | JN | JN | | | | | | КН | KH | | | | | | |
| 0.12 µF | 124 | F | G | J | К | М | | | | | | | | | | | | | | | | | | | | | | КJ | KJ | | | | | | |
| Capacitance | Cap Code | R | Rated Voltage (VDC) | | | | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 0000 |
| | | Voltage Code | | | | С | В | D | F | G | z | H | С | В | D | F | G | Z | H | c | В | D | F | G | z | H | c | В | D | F | G | z | H | ĸ | |
| | | Case Size/Series | | | | | | C1812C | | | | | | | | C1825C | | | | | | | C2220C | | | | | | | C2225C | | | | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82 and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).

These products are protected under US Patents 7,172,985 and 7,670,981, other patents pending, and any foreign counterparts.

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Table 1C - Capacitance Range/Selection Waterfall (2824 - 4540 Case Sizes)

| cap | | Ca | ise Si Serie | ze/ s | C2824C | | | | C | 3040 | C | | | C3640C | | | | | C | 454(| 40C | | | |
|-------------|------|-------|----------------------|----------|--------|-----|------|------|------|------|-------|-----------|--------------------|--------|--------|--------|--------|--------|------|-------------|-----|------|------|------|
| Canacitance | Сар | V V | oltage Co | ode | c | В | D | F | G | C | В | D | F | G | C | В | D | F | G | c | В | D | F | G |
| oupuontanoe | Code | Vo | Rated Itage (V | DC) | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 |
| | | C | apacitan Toleranc | ce | | | | | | P | roduc | t Ava | ilabili 2 for 1 | ty and | d Chip | Thic | kness | Cod | es | • • • • • • | | | | |
| 2 200 nF | 222 | J | K | M | TA | TA | TA | TA | TA | | Jeel | able | 2 101 0 | | | 1622 1 | Jillen | 510115 | | | | | | |
| 2,200 pF | 272 | Ĵ | ĸ | M | ТА | ТА | ТА | ТА | ТА | | | | | | | | | | | | | | | |
| 3 300 pF | 332 | J | ĸ | M | ТА | ТА | ТА | TA | TA | OB | OB | OB | OB | OB | | | | | | | | | | |
| 3.900 pF | 392 | Ĵ | ĸ | M | ТА | TA | TA | TA | ТВ | OB | OB | OB | OB | OB | МА | МА | MA | MA | МА | | | | | |
| 4.700 pF | 472 | Ĵ | ĸ | M | ТА | TA | TA | ТВ | TB | OB | OB | OB | OB | OB | MA | MA | MA | MA | MA | SA | SA | SA | SA | SA |
| 5.600 pF | 562 | J | K | M | TA | TA | TA | TB | TC | OB | OB | OB | OB | OB | MA | MA | MA | MA | MA | SA | SA | SA | SA | SA |
| 6.800 pF | 682 | J | ĸ | M | TA | TA | TA | TB | | OB | OB | OB | OB | oc | МА | MA | MA | MA | MA | SA | SA | SA | SA | SA |
| 8.200 pF | 822 | J | ĸ | M | TA | TA | TA | TC | | OB | OB | OB | oc | oc | МА | MA | MA | MA | MB | SA | SA | SA | SA | SA |
| 10.000 pF | 103 | J | ĸ | M | TA | TA | TA | | | OB | OB | OB | oc | OD | МА | MA | MA | MA | MB | SA | SA | SA | SA | SB |
| 12.000 pF | 123 | Ĵ | ĸ | M | ТА | TA | TA | | | OB | OB | OB | OD | 1 | МА | MA | MA | MB | MB | SA | SA | SA | SA | SB |
| 15.000 pF | 153 | J | K | M | TA | TA | TB | | | OB | OB | OB | OD | | MA | MA | MA | MB | MC | SA | SA | SA | SB | SB |
| 18 000 pF | 183 | J | ĸ | M | TA | TA | TB | | | OB | OB | OB | - | | MA | MA | MA | MC | | SA | SA | SA | SB | SC |
| 22 000 pF | 223 | J | ĸ | M | ТА | TB | тс | | | OB | OB | 0C | | | МА | MA | MA | | | SA | SA | SA | SB | |
| 27 000 pF | 273 | J | ĸ | M | ТА | TB | | | | OB | OB | 0C | | | МА | MA | MA | | | SA | SA | SA | SC | |
| 33 000 pF | 333 | J | ĸ | M | ТВ | TB | | | | OB | 0C | 0C | | | МА | MA | MB | | | SA | SA | SA | | |
| 39 000 pF | 393 | J | ĸ | M | TB | TC | | | | OB | 00 | | | | МА | MA | MB | | | SA | SA | SB | | |
| 47,000 pF | 473 | J | ĸ | M | TB | | | | | OB | 0C | | | | МА | MB | MC | | | SA | SA | SB | | |
| 56 000 pF | 563 | J | ĸ | M | тс | | | | | 0C | | | | | МА | MB | | | | SA | SA | SB | | |
| 68,000 pF | 683 | Ĵ | ĸ | M | | | | | | 0C | | | | | MB | мс | | | | SA | SB | SC | | |
| 82 000 pF | 823 | Ĵ | ĸ | M | | | | | | 0C | | | | | MB | | | | | SA | SB | | | |
| 01 uF | 104 | J | K | M | | | | | | | | | | | MC | | | | | SB | SC | | | |
| 0.12 µF | 124 | J | ĸ | M | | | | | | 1 | | | | | мс | | | | | SB | | | | |
| 0.15 µF | 154 | Ĵ | ĸ | M | | | | | | | | | | | | | | | | SC | | | | |
| | | | | (112.0) | • | • | 8 | 8 | 8 | - | • | 8 | 8 | 8 | - | • | 8 | 8 | 8 | 0 | • | 8 | 8 | 8 |
| | | Rated | Voltage | (VDC) | 5 | 63 | 10 | 150 | 20(| 5 | 63 | <u>10</u> | 150 | 20(| 50 | 63 | 5 | 150 | 20(| 50 | 63 | 10 | 150 | 20(|
| Capacitance | Cap | Vo | oltage Co | ode | С | В | D | F | G | C | В | D | F | G | C | В | D | F | G | C | В | D | F | G |
| | Cone | Case | e Size/S | eries | | C | 2824 | C | | | C | 3040 | С | | | C | 3640 | С | | | C | 4540 | С | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82 and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).

These products are protected under US Patents 7,172,985 and 7,670,981, other patents pending, and any foreign counterparts.



Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper C |)uantity | Plastic (| Quantity |
|-----------|------|--------------|---------|----------|-----------|----------|
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| BB | 0402 | 0.50 ± 0.05 | 10000 | 50000 | 0 | 0 |
| BD | 0402 | 0.55 ± 0.05 | 10000 | 50000 | 0 | 0 |
| CG | 0603 | 0.80 ± 0.10* | 4000 | 15000 | 0 | 0 |
| DN | 0805 | 0.78 ± 0.10* | 4000 | 15000 | 0 | 0 |
| DP | 0805 | 0.90 ± 0.10* | 4000 | 15000 | 0 | 0 |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EB | 1206 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| EC | 1206 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| ED | 1206 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| EE | 1206 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EG | 1206 | 1.60 ± 0.15 | 0 | 0 | 2,000 | 8,000 |
| EH | 1206 | 1.60 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FE | 1210 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FF | 1210 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FG | 1210 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| FL | 1210 | 1.40 ± 0.15 | 0 | 0 | 2,000 | 8,000 |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FY | 1210 | 2.00 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FK | 1210 | 2.10 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1,000 | 4,000 |
| LA | 1808 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| LB | 1808 | 1.60 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| LC | 1808 | 2.00 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size | Range (mm) | Paper C |)uantity | Plastic | Quantity |

Package quantity based on finished chip thickness specifications.



Table 2A - Chip Thickness/Tape & Reel Packaging Quantities cont.

| Thickness | Case | Thickness ± | Paper C |)uantity | Plastic | Quantity | | |
|-----------|------|-------------|---------|----------|---------|----------|--|--|
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | |
| GD | 1812 | 1.25 ± 0.15 | 0 | 0 | 1,000 | 4,000 | | |
| GH | 1812 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | | |
| GK | 1812 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 | | |
| GM | 1812 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 | | |
| GO | 1812 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 | | |
| HE | 1825 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | | |
| HG | 1825 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 | | |
| HJ | 1825 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 | | |
| HK | 1825 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 | | |
| JE | 2220 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | | |
| JK | 2220 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 | | |
| JL | 2220 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 | | |
| JN | 2220 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 | | |
| KE | 2225 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | | |
| KF | 2225 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 | | |
| KH | 2225 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 | | |
| KJ | 2225 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 | | |
| TA | 2824 | 1.40 ± 0.15 | 0 | 0 | 750 | 1,500 | | |
| ТВ | 2824 | 2.00 ± 0.20 | 0 | 0 | 300 | 1,500 | | |
| TC | 2824 | 2.50 ± 0.20 | 0 | 0 | 300 | 1,500 | | |
| QB | 3040 | 1.40 ± 0.15 | 0 | 0 | 500 | 1,000 | | |
| QC | 3040 | 2.00 ± 0.20 | 0 | 0 | 500 | 1,000 | | |
| QD | 3040 | 2.50 ± 0.20 | 0 | 0 | 350 | 1,000 | | |
| MA | 3640 | 1.40 ± 0.15 | 0 | 0 | 250 | 1,000 | | |
| MB | 3640 | 2.00 ± 0.20 | 0 | 0 | 250 | 1,000 | | |
| MC | 3640 | 2.50 ± 0.20 | 0 | 0 | 250 | 1,000 | | |
| SA | 4540 | 1.40 ± 0.15 | 0 | 0 | 200 | 1,000 | | |
| SB | 4540 | 2.00 ± 0.20 | 0 | 0 | 200 | 1,000 | | |
| SC | 4540 | 2.50 ± 0.20 | 0 | 0 | 200 | 1,000 | | |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | |
| Code | Size | Range (mm) | Paper (|)uantity | Plastic | Quantity | | |

Package quantity based on finished chip thickness specifications.



Table 2B – Bulk Packaging Quantities

| Deeker | | Loose Packaging | | | | | |
|----------|-----------------------|------------------------|------------------------|--|--|--|--|
| Раскау | ing type | Bulk Bag (default) | | | | | |
| Packagin | g C-Spec ¹ | N/ | /A ² | | | | |
| Case | Size | Packaging Quantities (| pieces/unit packaging) | | | | |
| EIA (in) | Metric (mm) | Minimum | Maximum | | | | |
| 0402 | 1005 | | | | | | |
| 0603 | 1608 | | | | | | |
| 0805 | 2012 | | 50,000 | | | | |
| 1206 | 3216 | | | | | | |
| 1210 | 3225 | 1 | | | | | |
| 1808 | 4520 | | | | | | |
| 1812 | 4532 | | | | | | |
| 1825 | 4564 | | 20,000 | | | | |
| 2220 | 5650 | | | | | | |
| 2225 | 5664 | | | | | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial Grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive Grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size Code | EIAMetricDensity Level A:SizeSizeMaximum (Most)CodeCodeLand Protrusion (mm) | | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | |
|---------------------|---|------|------|-------|--|-------|------|------|-------|---|-------|------|------|-------|-------|-------|
| | | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 |
| 1825 | 4564 | 2.15 | 1.60 | 6.90 | 6.90 | 7.90 | 2.05 | 1.40 | 6.80 | 6.00 | 7.30 | 1.95 | 1.20 | 6.70 | 5.30 | 7.00 |
| 2220 | 5650 | 2.75 | 1.70 | 5.50 | 8.20 | 6.50 | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | 2.55 | 1.30 | 5.30 | 6.60 | 5.60 |
| 2225 | 5664 | 2.70 | 1.70 | 6.90 | 8.10 | 7.90 | 2.60 | 1.50 | 6.80 | 7.20 | 7.30 | 2.50 | 1.30 | 6.70 | 6.50 | 7.00 |
| 2824 | 7260 | 3.45 | 1.70 | 6.60 | 9.60 | 7.60 | 3.35 | 1.50 | 6.50 | 8.70 | 7.00 | 3.25 | 1.30 | 6.40 | 8.00 | 6.70 |
| 3040 | 7610 | 3.70 | 1.70 | 10.70 | 10.10 | 11.70 | 3.60 | 1.50 | 10.60 | 9.20 | 11.10 | 3.50 | 1.30 | 10.50 | 8.50 | 10.80 |
| 3640 | 9210 | 4.45 | 1.70 | 10.70 | 11.60 | 11.70 | 4.35 | 1.50 | 10.60 | 10.70 | 11.10 | 4.25 | 1.30 | 10.50 | 10.00 | 10.80 |
| 4540 | - | 5.60 | 1.70 | 10.70 | 13.90 | 11.70 | 5.50 | 1.50 | 10.60 | 13.00 | 11.10 | 5.40 | 1.30 | 10.50 | 12.30 | 10.80 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/ J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Terminat | on Finish | | |
|--|-----------------------|-----------------------|--|--|
| Tomeredure | SnPb | 100% Matte Sn | | |
| Preheat/Soak | | | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C | | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | | |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds | | |
| Ramp-Up Rate (T_L to T_p) | 3°C/second maximum | 3°C/second maximum | | |
| Liquidous Temperature (T _L) | 183°C | 217°C | | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | | |
| Peak Temperature (T _P) | 235°C | 260°C | | |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum | 30 seconds maximum | | |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | 6°C/second maximum | | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | | |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test Condition | Limits |
|--|----------------|--|--|
| Visual and Mechanical | KEMET Internal | No defects that may affect performance (10X) | Dimensions according KEMET Spec Sheet |
| Capacitance (Cap) | KEMET Internal | C ≤ 1,000 pF Frequency: 1 MHz ±100 kHz Voltage*:1.0 V _{rms} ±0.2 V C > 1,000 pF Frequency: 1 kHz ±50 Hz Voltage: 1.0 V _{rms} ±0.2 V * See part number specification sheet for voltage | Within Tolerance |
| Dissipation Factor (DF) | KEMET Internal | C ≤ 1,000 pF Frequency: 1 MHz ±100 kHz Voltage*:1.0 V _{rms} ±0.2 V C > 1,000 pF Frequency: 1 kHz ±50 Hz Voltage: 1.0 V _{rms} ±0.2 V * See part number specification sheet for voltage | Within Specification Dissipation factor (DF) maximum limit at 25°C = 0.1% |
| Insulation Resistance (IR) | KEMET Internal | 500 VDC applied for 120 ±5 seconds at 25°C | Within Specification To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ limit. Select the lower of the two limits. 1,000 megohm microfarads or 100 GΩ. |
| Temperature Coefficient of Capacitance (TCC) | KEMET Internal | Capacitance change with reference to +25°C and 0 VDC applied. * See part number specification sheet for voltage Step Temperature (°C) 1 +25°C 2 -55°C 3 +25°C (Reference Temperature) 4 +125°C | Within Specification: ±30 ppm / °C |



Table 4 – Performance & Reliability: Test Methods and Conditions cont.

| Stress | Reference | Test C | Limits | | | |
|--|-------------------------|--|--|--------------------------------|--|--|
| | | See Dielectric Withstanding \ (5 ±1 seconds and charge/dis | Voltage (DWV) Table scharge not exceeding | g 50 mA) | | |
| | | EIA Case 500 V Size | 630 V | ≥ 1,000 V | | |
| | | 0402 120% of rated voltage | N/A | N/A | | |
| | | 0603 | 130% of rated voltage | | | |
| Dielectric | | 0805 | 620pF 150% of rated voltage 620pF 130% of rated voltage | | DF: Initial Limit | |
| Withstanding | KEMET Internal | 1206 | < 5.1nF 150% of rated voltage ≥ 5.1nF 130% of rated voltage | | IR: Initial Limit | |
| Voltage (DWV) | | 1210 | < 7.5nF 150% of rated voltage ≥ 7.5nF 130% of rated voltage | | Withstand test voltage without | |
| | | 1808 150% | < 5.1nF 150% of rated voltage ≥ 5.1nF 130% of rated voltage | 120% of | insulation breakdown or damage. | |
| | | 1812 | < 12nF 150% of rated voltage ≥ 12nF 130% of rated voltage | | | |
| | | 1825 | < 22nF 150% of rated voltage ≥ 22nF 130% of rated voltage | | | |
| | | 2220 | < 27nF 150% of rated voltage ≥ 27nF 130% of rated voltage | | | |
| | | 2225 | < 33nF 150% of rated voltage ≥ 33nF 130% of rated voltage | | | |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | KEMET Internal | Maximum % capacit | ance loss/decade ho | 0% Loss/Decade Hour | | |
| | | Shear stress test p Time: 60 | per specific case size,) ±1 second. | , | | |
| Terminal Strength | KEMET Internal | Case Size Force 0402 3N 0603 5N 0805 9N ≥ 1206 18N | | | No evidence of mechanical damage | |
| Board Flex | AEC-Q200-005 | Standard Termination System 2.0 mm Flexible Termination System 3.0 mm Test Time: 60 ±5 seconds Ramp Time: 1 mm/second | | 2000 t → t * (Unit : mm) | No evidence of mechanical damage | |
| Solderability | J-STD-002 | Condition: 4 hours ± 15 apply a Test 245 ±5°C | minutes at 155°C dry Il methods (SnPb & Pb-Free) | bake | Visual Inspection. 95% coverage on termination. No leaching | |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (2 – 3 cyc Soak Time | -55°C to +125°C) les per hour 1 or 5 minutes | | Measurement at 24 hours ±4 hours after test conclusion. Cap: Initial Limit DF: Initial Limit IR: Initial Limit | |



Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test Condition | Limits |
|---------------------------|---------------------------|---|---|
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and 200 VDC maximum Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5% |
| Moisture Resistance | MIL-STD-202 Method 106 | Number of Cycles Required: 10, 24 hours per cycle. Steps 7a and 7b not required | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Thermal Shock | MIL-STD-202 Method 107 | Number of Cycles Required: 5, (-55°C to 125°C) Dwell time 15 minutes. | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| High Temperature Life | MIL-STD-202 | 1,000 hours at 125°C with 1.2 X rated voltage applied. | Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift |
| Storage Life | Method 108 | 1,000 hours at 150°C, Unpowered | DF Limits Maximum: 0.5% IR: 10% of Initial Limit |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Test from 10 – 2,000 Hz | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Mechanical Shock | MIL-STD-202 Method 213 | 1,500 g's 0.5 millisecond Half-sine, Velocity Change: 15.4 feet/second (Condition F) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents. | Visual Inspection 10X Readable marking, no decoloration or stains. No physical damage. |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction



Capacitor Marking (Optional)

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- · EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12, 16 and 24 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punched Paper | | | |
|-------------------|------|---------|--------------------|---------------|--------------------|---|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | |
| | (W)* | Pitch | (P ₁)* | Pitch | (P ₁)* | | |
| 01005 - 0402 | 8 | | | 2 | 2 | | |
| 0603 | 8 | | | 2/4 | 2/4 - | - | |
| 0805 | 8 | 4 | 4 | 4 | 4 | | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | | |
| 1805 - 1808 | 12 | 4 | 4 | | | | |
| ≥ 1812 | 12 | 8 | 8 | | | | |
| 2824 | 16 | 12 | 12 | | | | |
| 3040 - 4540 | 24 | 16 | 16 | | | | |
| KPS 1210 | 12 | 8 | 8 | | | | |
| KPS 1812 & 2220 | 16 | 12 | 12 | | | | |
| Array 0508 & 0612 | 8 | 4 | 4 | | | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs
- Double the parts on each reel results in fewer reel changes and increased efficiency
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions — Millimeters (Inches) | | | | | | | | | | | |
|-----------|--|----------------------------|----------------------------|----------------------------|---------------------------|----------------------------------|--------------------------------|------------------|--|--|--|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T1 Maximum | | | | |
| 8 mm | | | | | 25.0 (0.984) | | | | | | | |
| 12 mm | 1.5+0.10/-0.0 (0.059+0.004/-0.0) | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.05 (0.079±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | | | |
| 16 mm | | | | | (1.181) | | | | | | | |
| 24 mm | 1.5+0.10/-0.0 (0.059+0.004/-0.0) | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.10 (0.078±0.003) | 30 (1.181) | 5 (0.196) | 0.250 (0.009) | 0.350 (0.013) | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | | | | |
| Tape Size | Pitch | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B ₀ | & K ₀ | | | | |
| 8 mm | Single (4 mm) | 6.25 (0.246) | 3.5±0.05 (0.138±0.002) | 4.0±0.10 (0.157±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | | | | |
| 12 mm | Single (4 mm) & Double (8 mm) | 10.25 (0.404) | 5.5±0.05 (0.217±0.002) | 8.0±0.10 (0.315±0.004) | 4.6 (0.181) | 12.3 (0.484) | Not | o F | | | | |
| 16 mm | Triple (12 mm) | 14.25 (0.561) | 7.5±0.05 (0.138±0.002) | 12.0±0.10 (0.157±0.004) | 4.6 (0.181) | 16.3 (0.642) | NOL | сJ | | | | |
| 24 mm | 16 mm | 22.25 (0.875) | 11.5±0.10 (0.452±0.003) | 16.0±0.10 (0.629±0.004) | 3 (0.118) | 24.3 (0.956) | | | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6).

3. If S₁ < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Standard 481 paragraph 4.3 section b).

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3).

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4).

(e) for KPS Series product, A_0 and B_0 are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | | Constant D |)imensions — M | lillimeters (Inch | es) | | |
|-----------|-------------------------------------|----------------------------|---------------------------|---------------------------|----------------------------|-----------------|-------------------------------|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 |
| 8 mm | 1.5+0.10/-0.0 (0.059+0.004/-0.0) | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.05 (0.079±0.002) | 0.10 (0.004) Maximum | 0.75 (0.030) | 2 (0.984) |
| | | Variable D | imensions — M | illimeters (Inche | es) | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ |
| 8 mm | Half (2 mm) | 6.25 | 3.5±0.05 | 2.0±0.05 (0.079±0.002) | 1.1 | 8.3 (0.327) | Noto 1 |
| 8 mm | Single (4 mm) | (0.246) | (0.138±0.002) | 4.0±0.10 (0.157±0.004) | (0.098) | 8.3 (0.327) | NOLE I |

1. The cavity defined by $A_{o'}B_{o}$ and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3).

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4).

e) see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6).



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 Kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |
| 24 mm | 0.1 to 1.6 newton (10 to 160 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ±10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant | Dimensions — Millimete | rs (Inches) | |
|-----------|-------------------|-------------------------------------|---------------------------------------|----------------------------|
| Tape Size | А | B Minimum | С | D Minimum |
| 8 mm | 170:0.00 | | | |
| 12 mm | (7.008 ± 0.008) | 1.5 (0.059) | 13.0+0.5/-0.2 (0.521+0.02/-0.008) | 20.2 (0.795) |
| 16 mm | or 330±0.20 | | | |
| 24 mm | (13.000±0.008) | 1.2 (0.047) | 13.0 + -0.2 (0.521 + -0.008) | 21 (0.826) |
| | Variable | Dimensions — Millimete | rs (Inches) | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ |
| 8 mm | | 8.4+1.5/-0.0 (0.331+0.059/-0.0) | 14.4 (0.567) | |
| 12 mm | 50 | 12.4+2.0/-0.0 (0.488+0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape |
| 16 mm | (1.969) | 16.4+2.0/-0.0 (0.646+0.078/-0.0) | 22.4 (0.882) | width without interference |
| 24 mm | | 25+1.0/-0.0 (0.984+0.039/-0.0) | 27.4+1.0/-1.0 (1.078+0.039/-0.039) | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Application Guide

Solder Fluxes and Cleaning

The use of water-soluble fluxes provides advantages of excellent solderability due to high activation. However, these fluxes contain organic acids that can induce arcing under high DC or AC voltages. Notable problem areas are underneath the MLCC where flux can be trapped between the ceramic material and PCB. It is therefore critical that PCBs are properly cleaned to remove all flux residue to maintain reliability.

Coating for High Voltage MLCCs

For MLCC ratings \geq 1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

| Dielectric | CTE (ppm/°C) |
|----------------------------|--------------|
| Class II BaTiO₃ | 10.7 |
| Class I CaZrO ₃ | 9.8 |

Slits in PCB

It is recommended to apply a slit in the PCB under the MLCC to improve washing of flux residue that may get trapped underneath. In some cases, it is not possible to slit entirely through the PCB due to underlying metal planes. It is also acceptable to apply a recessed slit under the MLCC which will also promote cleaning.

- Recommended for case sizes ≥1206
- The width (w) of the slit should be 1mm
- Length of the slit should be as short as possible to prevent damaging the MLCC due to mechanical stress of the PCB.
- Slits also reduce the risk of solder balls under MLCC which decreased the creepage distance.



Solder Resist

If a slit cannot be applied as above, it is recommended to not use solder resist directly under the MLCC. The use of solder resist material reduces the distance between MLCC ceramic material and PCB thus making it difficult to clean.

Solder Balls

Improper reflow techniques and/or improper washing can induce solder balls under or adjacent to the MLCC. Solder balls reduce the creepage distance between the MLCC terminations and increase the risk of arcing or damage to the ceramic material. To reduce the risk of solder balls:

- Follow KEMET's solder recommendations as outlined in the datasheet.
- If performing a cleaning procedure, properly clean the PCB per KEMET's cleaning recommendations.
- Add slit to the PCB as shown above.



Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs) **High Voltage X7R Dielectric, 500 – 3,000 VDC** (Commercial Grade)



Overview

KEMET's High Voltage surface mount MLCCs in X7R Dielectric feature a 125°C maximum operating temperature and are considered "temperature stable." The Electronics Industries Alliance (EIA) characterizes X7R dielectric as a Class II material. Components of this classification are fixed, ceramic dielectric capacitors suited for bypass and decoupling applications or for frequency discriminating circuits where Q and stability of capacitance characteristics are not critical. X7R exhibits a predictable change in capacitance with respect to time and voltage and boasts a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to $\pm 15\%$ from -55° C to $+125^{\circ}$ C.

In addition to Commercial Grade, Automotive Grade devices are available which meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.

Applications

- Charging stations
- · LCD fluorescent backlight ballasts
- · Voltage multiplier circuits
- DC/DC converters
- Power supply
- LAN/WAN interface
- High voltage decoupling
- Filters
- DC blocking
- ESD Protection



Ordering Information

| С | 1210 | C | 154 | K | C | R | Α | C | TU |
|---------|--|--------------------------|---|---------------------------------|---|------------|------------------------|---|--|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/Design | Termination Finish ¹ | Packaging/ Grade (C-Spec) |
| | 0402 0603 0805 1206 1210 1808 1812 1825 2220 2225 | C = Standard | Two significant digits and number of zeros. | J = ±5% K = ±10% M = ±20% | C = 500 B = 630 D = 1,000 F = 1,500 G = 2,000 Z = 2,500 H = 3,000 | R = X7R | A = N/A | C = 100% Matte Sn L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ Additional termination finish options may be available. Contact KEMET for details.



Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) |
|--|---|
| Bulk Bag/Unmarked | Not required (Blank) |
| 7" Reel/Unmarked | TU |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) |
| 7" Reel/Marked | ТМ |
| 13" Reel/Marked | 7040 (EIA 0603) 7215 (EIA 0805 and largSer case sizes) |
| 7" Reel/Unmarked/2mm pitch ² | 7081 |
| 13" Reel/Unmarked/2mm pitch ² | 7082 |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking".

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

Benefits

- -55°C to +125°C operating temperature range
- · Industry-leading CV values
- · Exceptional performance at high frequencies
- Lead (Pb)-free, RoHS and REACH compliant
- EIA 0402, 0603, 0805, 1206, 1210, 1808, 1812, 1825, 2220, and 2225 case sizes
- DC voltage ratings of 500 V, 630 V, 1 KV, 1.5 KV, 2 KV, 2.5 KV, and 3 KV
- Capacitance offerings ranging from 10 pF to 560 nF

- Available capacitance tolerances of ±5%, ±10%, and ±20%
- Low ESR and ESL
- Non-polar device, minimizing installation concerns
- Automotive (AEC-Q200) Grade available
- 100% pure matte tin-plated termination finish allowing for excellent solderability
- SnPb plated termination finish option available upon request (5% Pb minimum)

Applications

Typical applications include switch mode power supplies (input filters, resonators, tank circuits, snubber circuits, output filters), high voltage coupling and DC blocking, lighting ballasts, voltage multiplier circuits, DC/DC converters and coupling capacitors in Ćuk converters. Markets include power supply, LCD fluorescent backlight ballasts, HID lighting, telecom equipment, industrial and medical equipment/control, LAN/WAN interface, analog and digital modems, and automotive (electric and hybrid vehicles, charging stations and lighting applications).

Application Note

X7R dielectric is not recommended for AC line filtering or pulse applications. These capacitors and/or the assembled circuit board containing these capacitors may require a protective surface coating to prevent external surface arcing.



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|-------------------------------|-----------------|-------------------------------|----------------------------|---------------------------------|
| 0402 | 1005 | 1.00 (0.040) ±0.05 (0.002) | 0.50 (0.020) ±0.05 (0.002) | | 0.30 (0.012) ±0.10 (0.004) | 0.30 (0.012) | Solder Reflow Only |
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | |
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave or Solder Reflow |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | | |
| 1210 | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | See Table 2 for | 0.50 (0.02) ±0.25 (0.010) | | |
| 1808 | 4520 | 4.70 (0.185) ±0.50 (0.020) | 2.00 (0.079) ±0.20 (0.008) | Thickness | 0.60 (0.024) ±0.35 (0.014) | | |
| 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | | 0.60 (0.024) ±0.35 (0.014) | N/A | Solder Reflow |
| 1825 | 4564 | 4.50 (0.177) ±0.30 (0.012) | 6.40 (0.252) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | Only |
| 2220 | 5650 | 5.70 (0.224) ±0.40 (0.016) | 5.00 (0.197) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | |
| 2225 | 5664 | 5.60 (0.220) ±0.40 (0.016) | 6.40 (0.248) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | |

Qualification/Certification

Commercial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance & Reliability.

Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions (excluding SnPb termination finish option).



Table 1A - Capacitance Range/Selection Waterfall (0603 - 1812 Case Sizes)

| | | Cas S | se S Serie | ize/ s | C0402C | C | 060: | 3C | С |)805 | 5C | | C | 120 | 6C | | | C | 121(| C | | | | C 1 | 1808 | BC | | | | | C1 | 812 | C ² | | |
|----------------------|------------|-----------|----------------|------------------|--------|-----|------|------|----------|----------|------------|----------|----------|----------|----------|----------|----------|----------|------|------|------|-------|-------|------------|-----------|------|------|------|------|-----|----------|------|-----------------------|------|------|
| Сар | Сар | Volt | age (| Code | C | C | В | D | C | B | D | C | В | D | F | G | C | В | D | F | G | С | В | D | F | G | z | н | С | B | D | F | G | z | н |
| | Code | Rate | ed Vol (VDC | tage | 500 | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 000 | 1500 | 2000 | 500 | 630 | 000 | 1500 | 2000 | 500 | 630 | 000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 5000 | 2500 | 000 |
| | | Cap To | acita | , ince ice | | I | | Pr | odu | ct Av | , vaila | bilit | y an | d Cl | nip T | hick | nes | s Co | odes | - Se | e Ta | ble 2 | 2 for | Chi | , p Th | ickı | ness | Dim | ensi | ons | | | | | |
| 10 pF | 100 | J | K | М | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GK | GK | GK | GK | GK | GK | GK |
| 11 pF 12 nF | 110 120 | J | K | M | | | | | DG DG | DG DG | DG DG | ED FD | ED FD | ED FD | ED FD | ED FD | FM FM | FM FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | | GK | GK | GK GK | GK | GK | GK | GK |
| 13 pF | 130 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GK | GK | GK | GK | GK | GK | GK |
| 15 pF | 150 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GK | GK | GK | GK | GK | GK | GK |
| 16 pF 18 pF | 180 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GK | GK | GK | GK | GK | GK | GK |
| 20 pF | 200 | J | К | м | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GK | GK | GK | GK | GK | GK | GK |
| 22 pF | 220 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GK | GK | GK | GK | GK | GK | GK |
| 24 pF 27 pF | 240 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GK | GK | GK | GK | GK | GK | GK |
| 30 pF | 300 | J | K | М | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FΜ | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GK | GK | GK | GK | GK | GK | GK |
| 33 pF | 330 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GK | GK | GK | GK | GK | GK | GK |
| 30 pF 39 pF | 390 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GK | GK | GK | GK | GK | GK | GK |
| 43 pF | 430 | J | К | М | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GK | GK | GK | GK | GK | GK | GK |
| 47 pF | 470 510 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | | | | | | | | GK | GK | GK | GK | GK | GK | GK |
| 56 pF | 560 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GK | GK | GK | GK | GK | GK | GK |
| 62 pF | 620 | J | К | М | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FΜ | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GK | GK | GK | GK | GK | GK | GK |
| 68 pF | 680 750 | J | K | M | | | | | DG | | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GK | GK | GK | GK | GK | GK | GK |
| 82 pF | 820 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | ED | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GK | GK | GK | GK | GK | GK | GK |
| 91 pF | 910 | J | К | М | | | | | DG | DG | DG | ED | ED | ED | ED | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GK | GK | GK | GK | GK | GK | GK |
| 100 pF | 101 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | ED | EF | FM | FM | FM | FM | FM | | LB | LB | LB | LB | | LB | GK | GK | GK | GK | GK | GK | GK |
| 120 pF | 121 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | ED | EG | FM | FM | FM | FM | FM | LA | LA | LA | LA | LB | LC | LB | GK | GK | GK | GK | GK | GK | GK |
| 130 pF | 131 | J | К | м | | | | | DG | DG | DG | ED | ED | ED | ED | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LB | LC | LB | GK | GK | GK | GK | GK | GK | GK |
| 150 pF | 151 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | EF | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | | | | GK | GK | GK | GK | GK | GK | GK |
| 220 pF | 221 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | EF | EF | FG | FG | FG | FM | FM | LA | LA | LA | LA | LC | LC | LB | GH | GH | GH | GH | GH | GK | GK |
| 270 pF | 271 | J | К | М | | | | | DG | DG | DG | ED | ED | ED | EF | EF | FG | FG | FG | FK | FK | LA | LA | LA | LB | LC | LC | LC | GH | GH | GH | GH | GH | GK | GK |
| 330 pF | 331 | J | K | M | | | | | DG | DG | DG | ED | ED | EF | EF | EF | FG | FG | FG | FK | FK | | LA | LA | | | LC | LC | GH | GH | GH | GH | GH | GK | GK |
| 470 pF | 471 | J | K | M | | | | | DG | DG | DG | ED | ED | EF | EF | EF | FG | FM | FM | FS | FS | LA | LB | LB | LC | LB | LB | LC | GK | GK | GK | GK | GK | GK | GK |
| 560 pF | 561 | J | K | М | | | | | DG | DG | DG | ED | ED | EF | EF | EF | FG | FM | FM | FS | FL | LA | LB | LB | LC | LB | LB | LC | GH | GH | GH | GK | GH | GK | GK |
| 680 pF | 681 821 | J | K | M | | | | | DG | DG | DG | ED | ED | EF | EF | EF | FG | FM | FM | FS | FL | | | | | | | | GН | GН | GН СН | GK | GН СН | GK | GK |
| 1,000 pF | 102 | J | K | M | BB | CG | CG | CG | DG | DG | DG | ED | ED | ED | EF | EF | FM | FM | FM | FL | FL | LB | LB | LB | LA | LB | LC | LC | GH | GH | GH | GH | GH | GK | GK |
| 1,200 pF | 122 | J | K | М | BB | CG | CG | | DG | DG | DG | ED | ED | ED | EG | EG | FM | FK | FK | FL | FM | LC | LC | LC | LB | LC | LA | | GH | GK | GK | GH | GH | GK | GK |
| 1,500 pF 1 800 pF | 152 182 | J | K | M | BD | CG | CG | | DG | DG | | ED | ED | ED | EG | EG | FK | FS | FS | FL | FM | | | | LB | | | | GK | GK | GK | GH | GH | GK | |
| 2,200 pF | 222 | J | K | M | | CG | | | DG | DG | DG | ED | ED | ED | EG | EG | FK | FL | FL | FL | FM | LC | LA | LA | LB | LC | LC | | GK | GK | GK | GH | GH | GK | |
| 2,700 pF | 272 | J | K | М | | CG | | | DG | DG | DG | ED | ED | ED | EG | | FS | FL | FL | FL | FM | LC | LA | LA | LB | LC | | | GK | GH | GH | GH | GK | GM | |
| 3,300 pF 3 900 pF | 332 | J | K | M | | CG | | | DG | DG | DG | ED | ED | ED ED | EG | | FS | FL | FL | FL | FM | | LA | LA | LB | | | | GK | GH | GH | GH | GK | GM | |
| 4,700 pF | 472 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | EG | | FL | FL | FL | FL | FK | LA | LA | LA | LB | LC | | | GH | GH | GH | GH | GH | GO | |
| 5,600 pF | 562 | J | K | м | | | | | DG | DG | | ED | EF | EF | EF | | FL | FL | FL | FM | FK | LA | LB | LB | LC | | | | GH | GH | GH | GK | GK | | |
| 6,800 pF 8,200 nF | 682 822 | J J | K | M | | | | | DG | DG | | EF | EF | EF | EF FF | | FL | FL FI | FL | FK | FS | LA | LB | LB | | | | | GH | GH | GH GH | GK | GM GM | | |
| 10,000 pF | 103 | J | K | М | | | | | DG | DG | | EF | EG | EG | EG | | FL | FL | FL | FK | | LA | LB | LB | LC | | | | GH | GH | GH | GK | GO | | |
| | | Rate | ed Vo (VDC | tage) | 500 | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| Cap | Cap | Volt | age (| Code | С | C | В | D | C | В | D | C | В | D | F | G | C | В | D | F | G | С | В | D | F | G | z | H | С | B | D | F | G | z | н |
| | ooue | Ca | se Si Serie | ze/ s | C0402C | C | 0603 | BC | C | 0805 | iC | | C | 1206 | 5C | | | C | 1210 | C | | | | C | 1808 | BC | | | | | C1 | 812 | C ² | | |

KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions). ² Available capacitance values available in <u>X7R with KONNEKT Technology</u>.



Table 1A – Capacitance Range/Selection Waterfall (0603 – 1812 Case Sizes) cont.

| | | Cas S | se Si erie | ze/ s | C0402C | C | 060 | 3C | С | 080 | 5C | | C | 120 | 5C | | | C | 121 | 0C | | | | C | 180 | 8C | | | | | C1 | 812 | 2. C 2 | | |
|-----------|------|----------|----------------|-----------|--------|-----|------|------|-----|-----|-------|-----|------|------|---------|------------|------|-----|----------------|------|------|----------|-------|------|------|--------|------|-----|------|-----|------|------|---------------|-----|-----|
| Con | Сар | Volt | age C | ;ode | С | С | В | D | С | В | D | С | В | D | F | G | С | В | D | F | G | С | В | D | F | G | z | н | С | В | D | F | G | Z | Н |
| Cap | Code | Rate | | tage | 500 | 500 | 630 | 000 | 500 | 630 | 000 | 500 | 630 | 000 | 500 | 000 | 500 | 630 | 000 | 500 | 000 | 500 | 630 | 000 | 500 | 000 | 500 | 000 | 500 | 630 | 000 | 500 | 000 | 500 | 000 |
| | | Cap | acita | nce | | | | | | - | | L.: | | | | - <u>-</u> | | | _ _ | | | | 2 6 | | - TL | i a ku | | D: | | | - | - | ~ | ~ | |
| | | To | leran | ce | | | | | oau | | valla | | y an | | <u></u> | me | cnes | SUC | aes | - 36 | e la | bie . | 2 101 | CIII | рп | IICKI | iess | חוע | iens | ons | | | | | |
| 12,000 pF | 123 | J | K | М | | | | | DG | DG | | EG | EJ | EJ | | | FL | FL | FL | FK | | LA | LC | LC | LB | | | | GH | GK | GK | GK | | | |
| 15,000 pF | 153 | J | K | М | | | | | DG | | | EG | EJ | EJ | | | FL | FL | FL | FL | | LA | LC | LC | LC | | | | GH | GK | GK | GH | | | |
| 18,000 pF | 183 | J | K | М | | | | | DG | | | EJ | EJ | EJ | | | FL | FL | FL | FM | | LA | LE | LE | | | | | GH | GK | GK | GM | | | |
| 22,000 pF | 223 | J | K | М | | | | | DG | | | EJ | EJ | EJ | | | FL | FM | FM | FM | | LA | LE | LE | | | | | GH | GK | GK | GM | | | |
| 27,000 pF | 273 | J | K | М | | | | | | | | EJ | EJ | | | | FM | FK | FK | FK | | LA | LA | LA | | | | | GH | GB | GB | GO | | | |
| 33,000 pF | 333 | J | K | М | | | | | | | | EJ | EJ | | | | FM | FG | FH | FS | | LC | LA | LA | | | | | GH | GB | GB | GO | | | |
| 39,000 pF | 393 | J | K | М | | | | | | | | EJ | | | | | FK | FG | FH | FS | | LC | LA | LA | | | | | GH | GB | GB | | | | |
| 47,000 pF | 473 | J | K | М | | | | | | | | EJ | | | | | FK | FH | FK | | | LC | LA | LB | | | | | GH | GB | GC | | | | |
| 56,000 pF | 563 | J | K | M | | | | | | | | EJ | | | | | FG | FH | FK | | | LC | LA | LB | | | | | GH | GB | GE | | | | |
| 68,000 pF | 683 | J | K | М | | | | | | | | EJ | | | | | FG | FK | FS | | | LA | LA | LC | | | | | GE | GE | GE | | | | |
| 82,000 pF | 823 | J | K | М | | | | | | | | | | | | | FH | FK | | | | LA | LC | | | | | | GB | GE | GK | | | | |
| 0.10 µF | 104 | J | K | М | | | | | | | | | | | | | FK | FS | | | | LA | LC | | | | | | GB | GH | GJ | | | | |
| 0.12 µF | 124 | J | K | M | | | | | | | | | | | | | FK | | | | | LA | | | | | | | GE | GK | | | | | |
| 0.15 µF | 154 | J | K | M | | | | | | | | | | | | | FK | | | | | LB | | | | | | | GE | GN | | | | | |
| 0.18 µF | 184 | J | K | M | | | | | | | | | | | | | | | | | | | | | | | | | GF | | | | | | |
| 0.22 µF | 224 | J | K | м | | | | | | | | | | | | | | | | | | | | | | | | | GJ | | | | | | |
| 0.27µF | 274 | J | K | M | | | | | | | | | | | | | | | | | | | | | | | | | GL | | | | | | |
| 0.33 µF | 334 | J | K JV-L | IVI | | | | _ | | | _ | | | _ | _ | - | | | - | - | - | <u> </u> | | _ | _ | - | - | - | 65 | | _ | _ | - | _ | _ |
| | | кате | u vol (VDC) | iage) | 500 | 500 | 630 | 100(| 500 | 630 | 100(| 500 | 630 | 100(| 150(| 200(| 500 | 630 | 100(| 150(| 200(| 500 | 630 | 100(| 150(| 200 | 250(| 300 | 500 | 630 | 100(| 150(| 200 | 250 | 300 |
| Cap | Cap | Volt | age C | ode | С | С | В | D | С | В | D | С | В | D | F | G | c | В | D | F | G | С | В | D | F | G | z | н | c | В | D | F | G | z | Н |
| | ooue | Ca: S | se Si Serie | ze/ s | C0402C | С | 060: | 3C | C | 080 | 5C | | C | 1206 | 6C | | | C | 121(| DC | | | | C | 1808 | BC | | | | | C | 1812 | C2 | | |

Table 1B - Capacitance Range/Selection Waterfall (1825-2225 Case Sizes)

| | | Ca | ise Si Serie | ize/ s | | | C | 182 | 5C | | | | | C | 2220 | OC | | | | | C | 222 | 5C | | |
|-------------|----------|---------|--------------------|-----------|-----|-----|-------|--------|--------|---------|-------|--------|------|-------|-------|------|-------|-------|------|-------|------|------|-------|------|------|
| Canacitanao | Сар | Vo | ltage C | ode | С | В | D | F | G | z | н | С | В | D | F | G | z | н | С | В | D | F | G | z | н |
| Capacitance | Code | Rated | Voltag | e (VDC) | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| | | Ca 1 | apacita Foleran | nce ce | | | Produ | ict Av | ailabi | ility a | nd Ch | ip Thi | ckne | ss Co | des – | See | Table | 2 for | Chip | Thick | ness | Dime | nsion | s | |
| 100 pF | 101 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 110 pF | 111 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 120 pF | 121 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 130 pF | 131 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 150 pF | 151 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 180 pF | 181 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 220 pF | 221 | J | K | M | HE | HE | HE | HE | HE | HE | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 270 pF | 271 | J | K | M | HE | HE | HE | HE | HE | HE | HG | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 330 pF | 331 | J | K | M | | | | | | | | JE | JE | JE | JE | JE | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 390 pF | 391 | J | K | M | | | | | | | | JE | JE | JE | JE | JE | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 470 pF | 471 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JE | JE | JE | JE | JE | JK | JK | KF | KF | KF | KF | KE | KE | KF |
| 560 pF | 561 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KE | KE | KF |
| 680 pF | 681 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JE | JE | JE | JK | JK | JK | JK | KF | KF | KF | KF | KE | KF | KF |
| 820 pF | 821 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JE | JE | JE | JK | JK | JK | JK | KE | KE | KE | KF | KE | KF | KF |
| | | Rated | Voltag | e (VDC) | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| Capacitance | Cap Code | Vo | ltage C | ode | C | В | D | F | G | Z | Н | C | В | D | F | G | Z | Н | C | В | D | F | G | Z | Н |
| | | Case | Size/ | Series | | | C | 1825 | C | | | | | C | 2220 | C | | | | | C | 2225 | С | | |

KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions). ² Available capacitance values available in <u>X7R with KONNEKT Technology</u>.

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Table 1B – Capacitance Range/Selection Waterfall (1825 – 2225 Case Sizes) cont.

| | | Ca | se Si Serie | ze/ s | | | C | 1825 | 5C | | | | | C | 2220 | OC | | | | | C | 222 | 5C | | | | |
|-------------|----------|-------|----------------|----------|-----|-----|-------|--------|--------|--------|-------|-------------|------|-------|-------|------|-------|-------|-------------------|---------------|------|------|-------|------|------|--|--|
| Canacitance | Сар | Vo | ltage C | ode | C | В | D | F | G | z | н | C | В | D | F | G | z | н | C | В | D | F | G | z | н | | |
| oapacitance | Code | Rated | Voltage | e (VDC) | 500 | 630 | 000 | 1500 | 000 | 2500 | 000 | 500 | 630 | 000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 000 | 1500 | 000 | 2500 | 3000 | | |
| | | Ca | apacitai | ice | | | Produ | ict Av | ailabi | lity a | nd Ch | i ip Thi | ckne | ss Co | des – | See | Table | 2 for | Chip [·] | Thick | ness | Dime | nsion | 5 | | | |
| 1 000 pF | 102 | | K | M | HG | HG | HG | HG | HG | HG | HG | JE | .IK | .IK | .IK | JK | JK | .IK | KF | KF | KF | KF | KF | KF | KF | | |
| 1,000 pT | 122 | J | ĸ | M | HG | HG | HG | HG | HG | HG | HG | JF | JK | JK | JK | JK | JK | JK | KE | KE | KE | KF | KE | KF | KF | | |
| 1.500 pF | 152 | Ĵ | K | M | HG | HG | HG | HG | HG | HG | HG | JE | JK | JK | JK | JK | JK | JK | KE | KE | KE | KF | KF | KF | KF | | |
| 1.800 pF | 182 | J | ĸ | M | HE | HE | HE | HE | HE | HG | HG | JE | JK | JK | JK | JK | JK | JK | KE | KE | KE | KF | KF | KF | KF | | |
| 2,200 pF | 222 | J | к | м | HE | HE | HE | HE | HE | HG | HG | JE | JK | JK | JE | JE | JK | JK | KF | KE | KE | KF | KF | KF | KF | | |
| 2,700 pF | 272 | J | К | м | HE | HE | HE | HE | HE | HG | | JK | JK | JK | JE | JE | JK | JK | KE | KE | KE | KE | KE | KF | KE | | |
| 3,300 pF | 332 | J | K | М | HE | HE | HE | HE | HE | HG | | JK | JK | JK | JE | JE | JK | JE | KE | KE | KE | KE | KE | KF | KE | | |
| 3,900 pF | 392 | J | K | М | HE | HE | HE | HE | HE | HG | | JK | JK | JK | JE | JE | JK | JE | KE | KF | KF | KE | KE | KF | KE | | |
| 4,700 pF | 472 | J | K | M | HE | HE | HE | HE | HE | HG | | JK | JK | JK | JE | JK | JE | JE | KE | KF | KF | KE | KE | KF | KE | | |
| 5,600 pF | 562 | J | K | M | HE | HE | HE | HE | HE | HG | | JK | JK | JK | JE | JK | JE | JE | KE | KF | KF | KE | KE | KF | KE | | |
| 6,800 pF | 682 | J | K | M | HE | HE | HE | HE | HE | HJ | | JK | JE | JE | JE | JK | JE | JE | KE | KF | KF | KE | KF | KE | KE | | |
| 8,200 pF | 822 | J | K | M | HE | HE | HE | HE | HE | HJ | | JK | JE | JE | JE | JK | JK | JK | KF | KE | KE | KE | KF | KF | KF | | |
| 10,000 pF | 103 | J | K | M | HE | HE | HE | HE | HJ | HK | | JE | JE | JE | JE | JL | JL | JL | KF | KE | KE | KE | KF | KH | KH | | |
| 12,000 pF | 123 | J | K | M | HE | HE | HE | HG | HJ | | | JE | JK | JK | JK | JL | JL | JL | KE | KE | KE | KE | KF | KH | KH | | |
| 15,000 pF | 153 | J | K | M | HE | HE | HE | HG | HK | | | JE | JK | JK | JK | JL | JN | JN | KE | KE | KE | KE | KF | KJ | KJ | | |
| 18,000 pF | 183 | J | K | М | HE | HE | HE | HG | | | | JE | JK | JK | JK | JN | | | KE | KE | KE | KE | KH | | | | |
| 22,000 pF | 223 | J | K | M | HE | HG | HG | HG | | | | JE | JK | JK | JK | JN | | | KE | KF | KF | KF | KJ | | | | |
| 27,000 pF | 273 | J | K | M | HE | HG | HG | HG | | | | JE | JK | JK | JK | | | | KE | KF | KF | KF | KJ | | | | |
| 33,000 pF | 333 | J | K | M | HE | HG | HG | HE | | | | JE | JK | JK | JK | | | | KE | KF | KF | KF | | | | | |
| 39,000 pF | 393 | J | K | M | HE | HG | HG | HG | | | | JE | JK | JK | JE | | | | KE | KF | KF | KF | | | | | |
| 47,000 pF | 473 | J | K | M | HE | HG | HG | HJ | | | | JE | JK | JK | JK | | | | KE | KF | KF | KF | | | | | |
| 56,000 pF | 563 | J | K | M | HE | HG | HG | HJ | | | | JE | JE | JE | JL | | | | KE | KF | KF | KF | | | | | |
| 68,000 pF | 683 | J | K | M | HG | HJ | HJ | НК | | | | JE | JK | JK | JL | | | | KE | KF | KF | KJ | | | | | |
| 82,000 pF | 823 | J | K | M | HG | HJ | HJ | | | | | JE | JL | JL | JN | | | | KE | KF | KF | KJ | | | | | |
| 0.10 µF | 104 | J | K | M | HG | HK | нк | | | | | JE | JN | JN | | | | | KE | KH | KH | KJ | | | | | |
| 0.12 µF | 124 | J | K | M | HG | HE | | | | | | JE | JN | JN | | | | | KE | KH | KH | | | | | | |
| 0.15 µF | 154 | J | K | M | HG | HE | | | | | | JK | JE | | | | | | KF | KJ | KJ | | | | | | |
| 0.18 µF | 184 | J | K | M | HG | HG | | | | | | JK | JE | | | | | | KF | KE | | | | | | | |
| 0.22 µF | 224 | J | K | M | HG | HJ | | | | | | JK | JK | | | | | | KF | KF | | | | | | | |
| 0.27 µF | 274 | J | K | M | HJ | HJ | | | | | | JK | JL | | | | | | KF | KH | | | | | | | |
| 0.33 µF | 334 | J | K | M | HJ | | | | | | | JL | JN | | | | | | KF | KH | | | | | | | |
| U.39 µF | 394 | J | K | M | нк | | | | | | | | | | | | | | KH | KJ | | | | | | | |
| 0.47 μF | 4/4 | J | r k | M | | | | | | | | JN | | | | | | | | ĸJ | | | | | | | |
| υ.ου με | 304 | J | N | IVI | _ | | • | • | | 0 | • | | _ | • | • | - | • | 0 | | _ | • | • | | , | 0 | | |
| | | Rated | Voltage | e (VDC) | 50(| 63(| 100 | 150 | 200 | 250 | 300 | 50(| 63(| 100 | 150 | 200 | 250 | 300 | 50(| 63(| 100 | 150 | 200 | 250 | 300 | | |
| Capacitance | Cap Code | Vo | ltage C | ode | C | В | D | F | G | Z | Н | C | В | D | F | G | Z | н | C | C B D F G Z H | | | | | | | |
| | | Case | Size/ S | Series | | | C | :1825 | С | | | | | C | 2220 | C | | | C2225C | | | | | | | | |

KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).



Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic | Quantity |
|-----------|-------------------|------------------------------------|---------|----------------------|---------|----------|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| BB | 0402 | 0.50 ± 0.05 | 10000 | 50000 | 0 | 0 |
| BD | 0402 | 0.55 ± 0.05 | 10000 | 50000 | 0 | 0 |
| CG | 0603 | 0.80 ± 0.10 | 4,000 | 15,000 | 0 | 0 |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| ED | 1206 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EG | 1200 | 1.00 ± 0.15 | 0 | 0 | 2,000 | 8,000 |
| EJ | 1200 | 1.70 ± 0.20 1.25 ± 0.15 | | 0 | 2,000 | |
| FU | 1210 | 1.25 ± 0.15 1 10 ± 0.15 | 0 | 0 | 2,300 | 8 000 |
| FH | 1210 | 1 55 + 0 15 | 0 | 0 | 2,000 | 8 000 |
| FM | 1210 | 1.70 + 0.20 | 0 | Ő | 2,000 | 8,000 |
| FK | 1210 | 2.10 + 0.20 | 0 | 0 | 2,000 | 8,000 |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1,000 | 4,000 |
| LE | 1808 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| LA | 1808 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| LB | 1808 | 1.60 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| LC | 1808 | 2.00 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GC | 1812 | 1.10 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GE | 1812 | 1.30 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GH | 1812 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GF | 1812 | 1.50 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GK | 1012 | 1.00 ± 0.20 | | 0 | 1,000 | 4,000 |
| GN | 1012 | 1.70 ± 0.13 1.70 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GI | 1812 | 1 90 + 0 20 | 0 | 0 | 500 | 2 000 |
| GM | 1812 | 2 00 + 0 20 | 0 0 | Ő | 500 | 2,000 |
| GS | 1812 | 2.10 ± 0.20 | 0 | Ő | 500 | 2.000 |
| GO | 1812 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| HE | 1825 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| HG | 1825 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| HJ | 1825 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| НК | 1825 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| JE | 2220 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JK | 2220 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| JL | 2220 | 2.00 ± 0.20 | | | 500 | 2,000 |
| | 2220 | 2.50 ± 0.20 | | | 500 | |
| | 2223 | 1.40 ± 0.10 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| KH | 2225 | 2 00 + 0 20 | 0 | 0 | 500 | 2,000 |
| KJ | 2225 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic | Quantity |

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

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Table 2B – Bulk Packaging Quantities

| Deekee | uing Tuno | Loose P | Loose Packaging | | | |
|----------|---|------------------------|------------------------|--|--|--|
| Раска | ling type | Bulk Bag | (default) | | | |
| Packagi | ng C-Spec ¹ | N | /A ² | | | |
| Cas | e Size | Packaging Quantities (| pieces/unit packaging) | | | |
| EIA (in) | Metric (mm) | Minimum | Maximum | | | |
| 0402 | 1005 | | | | | |
| 0603 | 1608 | | 50,000 | | | |
| 0805 | 2012 | | | | | |
| 1206 | 3216 | | | | | |
| 1210 | 3225 | 1 | | | | |
| 1808 | 4520 | I | | | | |
| 1812 | 4532 | | | | | |
| 1825 | 1825 4564 2220 5650 | | 20,000 | | | |
| 2220 | | | | | | |
| 2225 | 5664 | | | | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial Grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive Grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size | A Metric e Size c Codo A Metric Land Protrusion (mm) | | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | | |
|-------------|--|------|------|------|--|------|------|------|---|------|------|------|------|------|------|------|
| Coue | Coue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 1.50 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 |
| 1825 | 4564 | 2.15 | 1.60 | 6.90 | 6.90 | 7.90 | 2.05 | 1.40 | 6.80 | 6.00 | 7.30 | 1.95 | 1.20 | 6.70 | 5.30 | 7.00 |
| 2220 | 5650 | 2.75 | 1.70 | 5.50 | 8.20 | 6.50 | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | 2.55 | 1.30 | 5.30 | 6.60 | 5.60 |
| 2225 | 5664 | 2.70 | 1.70 | 6.90 | 8.10 | 7.90 | 2.60 | 1.50 | 6.80 | 7.20 | 7.30 | 2.50 | 1.30 | 6.70 | 6.50 | 7.00 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Drofile Feature | Terminat | ion Finish |
|--|-----------------------|-----------------------|
| Tomeredure | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate (T_L to T_p) | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T _L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T_p to T_L)$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test Condition | Limits |
|--|----------------|---|---|
| Visual and Mechanical | KEMET Internal | No defects that may affect performance (10X) | Dimensions according KEMET Spec Sheet |
| Capacitance (Cap) | KEMET Internal | Within Tolerance | |
| Dissipation Factor (DF) | KEMET Internal | $\label{eq:constraint} \begin{array}{l} C \leq 10 \ \mu F \\ Frequency: 1 \ kHz \ \pm 50 \ Hz \\ Voltage*: 1.0 \ \pm 0.2 \ V_{rms}, \ 0.5 \ \pm 0.2 \ V_{rms}, \\ C > 10 \ \mu F \\ Frequency: 120 \ Hz \ \pm 10 \ Hz \\ Voltage: \ 0.5 \ \pm 0.1 \ V_{rms} \\ \end{array}$ | Within Specification Dissipation factor (DF) maximum limit at 25°C = 2.5% |
| Insulation Resistance (IR) | KEMET Internal | 500 VDC applied for 120 ±5 seconds at 25°C | $\label{eq:specification} \begin{array}{ c c c } \hline Within Specification \\ \hline To obtain IR limit, divide M\Omega \cdot \mu F value by the capacitance and compare to G\Omega limit. Select the lower of the two limits. \\ \hline \hline \\ \hline $ |
| Temperature Coefficient of Capacitance (TCC) | KEMET Internal | $C \leq 10 \ \mu\text{F}$ Frequency: 1 kHz ±50 Hz Voltage*: 1.0 ±0.2 V _{rms} , 0.5 ±0.2 V _{rms} , 0.2 ±0.1 V _{rms} C > 10 \ \mu\text{F} Frequency: 120 Hz ±10 Hz Voltage: 0.5 ±0.1 V _{rms} * See part number specification sheet for voltage $\frac{\text{Step} \qquad \text{Temperature (°C)}}{1 \qquad 1 \qquad +25^{\circ}\text{C}}$ $2 \qquad -55^{\circ}\text{C}$ $3 \qquad +25^{\circ}\text{C} (\text{Reference Temperature})}$ $4 \qquad +125^{\circ}\text{C}$ | Capacitance ±15% over -55°C to +125°C |



Table 4 – Performance & Reliability: Test Methods and Conditions cont.

| Stress | Reference | Test Condition | Limits |
|--|---------------------------|--|---|
| | | See Dielectric Withstanding Voltage (DWV) Table (5 ±1 second and charge/discharge not exceeding 50 r | nA) |
| | | EIA Case Size 500 V 630 V ≥ 1,000 V | |
| | | 0402 120% of rated voltage N/A N/A | Cap: Initial Limit |
| Dielectric Withstanding Voltage (DWV) | KEMET Internal | 0603 0805 1206 1210 1808 150% of rated voltage 1812 1825 2220 2225 | Withstand test voltage without insulation breakdown or damage. |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | KEMET Internal | Capacitance measurements (including tolerance) a indexed to a referee time of 48 or 1,000 hours. Please refer to a part number specific datasheet f referee time details. | Please refer to a part number specification sheet for specific Aging rate |
| Terminal Strength | KEMET Internal | Shear stress test per specific case size, Time: 60 ±1 second. Case Size Force 0402 3N 0603 5N 0805 9N ≥ 1206 18N | No evidence of mechanical damage |
| Board Flex | AEC-Q200-005 | Standard Termination System 2.0 mm Flexible Termination System 3.0 mm Test Time: 60± 5 seconds Ramp Time: 1 mm/second | No evidence of mechanical damage |
| Solderability | J-STD-002 | Condition: 4 hours ±15 minutes at 155°C dry bake apply all methods Test 245 ±5°C (SnPb & Pb-Free) | Visual Inspection. 95% coverage on termination. No leaching |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to +125°C) 2 - 3 cycles per hour Soak Time: 1 or 5 minute | Measurement at 24 hours ±4 hours after test conclusion. Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and 200 VDC maximum | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±20% shift IR: 10% of Initial Limit |
| | | Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V | DF Limit Maximum: 3.0% |



Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test Condition | Limits | |
|---|---------------------------|---|---|--|
| Moisture MIL-STD-202 Resistance Method 106 | | Number of Cycles Required: 10, 24 hours per cycle. Steps 7a and 7b not required | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±20% shift IR: 10% of Initial Limit DF Limit Maximum: 3.0% | |
| Thermal Shock | MIL-STD-202 Method 107 | Number of Cycles Required: 5, (-55°C to 125°C) Dwell time 15 minutes. | Cap: Initial Limit DF: Initial Limit IR: Initial Limit | |
| High Temperature Life | MIL-STD-202 | 1,000 hours at 125°C with 1.2 X rated voltage applied. | Within Post Environmental Limits Cap: ±20% shift | |
| Storage Life | Method 108 | 1,000 hours at 150°C, Unpowered | IR: 10% of Initial Limit DF Limit Maximum: 3.0% | |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Test from 10 – 2,000 Hz | Cap: Initial Limit DF: Initial Limit IR: Initial Limit | |
| Mechanical Shock | MIL-STD-202 Method 213 | 1,500 g's 0.5 millisecond Half-sine, Velocity Change: 15.4 feet/second (Condition F) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit | |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents. | Visual Inspection 10X Readable marking, no decoloration or stains. No physical damage. | |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction





Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a "K" to identify KEMET, followed by two characters (per EIA–198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the "K" character only.

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.
- X7R dielectric products in capacitance values outlined below.

| EIA Case Size | Metric Size Code | Capacitance |
|---------------|------------------|-------------|
| 0603 | 1608 | ≤ 170 pF |
| 0805 | 2012 | ≤ 150 pF |
| 1206 | 3216 | ≤ 910 pF |
| 1210 | 3225 | ≤ 2,000 pF |
| 1808 | 4520 | ≤ 3,900 pF |
| 1812 | 4532 | ≤ 6,700 pF |
| 1825 | 4564 | ≤ 0.018 µF |
| 2220 | 5650 | ≤ 0.027 µF |
| 2225 | 5664 | ≤ 0.033 µF |

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 μ F. Orientation of marking is vendor optional.





Capacitor Marking (Optional) cont.

| | C | apacita | ance (p | F) For \ | /arious | Alpha/ | Numera | al Identif | iers | | | | | |
|-----------|------------------|---------|---------|----------|---------|--------|---------|------------|------------|-------------|--|--|--|--|
| Alaba | | | | | | Numera | ıl | | | | | | | |
| Alpna | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | | |
| Character | Capacitance (pF) | | | | | | | | | | | | | |
| A | 0.10 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 | | | | |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 | | | | |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 | | | | |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 | | | | |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 | | | | |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 | | | | |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 | | | | |
| Н | 0.20 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 | | | | |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 | | | | |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 | | | | |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 | | | | |
| М | 0.30 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 | | | | |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 | | | | |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 | | | | |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 | | | | |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 | | | | |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 | | | | |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 | | | | |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 | | | | |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 | | | | |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 | | | | |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 | | | | |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 | | | | |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 | | | | |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 | | | | |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 | | | | |
| d | 0.40 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 | | | | |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 | | | | |
| f | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 | | | | |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 | | | | |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 | | | | |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 | | | | |
| у | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 | | | | |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punche | d Paper | |
|----------------------|------|---------|--------------------|--------------------------|----------|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | (W)* | Pitch | (P ₁)* | Pitch (P ₁)* | | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 | |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | |
| Array 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P₁ carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions — Millimeters (Inches) | | | | | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|--|--|--|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum | | | | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | | | |
| 16 mm | | (0.059) | | | | (1.181) | | | | | | | |
| | | , | Variable Dime | ensions – Mil | limeters (Incl | nes) | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ | | | | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | | | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | te 5 | | | | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions — Millimeters (Inches) | | | | | | | | | | | | | |
|-----------|--|--|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|--|--|--|--|--|
| Tape Size | D _o | D ₀ E ₁ P ₀ P ₂ T ₁ Maximum G Minimum | | | | | | | | | | | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | | | | | | |
| | | Variable D | imensions — M | illimeters (Inche | es) | | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | | | | | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | | | | | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | Note 1 | | | | | | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)


Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | | | |
|--|--|---------------------------------------|--|--|--|--|--|--|--|
| Tape Size | А | B Minimum | C | D Minimum | | | | | |
| 8 mm | 178 ±0.20 | | | | | | | | |
| 12 mm | Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | | | |
| 16 mm | (13.000 ±0.008) | | X | | | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Application Guide

Solder Fluxes and Cleaning

The use of water-soluble fluxes provides advantages of excellent solderability due to high activation. However, these fluxes contain organic acids that can induce arcing under high DC or AC voltages. Notable problem areas are underneath the MLCC where flux can be trapped between the ceramic material and PCB. It is therefore critical that PCBs are properly cleaned to remove all flux residue to maintain reliability.

Coating for High Voltage MLCCs

For MLCC ratings \geq 1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

| Dielectric | CTE (ppm/°C) |
|----------------------------|--------------|
| Class II BaTiO₃ | 10.7 |
| Class I CaZrO ₃ | 9.8 |

Slits in PCB

It is recommended to apply a slit in the PCB under the MLCC to improve washing of flux residue that may get trapped underneath. In some cases, it is not possible to slit entirely through the PCB due to underlying metal planes. It is also acceptable to apply a recessed slit under the MLCC which will also promote cleaning.

- Recommended for case sizes ≥1206
- The width (w) of the slit should be 1mm
- Length of the slit should be as short as possible to prevent damaging the MLCC due to mechanical stress of the PCB.
- Slits also reduce the risk of solder balls under MLCC which decreased the creepage distance.



Solder Resist

If a slit cannot be applied as above, it is recommended to not use solder resist directly under the MLCC. The use of solder resist material reduces the distance between MLCC ceramic material and PCB thus making it difficult to clean.

Solder Balls

Improper reflow techniques and/or improper washing can induce solder balls under or adjacent to the MLCC. Solder balls reduce the creepage distance between the MLCC terminations and increase the risk of arcing or damage to the ceramic material. To reduce the risk of solder balls:

- Follow KEMET's solder recommendations as outlined in the datasheet.
- If performing a cleaning procedure, properly clean the PCB per KEMET's cleaning recommendations.
- Add slit to the PCB as shown above.





Overview

The KEMET 250 VDC Tip and Ring MLCCs in X7R dielectric are designed and rated for telecommunication ringer circuits, where the capacitor is used to block -48 to -52 VDC of line voltage and pass a 16 - 25 Hz AC signal pulse of 70 Vrms to 90 Vrms. Serving as an excellent replacement for high voltage leaded film devices, these smaller surface mount technology footprints save valuable board space, which is critical when creating new designs.

The KEMET Tip and Ring capacitors feature a 125°C maximum operating temperature and are considered temperature stable. The Electronics Industries Alliance (EIA) characterizes X7R dielectric as a Class II material.

Benefits

- -55°C to +125°C operating temperature range
- Lead (Pb)-free, RoHS and REACH compliant
- EIA 0603, 0805, 1206, 1210, 1812, 1825, 2220 and 2225 case sizes
- DC voltage rating of 250 V
- Capacitance offerings ranging from 180 pF to .47 μF
- Available capacitance tolerances of ±5%, ±10% and ±20%
- · Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish that allows for excellent solderability
- SnPb termination finish option available upon request (5% Pb minimum)
- · Flexible termination option available upon request

Applications

Typical applications include telecommunication ringing circuits, switch mode power supply snubber circuits, high voltage DC blocking and high voltage coupling. Markets include telephone lines, analog and digital modems, facsimile machines, wireless base stations, cable and digital video recording set-top boxes, satellite dishes, high voltage power supply, DC/DC converters, and Ethernet, POS and ATM hardware.

Components of this classification are fixed, ceramic dielectric

capacitors suited for bypass and decoupling applications or

of capacitance characteristics are not critical. X7R dielectric

exhibits a predictable change in capacitance with respect to

time and voltage, and boasts a minimal change in capacitance

with reference to ambient temperature. Capacitance change is

These devices are able to withstand today's higher lead-

frequency filtering characteristics and low ESR.

free reflow processing temperatures and offer superior high

limited to $\pm 15\%$ from -55°C to ± 125 °C.

for frequency discriminating circuits, where Q and stability



Ordering Information

| С | 1825 | С | 105 | K | Α | R | Α | С | TU |
|---------|--|---|--|---------------------------------|---------------------------|------------|----------------------------|---|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ¹ | Packaging/ Grade (C-Spec) |
| | 0603 0805 1206 1210 1812 1825 2220 2225 | C = Standard X = Flexible termination | Two significant digits and number of zeros | J = ±5% K = ±10% M = ±20% | A = 250 V | R = X7R | A = N/A | C = 100% Matte Sn L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ Additional termination finish options may be available. Contact KEMET for details.

Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) | | |
|---|---|--|--|
| Bulk Bag/Unmarked | Not required (Blank) | | |
| 7" Reel/Unmarked | TU | | |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) | | |
| 7" Reel/Marked | ТМ | | |
| 13" Reel/Marked | 7040 (EIA 0603) 7215 (EIA 0805 and larger case sizes) | | |
| 7" Reel/Unmarked/2 mm pitch ² | 7081 | | |
| 13" Reel/Unmarked/2 mm pitch ² | 7082 | | |

¹ Default packaging is "Bulk Bag." An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking."

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information."

Qualification/Certification

Commercial grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance and Reliability.



Environmental Compliance

Lead (Pb)-free dielectric material, RoHS, and REACH compliant without exemptions.

Dimensions – Millimeters (Inches) – Standard & Flexible Termination



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|-------------------------------|-----------------|-------------------------------|----------------------------|---------------------------------|
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | |
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder wave or Solder reflow |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | | |
| 1210 | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | See Table 2 for | 0.50 (0.02) ±0.25 (0.010) | | |
| 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | Thickness | 0.60 (0.024) ±0.35 (0.014) | N1/A | |
| 1825 | 4564 | 4.50 (0.177) ±0.30 (0.012) | 6.40 (0.252) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | N/A | Solder reflow only |
| 2220 | 5650 | 5.70 (0.224) ±0.40 (0.016) | 5.00 (0.197) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | |
| 2225 | 5664 | 5.60 (0.220) ±0.40 (0.016) | 6.40 (0.248) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | |



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±15% |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| ² Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | 5% (6.3 V and 10 V), 3.5% (16 V and 25 V) and 2.5% (50 V to 250 V) |
| ^₄ Insulation Resistance (IR) Minimum Limit at 25°C | See Insulation Resistance Limit Table (Rated voltage applied for 120 ±5 seconds at 25°C) |

¹ Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours.

² DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

³ Capacitance and dissipation factor (DF) measured under the following conditions:

1 kHz ±50 Hz and 1.0 ±0.2 V_{rms} if capacitance \leq 10 μ F

120 Hz ±10 Hz and 0.5 ±0.1 $V_{\rm rms}$ if capacitance > 10 μF

⁴To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."



Post Environmental Limits

| High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | | |
|---|---------------------|----------------------|-----------------------------------|----------------------|--------------------------|--|--|--|--|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | | | | |
| | > 25 | | 3.0 | | 10% of Initial | | | | |
| X7R | 16/25 | All | 5.0 | ±20% | | | | | |
| | < 16 | | 7.5 | | mm | | | | |

Insulation Resistance Limit Table

| EIA Case Size | Rated DC Voltage | 1,000 megohm microfarads or 100 GΩ | 500 megohm microfarads or 10 GΩ | 100 megohm microfarads or 10 GΩ |
|---------------|------------------|---------------------------------------|------------------------------------|------------------------------------|
| 0201 | ALL | N/A | ALL | N/A |
| 0402 | ALL | < .012 µF | ≥ .012 µF | N/A |
| 06.00 | ≤ 200 V | < .047 µF | ≥ .047 µF | N/A |
| 0003 | 250 V | N/A | N/A | ALL |
| 0005 | ≤ 200 V | < 0.15 µF | ≥ 0.15 µF | N/A |
| 0805 | 250 V | < .027 µF | N/A | ≥ .027 µF |
| 1000 | ≤200 V | < 0.47 µF | ≥ 0.47 µF | N/A |
| 1206 | 250 V | < 0.12 µF | N/A | ≥ 0.12 µF |
| 1010 | ≤200 V | < 0.39 µF | ≥ 0.39 µF | N/A |
| 1210 | 250 V | < 0.27 µF | N/A | ≥ 0.27 µF |
| 1808 | ALL | ALL | N/A | N/A |
| 1812 | ALL | < 2.2 µF | ≥ 2.2 µF | N/A |
| 1825 | ALL | ALL | N/A | N/A |
| 2220 | ALL | < 10 µF | ≥ 10 µF | N/A |
| 2225 | ALL | ALL | N/A | N/A |



Table 1 – Capacitance Range/Selection Waterfall (0603 – 2225 Case Sizes)

| | Ormeritenes | Cas S | se S Serie | ize/ es | C0603C | C0805C | C1206C | C1210C | C1812C | C1825C | C2220C | C2225C |
|------------------------|-------------|-----------|-------------------|-------------|--------|--------|----------------------|--------------------------------------|--------------------------------|----------------------|----------|--------|
| Capacitance | Capacitance | Vol | tage C | ode | A | A | A | A | A | A | A | A |
| | Code | Rate | ed Vol (VDC) | tage) | Α | 250 | 250 | 250 | 250 | 250 | 250 | 250 |
| | | Cap To | oacita oleran | ince ice | | • | Product A See Tab | Availability and ole 2 for Chip T | d Chip Thickno hickness Dim | ess Codes ensions | | |
| 180 pF | 181 | J | К | М | | DR | | | | | | |
| 220 pF | 221 | J | K | M | | DR | | | | | | |
| 270 pF | 271 | J | K | M | | DR | | | | | | |
| 330 pF | 331 | J | K | M | | | | | | | | |
| 390 µF | 391 | J | r k | IVI | | | | | | | | |
| 470 pF | 561 | | K | M | | | | | | | | |
| 680 pF | 681 | | ĸ | M | | DR | | | | | | |
| 820 pF | 821 | J | ĸ | M | | DR | | | | | | |
| 1.000 pF | 102 | Ĵ | ĸ | M | СJ | DR | EO | | | | | |
| 1,200 pF | 122 | J | K | M | CJ | DR | EQ | | | | | |
| 1,500 pF | 152 | J | К | М | CJ | DR | EQ | | | | | |
| 1,800 pF | 182 | J | К | М | CJ | DR | EQ | | | | | |
| 2,200 pF | 222 | J | К | М | CJ | DR | EQ | FN | | | | |
| 2,700 pF | 272 | J | K | М | CJ | DR | EQ | FN | | | | |
| 3,300 pF | 332 | J | K | M | CJ | DR | EQ | FN | | | | |
| 3,900 pF | 392 | J | K | M | CJ | DR | EQ | FN | | | | |
| 4,700 pF | 472 | J | K | M | CJ | DR | EQ | FN | | | | |
| 5,600 pF | 562 | J | K | M | CJ | DR | EQ | FN | | | | |
| 6,800 pF | 682 | J | K | M | CJ | DR | EQ | FN | GB | | | |
| 8,200 pF | 822 | J | K | M | CJ | DR | EQ | FN | GB | | | |
| 10,000 pF | 103 | J | K | M | CJ | DR | EQ | FN | GB | | | |
| 12,000 pF | 123 | J | K | M | | DR | EQ | FN | GB | | | |
| 15,000 pF | 153 | J | K | | | | EQ | FN | GB | | | |
| 18,000 pF | 183 | J | r k | IVI | | | EQ | FIN | GB | ЦР | | |
| 22,000 pF 27,000 pF | 223 | J | ĸ | M | | DR | EQ | F N E N | GB | НВ | | |
| 33 000 pF | 333 | | K | M | | | FO | FN | GB | HB | | |
| 39 000 pF | 393 | J | ĸ | M | | DG | FO | FN | GB | HB | | |
| 47.000 pF | 473 | Ĵ | ĸ | M | | DG | ES | FO | GB | HB | | |
| 56,000 pF | 563 | J | К | М | | DG | ES | FQ | GB | HB | | |
| 68,000 pF | 683 | J | К | М | | DG | ES | FQ | GB | HB | | |
| 82,000 pF | 823 | J | К | М | | | ES | FA | GB | HB | JC | |
| 0.10 µF | 104 | J | К | M | | | EM | FZ | GB | HB | JC | кс |
| 0.12 µF | 124 | J | K | M | | | EM | FU | GB | HB | JC | КС |
| 0.15 µF | 154 | J | K | М | | | EH | FM | GE | HB | JC | КС |
| 0.18 µF | 184 | J | K | M | | | EM | FK | GG | HB | JC | кс |
| 0.22 µF | 224 | J | K | М | | | EH | FK | GG | HB | JC | KC |
| 0.27 µF | 274 | J | K | M | | | | FP | GG | HB | JC | KC |
| 0.33 µF | 334 | J | K | M | | | | FM | GG | HB | JC | KC |
| 0.39 µF | 394 | J | K | M | | | | FK | GG | HD | JC | KC |
| 0.47 μF | 4/4 | J | K | M | | | | FS | GJ | HD | JC | KD KD |
| 0.50 µF | 504 | J | K | | | | | | | HD | 1D 2D | KD KD |
| 0.00 µF | 824 | 1 | K | M | | | | | | HE | JD | KE |
| 1.0 µF | 105 | | K | M | | | | | | HF | JF | KE |
| 1.2 μF | 125 | Ĵ | K | M | | | | | | | | KE |
| | | Rate | ed Vol (VDC) | tage) | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 |
| Capacitance | Capacitance | Vol | tage C | ode | A | A | Α | A | A | A | A | A |
| | Jue | Ca | ase Siz Series | ze/ s | C0603 | C0805C | C1206C | C1210C | C1812C | C1825C | C2220C | C2225C |



| Table 2A – Chip | Thickness/Ta | be & Reel Pa | ckaging Quantition | es |
|-----------------|--------------|--------------|--------------------|----|
|-----------------|--------------|--------------|--------------------|----|

| Thickness | Case | Thickness ± | Paper C |)uantity | Plastic | Quantity |
|-----------|------|-------------|---------|----------|---------|----------|
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| CJ | 0603 | 0.80 ±0.15* | 4,000 | 15,000 | 0 | 0 |
| DR | 0805 | 0.78 ±0.20 | 4,000 | 10,000 | 0 | 0 |
| DG | 0805 | 1.25 ±0.15 | 0 | 0 | 2,500 | 10,000 |
| EQ | 1206 | 0.78 ±0.20 | 0 | 0 | 4,000 | 10,000 |
| ES | 1206 | 1.00 ±0.20 | 0 | 0 | 2,500 | 10,000 |
| EM | 1206 | 1.25 ±0.15 | 0 | 0 | 2,500 | 10,000 |
| EH | 1206 | 1.60 ±0.20 | 0 | 0 | 2,000 | 8,000 |
| FN | 1210 | 0.78 ±0.20 | 0 | 0 | 4,000 | 10,000 |
| FQ | 1210 | 0.90 ±0.20 | 0 | 0 | 4,000 | 10,000 |
| FA | 1210 | 1.10 ±0.15 | 0 | 0 | 2,500 | 10,000 |
| FZ | 1210 | 1.25 ±0.20 | 0 | 0 | 2,500 | 10,000 |
| FU | 1210 | 1.55 ±0.20 | 0 | 0 | 2,000 | 8,000 |
| FP | 1210 | 1.60 ±0.20 | 0 | 0 | 2,000 | 8,000 |
| FM | 1210 | 1.70 ±0.20 | 0 | 0 | 2,000 | 8,000 |
| FK | 1210 | 2.10 ±0.20 | 0 | 0 | 2,000 | 8,000 |
| FS | 1210 | 2.50 ±0.30 | 0 | 0 | 1,000 | 4,000 |
| GB | 1812 | 1.00 ±0.10 | 0 | 0 | 1,000 | 4,000 |
| GE | 1812 | 1.30 ±0.10 | 0 | 0 | 1,000 | 4,000 |
| GG | 1812 | 1.55 ±0.10 | 0 | 0 | 1,000 | 4,000 |
| GJ | 1812 | 1.70 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| HB | 1825 | 1.10 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| HD | 1825 | 1.30 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| HF | 1825 | 1.50 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| JC | 2220 | 1.10 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| JD | 2220 | 1.30 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| JF | 2220 | 1.50 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| KC | 2225 | 1.10 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| KD | 2225 | 1.30 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| KE | 2225 | 1.40 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size | Range (mm) | Paper (| Quantity | Plastic | Quantity |

Package quantity based on finished chip thickness specifications.



Table 2B - Bulk Packaging Quantities

| Deelver | ing Tune | Loose Pa | ackaging | | |
|----------|------------------------|------------------------|------------------------|--|--|
| Раскад | ing type | Bulk Bag (default) | | | |
| Packagin | lg C-Spec ¹ | N/ | /A² | | |
| Case | e Size | Packaging Quantities (| pieces/unit packaging) | | |
| EIA (in) | Metric (mm) | Minimum | Maximum | | |
| 0402 | 1005 | | | | |
| 0603 | 1608 | | 50,000 | | |
| 0805 | 2012 | | | | |
| 1206 | 3216 | - | | | |
| 1210 | 3225 | 1 | | | |
| 1808 | 4520 | | | | |
| 1812 | 4532 | - | | | |
| 1825 | 4564 | - | 20,000 | | |
| 2220 | 5650 | | | | |
| 2225 | 5664 | | | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for automotive grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and automotive grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3A – Land Pattern Design Recommendations per IPC-7351 – Standard Termination

| EIA Size | Metric Size | | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | |
|-------------------|----------------|------|--|------|------|------|--|------|------|------|---|------|------|------|------|------|
| Coue | Coue | С | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 |
| 1210 ¹ | 3225 | 1.50 | 1.60 | 2.90 | 5.60 | 3.90 | 1.40 | 1.40 | 2.80 | 4.70 | 3.30 | 1.30 | 1.20 | 2.70 | 4.00 | 3.00 |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 |
| 1825 | 4564 | 2.15 | 1.60 | 6.90 | 6.90 | 7.90 | 2.05 | 1.40 | 6.80 | 6.00 | 7.30 | 1.95 | 1.20 | 6.70 | 5.30 | 7.00 |
| 2220 | 5650 | 2.75 | 1.70 | 5.50 | 8.20 | 6.50 | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | 2.55 | 1.30 | 5.30 | 6.60 | 5.60 |
| 2225 | 5664 | 2.70 | 1.70 | 6.90 | 8.10 | 7.90 | 2.60 | 1.50 | 6.80 | 7.20 | 7.30 | 2.50 | 1.30 | 6.70 | 6.50 | 7.00 |

¹ Only for capacitance values \geq 22 μ F

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1210 case size.





Table 3B - Land Pattern Design Recommendations per IPC-7351 - Flexible Termination

| EIA Size | Metric Size | | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | |
|-------------|----------------|------|--|------|------|------|--|------|------|------|---|------|------|------|------|------|
| Coue | Coue | С | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0805 | 2012 | 0.99 | 1.44 | 1.66 | 4.47 | 2.71 | 0.89 | 1.24 | 1.56 | 3.57 | 2.11 | 0.79 | 1.04 | 1.46 | 2.42 | 1.81 |
| 1206 | 3216 | 1.59 | 1.62 | 2.06 | 5.85 | 3.06 | 1.49 | 1.42 | 1.96 | 4.95 | 2.46 | 1.39 | 1.22 | 1.86 | 4.25 | 2.16 |
| 1210 | 3225 | 1.59 | 1.62 | 3.01 | 5.90 | 4.01 | 1.49 | 1.42 | 2.91 | 4.95 | 3.41 | 1.39 | 1.22 | 2.81 | 4.25 | 3.11 |
| 1812 | 4532 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 |
| 1825 | 4564 | 2.15 | 1.80 | 6.90 | 7.10 | 7.90 | 2.05 | 1.60 | 6.80 | 6.20 | 7.30 | 1.95 | 1.40 | 6.70 | 5.50 | 7.00 |
| 2220 | 5650 | 2.85 | 2.10 | 5.50 | 8.80 | 6.50 | 2.75 | 1.90 | 5.40 | 7.90 | 5.90 | 2.65 | 1.70 | 5.30 | 7.20 | 5.60 |
| 2225 | 5664 | 2.85 | 2.10 | 6.90 | 8.80 | 7.90 | 2.75 | 1.90 | 6.80 | 7.90 | 7.30 | 2.65 | 1.70 | 6.70 | 7.20 | 7.00 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Terminat | ion Finish | |
|--|-----------------------|-----------------------|--|
| Tomeredure | SnPb | 100% Matte Sn | |
| Preheat/Soak | | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds | |
| Ramp-Up Rate $(T_L to T_P)$ | 3°C/second maximum | 3°C/second maximum | |
| Liquidous Temperature (T_L) | 183°C | 217°C | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | |
| Peak Temperature (T _P) | 235°C | 260°C | |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum | 30 seconds maximum | |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | 6°C/second maximum | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | |

Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method | | | |
|------------------------------|-----------------------------------|--|--|--|--|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds. | | | |
| Board Flex | JIS-C-6429 | Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm for COG. Flexible termination system – 3.0 mm (minimum). | | | |
| | | Magnification 50 X, conditions: | | | |
| Solderability | 1-STD-002 | a) Method B, 4 hours at 155°C, dry heat at 235°C | | | |
| | J-31D-002 | b) Method B category 3 at 215°C | | | |
| | | c) Method D, category 3 at 260°C | | | |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 Cycles (-55°C to +125°C). Measurement at 24 hours \pm 4 hours after test conclusion | | | |
| Discord Humidian MIL-STD-202 | | Load humidity: 1,000 hours 85°C/85% RH and rated voltage. Add 100 K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. | | | |
| Blased Humany | Method 103 | Low volt humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. | | | |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours ±4 hours after test conclusion. | | | |
| Thermal Shock | MIL-STD-202 Method 107 | -55°C/+125°C. Note: Number of cycles required – 300. Maximum transfer time – 20 seconds. Dwell time – 15 minutes. Air – air. | | | |
| High Temperature Life | MIL-STD-202 Method 108/EIA-198 | 1,000 hours at 125°C (85°C for X5R, Z5U and Y5V) with 2 X rated voltage applied. | | | |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC for 1,000 hours. | | | |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz | | | |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Condition F. | | | |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. | | | |

Storage & Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction – Standard Termination



Construction – Flexible Termination





Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a "K" to identify KEMET, followed by two characters (per EIA–198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the "K" character only.

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.
- X7R dielectric products in capacitance values outlined below.

| EIA Case Size | Metric Size Code | Capacitance |
|---------------|------------------|-------------|
| 0603 | 1608 | ≤ 170 pF |
| 0805 | 2012 | ≤ 150 pF |
| 1206 | 3216 | ≤ 910 pF |
| 1210 | 3225 | ≤ 2,000 pF |
| 1808 | 4520 | ≤ 3,900 pF |
| 1812 | 4532 | ≤ 6,700 pF |
| 1825 | 4564 | ≤ 0.018 µF |
| 2220 | 5650 | ≤ 0.027 µF |
| 2225 | 5664 | ≤ 0.033 µF |

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 μ F. Orientation of marking is vendor optional.





Capacitor Marking (Optional) cont.

| | C | apacita | ance (p | F) For \ | /arious | Alpha/ | Numera | al Identif | iers | |
|-----------|------|---------|---------|----------|---------|----------|---------|------------|------------|-------------|
| Alaba | | | | | | Numera | l I | | | |
| Alpha | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Character | | | | | Сара | acitance | e (pF) | | | |
| A | 0.10 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 |
| Н | 0.20 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 |
| М | 0.30 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 |
| d | 0.40 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 |
| f | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 |
| у | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | | Embosse | ed Plastic | Punche | d Paper | |
|----------------------|------|--------------------------|------------|--------------------------|----------|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | (W)* | Pitch (P ₁)* | | Pitch (P ₁)* | | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 | |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | |
| Array 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P₁ carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 16 mm | | (0.059) | | | | (1.181) | | | |
| | Variable Dimensions — Millimeters (Inches) | | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | Note 5 | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions — Millimeters (Inches) | | | | | | | |
|-----------|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|
| Tape Size | D _o | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | Note 1 | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant | Dimensions — Millimete | rs (Inches) | | | |
|---------------------|-----------------|--|--|---|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | |
| 8 mm | 178 ±0.20 | | | | | |
| 12 mm | Or 220 10 20 | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | |
| 16 mm | (13.000 ±0.008) | | | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | |
| 50 12 mm (1.969) | | 50 12.4 +2.0/-0.0 (1.969) (0.488 +0.078/-0.0) | | Shall accommodate tape width without interference | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber



Open Mode Design (FO-CAP), X7R Dielectric, 16 – 200 VDC (Commercial & Automotive Grade)



Overview

KEMET's Ceramic Open Mode capacitor in X7R dielectric is designed to significantly minimize the probability of a low IR or short circuit condition when forced to failure in a board stress flex situation, thus reducing the potential for catastrophic failure. The Open Mode capacitor may experience a drop in capacitance; however, a short is unlikely because a crack will not typically propagate across counter electrodes within the device's "active area." Since there will not be any current leakage associated with a typical Open Mode flex crack, there is no localized heating and therefore little chance for a catastrophic and potentially costly failure event.

Driven by the demand for a more robust and reliable component, the Open Mode capacitor was designed for critical applications where higher operating temperatures and mechanical stress are a concern. These capacitors are widely used in automotive circuits as well as power supplies (input and output filters) and general electronic applications.

Concerned with flex cracks resulting from excessive tensile and shear stresses produced during board flexure and thermal cycling? These devices are available with KEMET's Flexible termination technology which inhibits the transfer of board stress to the rigid ceramic body, therefore mitigating flex cracks which can result in low IR or short circuit failures. Although flexible termination technology does not eliminate the potential for mechanical damage that may propagate during extreme environmental and handling conditions, it does provide superior flex performance over standard termination systems. When combined with flexible termination technology these devices offer the ultimate level of protection against a low IR or short circuit condition. Open Mode devices compliment KEMET's Floating Electrode (FE-CAP) and Floating Electrode with Flexible Termination (FF-CAP) product lines by providing a fail-safe design optimized for mid to high range capacitance values. These devices exhibit a predictable change in capacitance with respect to time and voltage and boast a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to $\pm 15\%$ from -55° C to $+125^{\circ}$ C.



Ordering Information

| С | 1210 | J | 685 | K | 3 | R | Α | C | TU |
|---------|------------------------------|--|--|--------------------------|--|------------|----------------------------|--|--|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ¹ | Packaging/Grade (C-Spec) |
| | 0805 1206 1210 1812 | F = Open Mode J = Open Mode with Flexible Termination | Two significant digits and number of zeros | K = ±10% M = ±20% | 4 = 16 3 = 25 5 = 50 1 = 100 2 = 200 | R = X7R | A = N/A | C = 100% Matte Sn L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ Additional termination finish options may be available. Contact KEMET for details. ¹ SnPb termination finish option is not available on automotive grade product.



Packaging C-Spec Ordering Options Table

| Packaging Type | Packaging/Grade Ordering Code (C-Spec) |
|---|---|
| Commerc | ial Grade ¹ |
| Bulk Bag | Not Required (Blank) |
| 7" Reel/Unmarked | TU |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) |
| 7" Reel/Marked | TM |
| 13" Reel/Marked | 7040 (EIA 0603) 7215 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2 mm pitch ² | 7081 |
| 13" Reel/Unmarked/2 mm pitch ² | 7082 |
| Automotiv | ve Grade ³ |
| 7" Reel | AUTO |
| 13" Reel/Unmarked | AUTO7411 (EIA 0603 and smaller case sizes) AUTO7210 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2 mm pitch ² | 3190 |
| 13" Reel/Unmarked/2 mm pitch ² | 3191 |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked.

- ² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".
- ³ Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information".

³ For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information".

³ All Automotive packaging C-Specs listed exclude the option to laser mark components. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking".

Benefits

- -55°C to +125°C operating temperature range
- Open Mode/fail open design
- Mid to high capacitance flex mitigation
- Lead (Pb)-free, RoHS and REACH compliant
- EIA 0805, 1206, 1210, and 1812 case sizes
- DC voltage ratings of 16 V, 25 V, 50 V, 100 V, and 200 V
- Capacitance offerings ranging from 1,000 pF to 6.8 μF
- Available capacitance tolerances of ±5%, ±10%, and ±20%

- · Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish allowing for excellent solderability
- · Commercial and Automotive (AEC-Q200) grades available
- SnPb termination finish option available upon request (5% Pb minimum)
- Flexible termination option available upon request

Applications

Typical applications include input side filtering (power plane/bus), high current (battery line) and circuits that cannot be fused to open when short circuits occur due to flex cracks. Markets include automotive applications that are directly connected to the battery and/or involve conversion to a 42 V system and raw power input side filtering in power conversion.



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | tion Due To: | Days Prior To | | | | | |
|-----------------------------|----------------------------------|-----------------------------------|------------------|--|--|--|--|--|
| C-Spec | Process/Product change | cess/Product change Obsolescence* | | | | | | |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum | | | | | |
| AUTO | Yes (without approval) | Yes | 90 days minimum | | | | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | | PPAP (Product | Part Approval | Process) Leve | I |
|-----------------------------|---|---------------|---------------|---------------|---|
| C-Spec | 1 | 2 | 3 | 4 | 5 |
| KEMET assigned ¹ | • | • | • | • | • |
| AUTO | | | 0 | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches) – Standard Termination



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|-------------------------------|-----------------|-------------------------------|----------------------------|-----------------------|
| 0805 | 2012 | 2.00 (0.079) +0 20 (0.008) | 1.25 (0.049) +0 20 (0.008) | | 0.50 (0.02) +0 25 (0 010) | 0.75 (0.030) | Solder Wave or |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | See Table 2 for | 0.50 (0.02) ±0.25 (0.010) | | Solder Reflow |
| 1210 | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | Thickness | 0.50 (0.02) ±0.25 (0.010) | N/A | Solder Reflow |
| 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | | 0.60 (0.024) ±0.35 (0.014) | | Only |

Dimensions – Millimeters (Inches) – Flexible Termination

| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|--|-------------------------------|-----------------|-------------------------------|----------------------------|-----------------------|
| 0805 | 2012 | 2.00 (0.079) ±0.30 (0.012) | 1.25 (0.049) ±0.30 (0.012) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave or |
| 1206 | 3216 | 3.30 (0.130) ±0.40 (0.016) | 1.60 (0.063) ±0.35 (0.013) | See Table 2 for | 0.60 (0.024) ±0.25 (0.010) | | Solder Reflow |
| 1210 | 3225 | 3.30 (0.130) 2.60 (0.102) Thickness ±0.40 (0.016) ±0.30 (0.012) | | Thickness | 0.60 (0.024) ±0.25 (0.010) | N/A | Solder Reflow |
| 1812 | 4532 | 4.50 (0.178) ±0.40 (0.016) | 3.20 (0.126) ±0.30 (0.012) | | 0.70 (0.028) ±0.35 (0.014) | | Only |



Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions (excluding SnPb termination finish option).

Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|--|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 Vdc Applied (TCC) | ±15% |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| ² Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5±1 seconds and charge/discharge not exceeding 50mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | 5%(6.3V & 10V), 3.5%(16V & 25V) and 2.5%(50V to 250V) |
| ^₄ Insulation Resistance (IR) Minimum Limit at 25°C | See Insulation Resistance Limit Table (Rated voltage applied for 120±5 seconds at 25°C) |

¹ Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours.

²DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

³ Capacitance and dissipation factor (DF) measured under the following conditions:

1kHz ± 50Hz and 1.0 ± 0.2 Vrms if capacitance \leq 10 μ F

120Hz \pm 10Hz and 0.5 \pm 0.1 Vrms if capacitance >10 μF

⁴ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 & Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON".

Post Environmental Limits

| l | High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | | | | | |
|------------|---|----------------------|-----------------------------------|----------------------|--------------------------|--|--|--|--|--|--|--|--|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | | | | | | | | |
| | > 25 | | 3.0 | | | | | | | | | | |
| X7R | 16/25 | All | 5.0 | ±20% | 10% of Initial Limit | | | | | | | | |
| | < 16 | | 7.5 | | | | | | | | | | |



Insulation Resistance Limit Table (X7R Dielectric)

| EIA Case Size | 1,000 Megohm Microfarads or 100 GΩ | 500 Megohm Microfarads or 10 GΩ |
|---------------|---------------------------------------|------------------------------------|
| 0201 | N/A | ALL |
| 0402 | < 0.012 µF | ≥ 0.012 µF |
| 0603 | < 0.047 µF | ≥ 0.047 µF |
| 0805 | < 0.15 µF | ≥ 0.15 µF |
| 1206 | < 0.47 µF | ≥ 0.47 µF |
| 1210 | < 0.39 µF | ≥ 0.39 µF |
| 1808 | ALL | N/A |
| 1812 | < 2.2 µF | ≥ 2.2 µF |
| 1825 | ALL | N/A |
| 2220 | < 10 µF | ≥ 10 µF |
| 2225 | ALL | N/A |



Table 1A – Capacitance Range/Selection Waterfall - Standard Termination (0805 – 1812 Case Sizes)

| | 0 | Case Ser | Size/ ries | | CO | 805 | F/J | | | C1 | 2061 | F/J | | | C1 | 210 | F/J | | (| C181 | 2F/J | |
|------------------|--------------------------|----------------|---------------------|----|----|-------|-----|-----|-----|--------|-------------------|------------------|---------------|----------------|----------------|--------|-----------|-----|----|------|------|-----|
| Capacitance | Capacitance | Voltage Code | | 4 | 3 | 5 | 1 | 2 | 4 | 3 | 5 | 1 | 2 | 4 | 3 | 5 | 1 | 2 | 3 | 5 | 1 | 2 |
| | Code | Rated Volt | age (VDC) | 16 | 25 | 50 | 100 | 200 | 16 | 25 | 50 | 100 | 200 | 16 | 25 | 50 | 100 | 200 | 25 | 50 | 100 | 200 |
| | | Capac Toler | itance ance | | | | | | Pro | duct / | Availa ble 2 f | bility or Chi | and C | hip Th knes | ickne s Dim | ension | des 1s | | | | | |
| 1,000 pF | 102 | K | K M | | DP | DP | DP | DP | | | | | P 1111 | | | | | | | | | |
| 1,200 pF | 122 | К | М | DP | DP | DP | DP | DP | | | | | | | | | | | | | | |
| 1,500 pF | 152 | К | М | DP | DP | DP | DP | DP | | | | | | | | | | | | | | |
| 1,800 pF | 182 | K | М | DP | DP | DP | DP | DP | | | | | | | | | | | | | | |
| 2,200 pF | 222 | K | М | DP | DP | DP | DP | DP | | | | | | | | | | | | | | |
| 2,700 pF | 272 | K | М | DP | DP | DP | DP | DP | | | | | | | | | | | | | | |
| 3,300 pF | 332 | K | м | DP | DP | DP | DP | DP | | | | | | | | | | | | | | |
| 3,900 pF | 392 | K | M | DP | DP | DP | DP | DP | | | | | | | | | | | | | | |
| 4,700 pF | 4/2 | ĸ | M | | | | | | | | | | | | | | | | | | | |
| 5,000 pF | 682 | ĸ | M | | | | | | | | | | | | | | | | | | | |
| 8 200 pF | 822 | ĸ | M | | | | | | | | | | | | | | | | | | | |
| 10 000 pF | 103 | ĸ | M | DP | DP | DP | DP | DP | | | | | | | | | | | | | | |
| 12.000 pF | 123 | ĸ | M | DP | DP | DP | DP | DG | | | | | | | | | | | | | | |
| 15,000 pF | 153 | K | М | DP | DP | DP | DP | DG | | | | | | | | | | | | | | |
| 18,000 pF | 183 | К | М | DP | DP | DP | DP | | ER | ER | ER | ER | ER | | | | | | | | | |
| 22,000 pF | 223 | К | М | DP | DP | DP | DG | | ER | ER | ER | ER | ER | | | | | | | | | |
| 27,000 pF | 273 | к | М | DP | DP | DP | DG | | ER | ER | ER | ER | ER | | | | | | | | | |
| 33,000 pF | 333 | К | М | DP | DP | DP | DG | | ER | ER | ER | ER | ER | | | | | | | | | |
| 39,000 pF | 393 | К | М | DP | DP | DP | DG | | ER | ER | ER | ER | ER | | | | | | | | | |
| 47,000 pF | 473 | K | М | DP | DP | DP | DS | | ER | ER | ER | ER | EU | | | | | | GB | GB | GB | GB |
| 56,000 pF | 563 | K | М | DP | DP | DP | | | ER | ER | ER | ER | EU | | | | | | GB | GB | GB | GB |
| 68,000 pF | 683 | K | М | DP | DP | DG | DG | | ER | ER | ER | ER | EU | FX | FX | FX | FX | FX | GB | GB | GB | GB |
| 82,000 pF | 823 | K | М | DP | DP | DG | | | ER | ER | ER | ER | EU | FX | FX | FX | FX | FX | GB | GB | GB | GB |
| 0.10 µF | 104 | K | M | DG | DG | DG | | | ER | ER | ER | ER | EU | FX | FX | FX | FX | FZ | GB | GB | GB | GB |
| 0.12 µF | 124 | ĸ | M | | | | | | | ER | ER | ER | | | | | | | GB | GB | GB | GB |
| 0.15 µF | 104 | ĸ | M | | | | | | | | | | | | | | | | | CP | | |
| 0.10 µP | 224 | ĸ | M | | | DG | | | | FR | FR | FS | | FX | FX | FX | F7 | FS | GB | GB | GB | 60 |
| 0.22 µľ | 274 | ĸ | M | DP | DP | 00 | | | FR | FR | FR | | | FX | FX | FX | F7 | 10 | GB | GB | GB | GF |
| 0.33 uF | 334 | K | M | DP | DG | | | | EU | EU | EU | EU | | FX | FX | FX | FU | | GB | GB | GB | GK |
| 0.39 µF | 394 | ĸ | М | DP | DG | | | | EU | EU | | | | FX | FX | FZ | FU | | GB | GB | GB | GL |
| 0.47 µF | 474 | К | М | DS | DG | | | | EU | EU | ER | | | FX | FX | FZ | FJ | | GB | GB | GC | |
| 0.56 µF | 564 | К | М | | | | | | EU | | | | | FX | FX | FZ | FR | | GB | GB | GD | |
| 0.68 µF | 684 | К | М | DG | | | | | EU | | | | | FX | FZ | FU | FR | | GD | GD | GF | |
| 0.82 µF | 824 | К | М | | | | | | EU | | | | | FX | FZ | FU | FR | | GD | GD | GK | |
| 1.0 µF | 105 | К | М | | | | | | EU | ER | EH | | | FX | FU | FJ | FS | | GN | GN | GM | |
| 1.2 µF | 125 | К | М | | | | | | | | | | | FΖ | | | | | | | | |
| 1.5 µF | 155 | K | М | | | | | | | | | | | FU | | | | | | | | |
| 1.8 µF | 185 | K | M | | | | | | | | | | | FU | | | | | | | | |
| 2.2 µF | 225 | K | M | | | | | | ER | EH | | | | FJ | FM | FM | | | | | | |
| 3.3 µF | 335 | K | M | | | | | | EU | | | | | FM | FIM | | | | GV | GV | | |
| 4.7 μr 6.8 μF | 4/5 | ĸ | M | | | | | | | | | | | FS | FN | | | | GK | GK | | |
| 0.0 μι | 000 | Pated Vela | | 16 | 25 | 50 | 100 | 200 | 14 | 9E | 50 | 100 | 200 | 14 | 25 | 50 | 100 | 200 | 25 | 50 | 100 | 200 |
| | 0 | | Rated Voltage (VDC) | | 23 | 50 | 100 | 200 | 10 | 20 | 50 | 100 | 200 | 10 | 20 | 50 | 100 | 200 | 23 | 50 | 100 | 200 |
| Capacitance | Code | Voltag | e Code | 4 | 3 | 5 | 1 | 2 | 4 | 3 | 5 | 1 | 2 | 4 | 3 | 5 | 1 | 2 | 3 | 5 | 1 | 2 |
| | Capacitance Code Case Si | | e/ Series | | C | 0805F | /J | | | C | 1206F | /J | | | C | 1210F | /J | | | C181 | 2F/J | |



Table 1B – Capacitance Range/Selection Waterfall - Flexible Termination (0805 – 1812 Case Sizes)

| | 0 | Case Ser | Size/ ies | | CO | 805 | F/J | | | C1 | 206 | F/J | | | C1 | 210 | F/J | | (| C181 | 2 F /J | | | |
|-----------------|-----------------------------------|-------------|-------------------------------------|----------|-----|-----|----------|-----|-----|--------|----------------------------|------------------|-------|--------|----------------|-------|-------------------|-----|------|------|---------------|-----|--|--|
| Capacitance | Capacitance | Voltag | Voltage Code Rated Voltage (VDC) | | 3 | 5 | 1 | 2 | 4 | 3 | 5 | 1 | 2 | 4 | 3 | 5 | 1 | 2 | 3 | 5 | 1 | 2 | | |
| | Code | Rated Volt | age (VDC) | 16 | 25 | 50 | 100 | 200 | 16 | 25 | 50 | 100 | 200 | 16 | 25 | 50 | 100 | 200 | 25 | 50 | 100 | 200 | | |
| | | Capac | itance | | 1 | 1 | | 1 | Pro | duct / | Availa | bility or Chi | and C | hip Th | ickne s Dim | ss Co | des | | | | | | | |
| 1.000 pF | 102 | K | K M | | | | | | | | See Table 2 for Chip Thick | | | | | | CKIESS DIMENSIONS | | | | | | | |
| 1,200 pF | 122 | К | М | DD | DD | DD | DD | DD | | | | | | | | | | | | | | | | |
| 1,500 pF | 152 | K | М | DD | DD | DD | DD | DD | | | | | | | | | | | | | | | | |
| 1,800 pF | 182 | К | М | DD | DD | DD | DD | DD | | | | | | | | | | | | | | | | |
| 2,200 pF | 222 | K | М | DD | DD | DD | DD | DD | | | | | | | | | | | | | | | | |
| 2,700 pF | 272 | К | М | DD | DD | DD | DD | DD | | | | | | | | | | | | | | | | |
| 3,300 pF | 332 | K | М | DD | DD | DD | DD | DD | | | | | | | | | | | | | | | | |
| 3,900 pF | 392 | K | М | DD | DD | DD | DD | DD | | | | | | | | | | | | | | | | |
| 4,700 pF | 472 | K | М | DD | DD | DD | DD | DD | | | | | | | | | | | | | | | | |
| 5,600 pF | 562 | K | M | DD | DD | DD | DD | DD | | | | | | | | | | | | | | | | |
| 6,800 pF | 682 | K | M | עע | | | עע | | | | | | | | | | | | | | | | | |
| 8,200 pF | 0ZZ 102 | ĸ | M | עע חח | ם ס | ם ס | עע חח | ם ס | | | | | | | | | | | | | | | | |
| 12,000 pF | 103 | ĸ | M | ם חח | םם | םם | ם חח | DC | | | | | | | | | | | | | | | | |
| 15,000 pF | 153 | ĸ | M | חח | חח | חח | חח | DG | | | | | | | | | | | | | | | | |
| 18,000 pF | 183 | ĸ | M | | | | | 00 | FR | FR | FR | FR | FR | | | | | | | | | | | |
| 22.000 pF | 223 | ĸ | M | DD | DD | DD | DG | | ER | ER | ER | ER | ER | | | | | | | | | | | |
| 27.000 pF | 273 | ĸ | М | DD | DD | DD | DG | | ER | ER | ER | ER | ER | | | | | | | | | | | |
| 33,000 pF | 333 | к | М | DD | DD | DD | DG | | ER | ER | ER | ER | ER | | | | | | | | | | | |
| 39,000 pF | 393 | К | М | DD | DD | DD | DG | | ER | ER | ER | ER | ER | | | | | | | | | | | |
| 47,000 pF | 473 | K | М | DD | DD | DD | DS | | ER | ER | ER | ER | EU | | | | | | GB | GB | GB | GB | | |
| 56,000 pF | 563 | К | М | DD | DD | DD | | | ER | ER | ER | ER | EU | | | | | | GB | GB | GB | GB | | |
| 68,000 pF | 683 | K | М | DD | DD | DG | DG | | ER | ER | ER | ER | EU | FX | FX | FX | FX | FX | GB | GB | GB | GB | | |
| 82,000 pF | 823 | K | М | DD | DD | DG | | | ER | ER | ER | ER | EU | FX | FX | FX | FX | FX | GB | GB | GB | GB | | |
| 0.10 µF | 104 | K | М | DG | DG | DG | | | ER | ER | ER | ER | EU | FX | FX | FX | FX | FZ | GB | GB | GB | GB | | |
| 0.12 µF | 124 | K | М | DG | DG | | | | ER | ER | ER | ER | | FX | FX | FX | FX | FZ | GB | GB | GB | GB | | |
| 0.15 µF | 154 | K | M | DG | DG | | | | ER | ER | ER | EU | | FX | FX | FX | FX | FU | GB | GB | GB | GB | | |
| 0.18 µF | 184 | K | M | DG | DG | DC | | | ER | ER | ER | EU | | | | | FX | FU | GB | GB | GB | GB | | |
| 0.22 µF | 224 | ĸ | M | סט | ם ח | DG | | | | ER | | ES | | | | | FZ 57 | F9 | GB | GB | GB | | | |
| 0.27 µF | 274 | ĸ | M | חח | DC | | | | FII | EII | ER | FU | | FX | FX | FX | FL | | GB | GB | GB | GK | | |
| 0.35 µľ | 304 | ĸ | M | חח | DG | | | | FII | FII | LU | LU | | FX | FX | F7 | FII | | GB | GB | GB | GI | | |
| 0.47 µF | 474 | ĸ | M | DS | DG | | | | EU | EU | ER | | | FX | FX | F7 | E.I | | GB | GB | GC | 0L | | |
| 0.56 µF | 564 | ĸ | M | 20 | | | | | EU | | 2.11 | | | FX | FX | FZ | FR | | GB | GB | GD | | | |
| 0.68 µF | 684 | K | М | DG | | | | | EU | | | | | FX | FZ | FU | FR | | GD | GD | GF | | | |
| 0.82 µF | 824 | K | М | | | | | | EU | | | | | FX | FZ | FU | FR | | GD | GD | GK | | | |
| 1.0 µF | 105 | К | М | | | | | | EU | ER | EH | | | FX | FU | FJ | FS | | GN | GN | GM | | | |
| 1.2 µF | 125 | К | М | | | | | | | | | | | FZ | | | | | | | | | | |
| 1.5 µF | 155 | К | М | | | | | | | | | | | FU | | | | | | | | | | |
| 1.8 µF | 185 | K | М | | | | | | | | | | | FU | | | | | | | | | | |
| 2.2 µF | 225 | K | М | | | | | | ER | EH | | | | FJ | FM | FM | | | | | | | | |
| 3.3 µF | 335 | K | М | | | | | | | | | | | FM | FM | | | | 014 | 01/ | | | | |
| 4./μ⊦ 6.9.μ⊑ | 4/5 | K | M | | | | | | EH | | | | | FZ | FM | | | | GK | GK | | | | |
| 0.0 μr | 000 | N III | | 16 | 05 | 50 | 100 | 000 | 16 | 05 | 50 | 100 | 000 | 10 | r3 05 | 50 | 100 | 000 | 05 | 50 | 100 | 000 | | |
| | . . | Rated Volt | age (VDC) | 16 | 25 | 50 | 100 | 200 | 16 | 25 | 50 | 100 | 200 | 16 | 25 | 50 | 100 | 200 | 25 | 50 | 100 | 200 | | |
| Capacitance | Capacitance | Voltag | e Code | 4 | 3 | 5 | 1 | 2 | 4 | 3 | 5 | 1 | 2 | 4 | 3 | 5 | 1 | 2 | 3 | 5 | 1 | 2 | | |
| | apacitance Code Case Size/ Series | | e/ Series | C0805F/J | | | | | C | 1206F | /J | | | C | 1210F | /J | | | C181 | 2F/J | | | | |



Table 2A – Chip Thickness/Tape & Reel Packaging Quantities - Standard Termination

| Thickness | Case | Thickness ± | Paper Quantity | | Plastic Quantity | |
|-------------------|--------------|---------------------------|----------------|----------|------------------|----------|
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| DP | 0805 | 0.90 ± 0.10* | 4,000 | 15,000 | 0 | 0 |
| DS | 0805 | 1.00 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| ER | 1206 | 0.90 ± 0.20 | 0 | 0 | 4,000 | 10,000 |
| ES | 1206 | 1.00 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| EH | 1206 | 1.60 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| EU | 1206 | 1.60 ± 0.25 | 0 | 0 | 2,000 | 8,000 |
| FX | 1210 | 0.95 ± 0.20 | 0 | 0 | 4,000 | 10,000 |
| FZ | 1210 | 1.25 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| FU | 1210 | 1.55 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FJ | 1210 | 1.85 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FR | 1210 | 2.25 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1,000 | 4,000 |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GC | 1812 | 1.10 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GD | 1812 | 1.25 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GF | 1812 | 1.50 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GK | 1812 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GN | 1812 | 1.70 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GL | 1812 | 1.90 ± 0.20 | 0 | 0 | 500 | 2,000 |
| GM | 1812 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| Thickness Code | Case Size | Thickness ± Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| | | | Paper Quantity | | Plastic Quantity | |

Package quantity based on finished chip thickness specifications.



Table 2B – Chip Thickness/Tape & Reel Packaging Quantities - Flexible Termination

| Thickness | Case | Thickness ± | Paper Quantity | | Plastic Quantity | |
|-------------------|--------------|---------------------------|----------------|----------|------------------|----------|
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| DD | 0805 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| DS | 0805 | 1.00 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| ER | 1206 | 0.90 ± 0.20 | 0 | 0 | 4,000 | 10,000 |
| ES | 1206 | 1.00 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| EH | 1206 | 1.60 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| EU | 1206 | 1.60 ± 0.25 | 0 | 0 | 2,000 | 8,000 |
| FX | 1210 | 0.95 ± 0.20 | 0 | 0 | 4,000 | 10,000 |
| FZ | 1210 | 1.25 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| FU | 1210 | 1.55 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FJ | 1210 | 1.85 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FR | 1210 | 2.25 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1,000 | 4,000 |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GC | 1812 | 1.10 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GD | 1812 | 1.25 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GF | 1812 | 1.50 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GK | 1812 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GN | 1812 | 1.70 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GL | 1812 | 1.90 ± 0.20 | 0 | 0 | 500 | 2,000 |
| GM | 1812 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| Thickness Code | Case Size | Thickness ± Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| | | | Paper Quantity | | Plastic Quantity | |

Package quantity based on finished chip thickness specifications.



Table 2C – Bulk Packaging Quantities

| Dookogi | | Loose Packaging | | | |
|----------|-----------------------|--|---------|--|--|
| Packayi | lig Type | Bulk Bag (default) | | | |
| Packagin | g C-Spec ¹ | N/A ² | | | |
| Case | Size | Packaging Quantities (pieces/unit packaging) | | | |
| EIA (in) | Metric (mm) | Minimum | Maximum | | |
| 0402 | 1005 | | | | |
| 0603 | 1608 | | 50,000 | | |
| 0805 | 2012 | | | | |
| 1206 | 3216 | | | | |
| 1210 | 3225 | 1 | | | |
| 1808 | 4520 | | | | |
| 1812 | 4532 | | 20,000 | | |
| 1825 | 4564 | | | | |
| 2220 | 5650 | | | | |
| 2225 | 5664 | | | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial Grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive Grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.


Table 3A – Land Pattern Design Recommendations per IPC-7351 – Standard Termination

| EIA Size | Metric Size | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | |
|-------------------|----------------|--|------|------|------|--|------|------|------|------|---|------|------|------|------|------|
| Coue | Coue | С | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 |
| 1210 ¹ | 3225 | 1.50 | 1.60 | 2.90 | 5.60 | 3.90 | 1.40 | 1.40 | 2.80 | 4.70 | 3.30 | 1.30 | 1.20 | 2.70 | 4.00 | 3.00 |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 |

¹ Only for capacitance values $\ge 22 \ \mu F$

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1210 case size.





Table 3B – Land Pattern Design Recommendations per IPC-7351 – Flexible Termination

| EIA Size | Metric Size | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | |
|-------------|----------------|--|------|------|------|--|------|------|------|---|------|------|------|------|------|------|
| Coue | Coue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0805 | 2012 | 0.99 | 1.44 | 1.66 | 4.47 | 2.71 | 0.89 | 1.24 | 1.56 | 3.57 | 2.11 | 0.79 | 1.04 | 1.46 | 2.42 | 1.81 |
| 1206 | 3216 | 1.59 | 1.62 | 2.06 | 5.85 | 3.06 | 1.49 | 1.42 | 1.96 | 4.95 | 2.46 | 1.39 | 1.22 | 1.86 | 4.25 | 2.16 |
| 1210 | 3225 | 1.59 | 1.62 | 3.01 | 5.90 | 4.01 | 1.49 | 1.42 | 2.91 | 4.95 | 3.41 | 1.39 | 1.22 | 2.81 | 4.25 | 3.11 |
| 1812 | 4532 | 2.10 | 1.80 | 3.60 | 7.00 | 4.60 | 2.00 | 1.60 | 3.50 | 6.10 | 4.00 | 1.90 | 1.40 | 3.40 | 5.40 | 3.70 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Terminat | ion Finish |
|--|-----------------------|-----------------------|
| Tomeredure | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate (T_L to T_P) | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T_L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T_{p} to T_{l})$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method |
|--|---------------------------|---|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds. |
| Board Flex | JIS-C-6429 | Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm for COG. Flexible termination system – 3.0 mm (minimum). |
| | | Magnification 50 X. Conditions: |
| 0-ld | | a) Method B, 4 hours at 155°C, dry heat at 235°C |
| Solderability | J-81D-002 | b) Method B at 215°C category 3 |
| | | c) Method D, category 3 at 260°C |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 Cycles (-55°C to +125°C). Measurement at 24 hours +/- 4 hours after test conclusion. |
| | MIL-STD-202 Method | Load Humidity: 1,000 hours 85°C/85% RH and rated voltage. Add 100 K ohm resistor. Measurement at 24 hours +/- 4 hours after test conclusion. |
| Blased Humidity | 103 | Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours +/- 4 hours after test conclusion. |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours +/- 4 hours after test conclusion. |
| Thermal Shock | MIL-STD-202 Method 107 | –55°C/+125°C. Note: Number of cycles required – 300, maximum transfer time – 20 seconds, dwell time – 15 minutes. Air – Air. |
| High Temperature Life | MIL-STD-202 Method | 1,000 hours at 125°C (85°C for YSD, 751) and YSV) with 2 X rated voltage applied |
| | /EIA-198 | |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC for 1,000 hours. |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 min., 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz |
| Mechanical Shock MIL-STD-202 Method 213 Figure 1 of Method 213, Condition F. | | Figure 1 of Method 213, Condition F. |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction – Standard Termination



Construction – Flexible Termination





Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a "K" to identify KEMET, followed by two characters (per EIA–198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the "K" character only.

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.
- X7R dielectric products in capacitance values outlined below.

| EIA Case Size | Metric Size Code | Capacitance | | |
|---------------|------------------|-------------|--|--|
| 0603 | 1608 | ≤ 170 pF | | |
| 0805 | 2012 | ≤ 150 pF | | |
| 1206 | 3216 | ≤ 910 pF | | |
| 1210 | 3225 | ≤ 2,000 pF | | |
| 1808 | 4520 | ≤ 3,900 pF | | |
| 1812 | 4532 | ≤ 6,700 pF | | |
| 1825 | 4564 | ≤ 0.018 µF | | |
| 2220 | 5650 | ≤ 0.027 µF | | |
| 2225 | 5664 | ≤ 0.033 µF | | |

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 μ F. Orientation of marking is vendor optional.





Capacitor Marking (Optional) cont.

| | Capacitance (pF) For Various Alpha/Numeral Identifiers | | | | | | | | | | | |
|-----------|--|-----|----|-----|-------|--------|---------|-----------|------------|-------------|--|--|
| Alaba | | | | | | Numera | al | | | | | |
| Alpha | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | |
| Character | Capacitance (pF) | | | | | | | | | | | |
| A | 0.10 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 | | |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 | | |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 | | |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 | | |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 | | |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 | | |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 | | |
| Н | 0.20 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 | | |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 | | |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 | | |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 | | |
| М | 0.30 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 | | |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 | | |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 | | |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 | | |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 | | |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 | | |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 | | |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 | | |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 | | |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 | | |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 | | |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 | | |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 | | |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 | | |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 | | |
| d | 0.40 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 | | |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 | | |
| f | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 | | |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 | | |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 | | |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 | | |
| у | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 | | |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | | Embosse | ed Plastic | Punched Paper | | |
|----------------------|--------------|---------|--------------------|---------------|--------------------|--|
| EIA Case Size | Size (W)* | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | | Pitch | (P ₁)* | Pitch | (P ₁)* | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 | |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | |
| Array 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size. 2 mm pitch reel for 0805 EIA case size under development.

2 mm prich reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | |
| 16 mm | | (0.059) | | | | (1.181) | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | Note 5 | | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|-----------|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|--|--|
| Tape Size | D _o | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | | | |
| | Variable Dimensions — Millimeters (Inches) | | | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|-----------|--|---------------------------------------|--|--|--|--|--|--|--|--|--|
| Tape Size | А | B Minimum | C | D Minimum | | | | | | | |
| 8 mm | 178 ±0.20 | | | | | | | | | | |
| 12 mm | Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | | | | | |
| 16 mm | (13.000 ±0.008) | | X | | | | | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | | | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Overview

The KEMET Flexible Termination (FT-CAP) multilayer ceramic capacitor in X7R dielectric incorporates a unique, flexible termination system that is integrated with the KEMET standard termination materials. A conductive silver epoxy is utilized between the base metal and nickel barrier layers of KEMET's standard termination system in order to establish pliability, while maintaining terminal strength, solderability and electrical performance. This technology was developed in order to address the primary failure mode of MLCCs – flex cracks, which are typically the result of excessive tensile and shear stresses produced during board flexure and thermal cycling. Flexible termination technology inhibits the transfer of board stress to the rigid ceramic body, therefore mitigating flex cracks which can result in low IR or short circuit failures.

Although this technology does not eliminate the potential for mechanical damage that may propagate during extreme environmental and handling conditions, it does provide superior flex performance over standard termination systems. FT-CAP complements the KEMET Open Mode, Floating Electrode (FE-CAP), Floating Electrode with Flexible Termination (FF-CAP) and KEMET Power Solutions (KPS) product lines by providing a complete portfolio of flex mitigation solutions.

Combined with the stability of an X7R dielectric and designed to accommodate all capacitance requirements, these flexrobust devices are RoHS-compliant, offer up to 5 mm of flex-bend capability and exhibit a predictable change in capacitance with respect to time and voltage. Capacitance change with reference to ambient temperature is limited to $\pm 15\%$ from -55° C to $\pm 125^{\circ}$ C.

In addition to commercial grade, automotive grade devices are available which meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.



| С | 1206 | X | 106 | K | 4 | R | Α | С | TU |
|---------|--|-----------------------------|--|---------------------------------|--|------------|----------------------------|---|--|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ¹ | Packaging/Grade (C-Spec)² |
| | 0603 0805 1206 1210 1808 1812 1825 2220 2225 | X = Flexible termination | Two significant digits and number of zeros | J = ±5% K = ±10% M = ±20% | 9 = 6.3 8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 2 = 200 A = 250 | R = X7R | A = N/A | C = 100% Matte Sn L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

Ordering Information

¹ Additional termination finish options may be available. Contact KEMET for details.



Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) |
|---|---|
| Bulk Bag/Unmarked | Not required (Blank) |
| 7" Reel/Unmarked | TU |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) |
| 7" Reel/Marked | ТМ |
| 13" Reel/Marked | 7040 (EIA 0603) 7215 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2 mm pitch ² | 7081 |
| 13" Reel/Unmarked/2 mm pitch ² | 7082 |

¹ Default packaging is "Bulk Bag." An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking."

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information."

Benefits

- -55°C to +125°C operating temperature range
- Superior flex performance (up to 5 mm)
- · High capacitance flex mitigation
- Lead (Pb)-free, RoHS and REACH compliant
- EIA 0603, 0805, 1206, 1210, 1808, 1812, 1825, 2220, and 2225 case sizes
- DC voltage ratings of 6.3 V, 10 V, 16 V, 25 V, 50 V, 100 V, 200 V, and 250 V
- Capacitance offerings ranging from 180 pF to 22 μ F
- Available capacitance tolerances of ±5%, ±10%, and ±20%
- Automotive (AEC-Q200) grade available
- · Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish allowing for excellent solderability
- SnPb termination finish option available upon request (5% Pb minimum)

Applications

Typical applications include circuits with a direct battery or power source connection, critical and safety relevant circuits without (integrated) current limitation and any application that is subject to high levels of board flexure or temperature cycling. Examples include raw power input side filtering (power plane/bus), high current applications (automobile battery line) and circuits that cannot be fused to open. Markets include consumer, medical, industrial (power supply), automotive, aerospace and telecom.



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|-------------------|---------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|----------------------------|---------------------------|
| 0603 ¹ | 1608 | 1.60 (0.063) ±0.17 (0.007) | 0.80 (0.032) ±0.15 (0.006) | | 0.45 (0.018) ±0.15 (0.006) | 0.58 (0.023) | Colder wave |
| 0805 ² | 2012 | 2.00 (0.079) ±0.30 (0.012) | 1.25 (0.049) ±0.30 (0.012) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Or Or Solder reflow |
| 1206 | 3216 | 3.30 (0.130) ±0.40 (0.016) | 1.60 (0.063) ±0.35 (0.013) | | 0.60 (0.024) ±0.25 (0.010) | | Soluei Tellow |
| 1210 | 3225 | 3.30 (0.130) ±0.40 (0.016) | 2.60 (0.102) ±0.30 (0.012) | | 0.60 (0.024) ±0.25 (0.010) | | |
| 1808 | 4520 | 4.70 (0.185) ±0.50 (0.020) | 2.00 (0.079) ±0.20 (0.008) | See Table 2 for Thickness | 0.70 (0.028) ±0.35 (0.014) | | |
| 1812 | 4532 | 4.50 (0.178) ±0.40 (0.016) | 3.20 (0.126) ±0.30 (0.012) | | 0.70 (0.028) ±0.35 (0.014) | N/A | Solder reflow |
| 1825 | 4564 | 4.60 (0.181) ±0.40 (0.016) | 6.40 (0.252) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | only |
| 2220 | 5650 | 5.90 (0.232) ±0.75 (0.030) | 5.00 (0.197) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | |
| 2225 | 5664 | 5.90 (0.232) ±0.75 (0.030) | 6.40 (0.248) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | |

¹ For capacitance values ≥ 0.56 μF add 0.03 (0.001) to length tolerance dimension with exception on capacitance value 0.22 μF 50V add 0.08 (0.003) to length tolerance dimension.

² For capacitance values 1.0 μ F or \ge 2.2 μ F add 0.05 (0.002) to length tolerance dimension.



Qualification/Certification

Commercial grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance & Reliability.

Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions (excluding SnPb termination finish option.)

Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±15% |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| ² Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | See Dissipation Factor Limit table |
| ^₄ Insulation Resistance (IR) Minimum Limit at 25°C | See Insulation Resistance Limit table (Rated voltage applied for 120 ±5 seconds at 25°C) |

¹ Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 48 or 1,000 hours. Please refer to a part number specific datasheet for referee time details

²DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

³ Capacitance and dissipation factor (DF) measured under the following conditions:

1 kHz ± 50 Hz and 1.0 ± 0.2 V_{rms} if capacitance \leq 10 μ F

120 Hz ± 10 Hz and 0.5 ± 0.1 V_{rms} if capacitance > 10 μ F

⁴ To obtain IR limit, divide $M\Omega - \mu F$ value by the capacitance and compare to $G\Omega$ limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."



Insulation Resistance Limit Table

| EIA Case Size | Rated DC Voltage | 1,000 megohm microfarads or 100 GΩ | 500 megohm microfarads or 10 GΩ | 100 megohm microfarads or 10 GΩ |
|---------------|------------------|---------------------------------------|------------------------------------|------------------------------------|
| 0602 | ≤ 200 V | < 0.047 µF | ≥ 0.047 µf < 0.47 µf | ≥ 0.47 µf |
| 0003 | 250 V | N/A | N/A | ALL |
| 00051 | ≤ 200 V | < 0.15 µF | ≥ 0.15 µF < 2.2 µf | ≥ 2.2 µf |
| 0805 | 250 V | < .027 µF | N/A | ≥ .027 µF |
| 1000 | ≤ 200 V | < 0.47 µF | ≥ 0.47 µF < 2.2 µf | ≥ 2.2 µf |
| 1200 | 250 V | < 0.12 µF | N/A | ≥ 0.12 µF |
| 10102 | ≤ 200 V | < 0.39 µF | ≥ 0.39 µF < 10 µf | ≥ 10 µf |
| 1210- | 250 V | < 0.27 µF | N/A | ≥ 0.27 µF |
| 1805 | ALL | ALL | N/A | N/A |
| 1808 | ALL | ALL | N/A | N/A |
| 1812 | ALL | < 2.2 µF | ≥ 2.2 µF | N/A |
| 1825 | ALL | ALL | N/A | N/A |
| 2220 | ALL | < 10 µF | ≥ 10 µF | N/A |
| 2225 | ALL | ALL | N/A | N/A |

¹ For Capacitance value 1.0 μ F (50 V) IR should be calculated under 100 megohm microfarads or 10 GΩ. ² For Capacitance value 4.7 μ F (50 V) IR should be calculated under 100 megohm microfarads or 10 GΩ.

Dissipation Factor (DF) Limit Table

| EIA Case Size | Rated DC Voltage | Capacitance | Dissipation Factor (Maximum %) | EIA Case Size | Rated DC Voltage | Capacitance | Dissipation Factor (Maximum %) |
|-------------------|---------------------|----------------|--------------------------------------|-------------------|---------------------|-------------|--------------------------------------|
| | < 16 | | 5.0 | | < 16 | All | 5.0 |
| 06.021 | 16/25 | < 1.0 µF | 3.5 | 1206 ³ | 16/25 | All | 3.5 |
| 0003 | > 25 | | 2.5 | | > 25 | All | 2.5 |
| | All | ≥ 1.0 µF | 10.0 | | < 16 | All | 5.0 |
| | . 16 | < 4.7 µF | 5.0 | | 16 | All | 3.5 |
| | × 10 | ≥ 4.7 µF | 10.0 | | 25 | < 10 µF | 3.5 |
| | 16 | < 4.7 µF | 3.5 | 1210 ⁴ | 25 | ≥ 10 µF | 10.0 |
| | 10 | ≥ 4.7 µF | 10.0 | | > 25 | All | 2.5 |
| 0805 ² | 0.5 | < 2.2 µF | 3.5 | | 50 | All | 2.5 |
| | 25 | ≥ 2.2 µF | 10.0 | | > 50 | All | 2.5 |
| | | <1.0 µF | 2.5 | | < 16 | All | 5.0 |
| | > 25 | <u>ь 10 иг</u> | 10.0 | 1808 - 2225 | 16/25 | All | 3.5 |
| | | ≥ 1.0 µF | 10.0 | | > 25 | All | 2.5 |

 1 For Capacitance values 0.22 μF (16 and 25 Volts) DF is 5% and for Capacitance value 4.7 μF (25 V) DF is 3.5%.

 2 For Capacitance values 2.2 μF (6.3, 10, and 16 Volts) DF is 10%.

 3 For Capacitance values 4.7 and 10 μF (All Voltages) and 2.2 μF (25 and 50 Volts) DF is 10%.

⁴ For Capacitance values \geq 10 μ F (\leq 16 V) DF is 10% and for Capacitance value 4.7 μ F (50 V) DF is 5%.



Post Environmental Limits

| High | Temperature | Life, Biased | Humidity, Mo | oisture Resis | tance |
|-------------------|---------------------|--------------|--------------------------------------|----------------------|--------------------------|
| EIA Case Size | Rated DC Voltage | Capacitance | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance |
| | < 16 | | 7.5 | | |
| 06031 | 16/25 | < 1.0 µF | 5.0 | | |
| 0005 | > 25 | | 3.0 | | |
| | All | ≥ 1.0 µF | 20.0 | | |
| | < 16 | < 4.7 µF | 7.5 | | |
| | < 10 | ≥ 4.7 µF | 20.0 | | |
| | 16 | < 4.7 µF | 5.0 | | |
| 08052 | 10 | ≥ 4.7 µF | 20.0 | | |
| 0005 | 25 | < 2.2 µF | 5.0 | | |
| | 23 | ≥ 2.2 µF | 20.0 | | |
| | > 25 | < 1.0 µF | 3.0 | | |
| | ~ 25 | ≥ 1.0 µF | 20.0 | | |
| | < 16 | All | 7.5 | ±20% | 10% of Initial limit |
| 1206 ³ | 16/25 | All | 5.0 | | |
| | > 25 | All | 3.0 | | |
| | < 16 | All | 7.5 | | |
| | 16 | All | 5.0 | | |
| | 25 | < 10µF | 5.0 | | |
| 1210 ^₄ | 23 | ≥ 10µF | 20.0 | | |
| | > 25 | All | 3.0 | | |
| | 50 | All | 3.0 | | |
| | > 50 | All | 3.0 | | |
| | < 16 | All | 7.5 | | |
| 1808 - 2225 | 16/25 | All | 5.0 | | |
| | > 25 | All | 3.0 | | |

¹ For Capacitance values 0.22 μF (16 and 25 V) DF is 7.5%.

 2 For Capacitance values 2.2 μF (6.3, 10, and 16 V) DF is 20%.

 3 For Capacitance values 4.7 and 10 μF (All Voltages) and 2.2 μF (25 and 50 V) DF is 20%.

⁴ For Capacitance values \geq 10 μ F (\leq 16 V) DF is 20% and for Capacitance value 4.7 μ F (50 V) DF is 7.5%



Table 1A – Capacitance Range/Selection Waterfall (0603 – 1210 Case Sizes)

| | | Cas S | se Si Serie | ize/ s | | | 0 | CO 6 | 03) | x | | | | | C | :08 | 05) | x | | | | | (| C12 | 06) | K | | | | | (| C12 | 10) | (| | |
|-----------|------------|----------|----------------|-----------|-----|-----|-----|-------------|-----|------|-----|------|------------|-------|------|----------|------|-----|------|----------|-------|-------|-------|-------|-------|------------|------|----------|-----------|-----|------|-----|-----|-----|-----|-----|
| Cap | Сар | Vol | tage C | Code | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A |
| | Code | Rate | ed Vol | tage | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 5 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 |
| | | Cap | Toler | ance | | ļ | ļ | ļ | F | Prod | uct | Avai | ı labil | itv a | nd C | hip | Thic | kne | ss C | ode | s – S | See 1 | Table | e 2 f | or Cl | l hip T | hicl | knes | ı s Di | men | sion | s | | | | |
| 180 pF | 181 | J | К | М | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | DR | DR | | | | | | ľ | | | | | | - | | | | |
| 220 pF | 221 | J | К | м | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | DR | DR | | | | | | | | | | | | | | | | |
| 270 pF | 271 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | DR | DR | | | | | | | | | | | | | | | | |
| 330 pF | 331 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | DR | DR | | | | | | | | | | | | | | | | |
| 390 pF | 391 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | DR | DR | | | | | | | | | | | | | | | | |
| 470 pF | 471 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | | | | | | | | | | | |
| 560 pF | 561 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | DR | DR | | | | | | | | | | | | | | | | |
| 680 pF | 681 001 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | | DR | DR | DR | | DR | DR | | | | | | | | | | | | | | | | | |
| 820 pF | 021 102 | J | r v | M | | CJ | CJ | CI | CI | CI | CJ | 0 | | | | | | | | | | EO | EO | EO | EO | EO | EO | EO | | | | | | | | |
| 1,000 pF | 102 | J | K | M | CI | CI | CI | CI | CI | CI | CI | CI | | | | | | | | DR | FO | EQ | FO | FO | FO | FO | FO | FO | | | | | | | | |
| 1,200 pT | 152 | J | K | M | C.J | CJ | CJ | C.J | C.J | C.J | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | FO | FO | FO | FO | FO | FO | FO | FO | | | | | | | | |
| 1.800 pF | 182 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EO | EO | EO | EO | EO | EO | EO | EO | | | | | | | | |
| 2,200 pF | 222 | J | К | М | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN |
| 2,700 pF | 272 | J | К | М | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN |
| 3,300 pF | 332 | J | K | М | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN |
| 3,900 pF | 392 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN |
| 4,700 pF | 472 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN |
| 5,600 pF | 562 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN |
| 6,800 pF | 682 | J | K | М | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN |
| 8,200 pF | 822 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN |
| 10,000 pF | 103 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN |
| 12,000 pF | 123 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | | | | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | | FN | FN | FN | FN | FN | FN | FN |
| 10,000 pF | 100 | J | r v | | | CJ | CJ | CJ | CJ | CJ | | | | | DR | | | סט | | | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | | | EN | | | | | |
| 22 000 pF | 223 | J | K | M | | CI | CI | CI | CI | CI | | | | | | | | סס | | | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | | FN | FN | FN | EN | FN | EN | EN |
| 27,000 pi | 223 | 1 | ĸ | M | C I | C I | CI | C I | C I | C I | | | | | | | | חח | חפ | | FO | FO | FO | FO | FO | FO | FO | FO | FN | FN | FN | FN | FN | FN | FN | FN |
| 33 000 pF | 333 | .1 | ĸ | M | C.I | C.I | C.I | C.I | C.I | C.I | | | | DR | DR | DR | DR | | DS | DG | FO | FO | FO | FO | FO | FO | FO | FO | FN | FN | FN | FN | FN | FN | FN | FN |
| 39.000 pF | 393 | J | ĸ | M | CJ | CJ | CJ | CJ | CJ | CJ | | | DR | DR | DR | DR | DR | DD | DS | DG | EO | EO | EO | EO | EO | ER | EO | EO | FN | FN | FN | FN | FN | FN | FN | FN |
| 47,000 pF | 473 | Ĵ | ĸ | M | CJ | CJ | CJ | CJ | CJ | CJ | | | DR | DR | DR | DR | DR | DS | DG | DG | EQ | EQ | EQ | EQ | EQ | ER | ES | ES | FN | FN | FN | FN | FN | FN | FQ | FQ |
| | | Rate | ed Vol | tage | 6.3 | 10 | 16 | 25 | 50 | 00 | 0 | 50 | 5.3 | 10 | 16 | 25 | 50 | 0 | 00 | 250 | 6.3 | 5 | 16 | 25 | 50 | 0 | 00 | 250 | 6.3 | 10 | 16 | 25 | 50 | 00 | 8 | 50 |
| Can | Cap (VDC) | | |) Code | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | Δ | 9 | 8 | 4 | 3 | 5 | 1 | 2 | Δ | 9 | 8 | 4 | 3 | 5 | 1 | 2 | Δ |
| Joup | Code | Ca | se Si | ze/ | É | | | C06 | 03¥ | | - | - | É | | | ت ۵۵۵ | 05¥ | | | <u> </u> | É | Ľ | | C12 | 06¥ | | - | <u> </u> | ļ- | | | C12 | 10¥ | · | - | _ |
| | | | | s | | | | 500 | | | | | | | | 500 | | | | | | | | 512 | | | | | | | | 512 | | | | |



Table 1A - Capacitance Range/Selection Waterfall (0603 - 1210 Case Sizes) cont.

| | | Case Size, Series Voltage Code | | | | | (| C06 | 03) | X | | | | | (| CO 8 | 05) | X | | | | | (| C12 | 06) | K | | | | | (| C12 | 10) | (| | |
|-----------|------|--------------------------------------|---------------|----------|-----|-----|-----|-----|-----|------|-----|------|------------|-------|------|-------------|------|-----|------|-----|------------|------|-------|-------|-------|------------|-----|------|-----------|-----|------|-----|-----|-----|----------|-----|
| Cap | Cap | Vol | tage (| Code | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A |
| p | Code | Rat | ed Vo (VDC | ltage | 6.3 | 10 | 16 | 25 | 50 | 10 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 |
| | | Can | Toler | ance | | | l | | F | Prod | | ∆vai | ı lahil | itv a | nd C | hin | Thic | kne | ss C | ode | ۱ s – s | ee 1 | Tahlo | - 2 f | or Cl | i hin T | hic | cnes | ı s Di | nen | sion | s | | | | |
| 56 000 pE | E62 | | V V | M | C I | C I | C I | CI | | 100 | | | חח | | | | חח | DC | | | | EO | EO | EO | EO | E0 | EC | EC | | ENI | EN | ENI | EN | EN | ΕO | EO |
| 68 000 pF | 683 | J | K | M | | 03 | CI | 00 | C1 | | | | | חח | | חח | חח | | DG | | FO | FO | FO | FO | FO | FO | ES | FS | EN | EN | FN | EN | EN | EN | FQ | FQ |
| 00,000 pF | 003 | J | | M | | 03 | 00 | 03 | 03 | | | | | | | | סט | | 00 | 00 | | EO | EO | EO | EO | EO | EQ | EQ | | | EN | EN | EN | | EA | |
| 02,000 pF | 104 | J | K | M | | C1 | CI | 03 | C1 | | | | | סט | | סט | | | | | FO | FO | FO | FO | FO | FO | EM | EM | EN | EN | FN | EN | EN | FY | FA F7 | F7 |
| 0.10 µF | 104 | 1 | ĸ | M | | C1 | C1 | 00 | C1 | | | | | | | | | DG | | | FD | FD | FD | FD | FD | FD | FIL | EM | EN | EN | EN | EN | EN | FY | FII | FIL |
| 0.12 µi | 124 | 1 | K | M | CI | C1 | 00 | 00 | 00 | | | | | | | | | DG | | | FD | FD | FD | FD | FD | FD | FII | EH | FO | FO | FO | FO | FO | FY | FM | FM |
| 0.15 µF | 184 | J | ĸ | M | C I | C I | CI | CI | 00 | | | | | | | | DG | DG | | | FR | FR | FR | FR | FR | FR | FM | EM | FO | FO | FO | FO | FO | FX | FK | FK |
| 0.10 µl | 224 | J J | ĸ | M | C I | C I | CI | CI | C I | | | | | | | | DG | DG | | | FR | FR | FR | FR | FR | FR | FH | EH | FO | FO | FO | FO | FO | FX | FK | FK |
| 0.22 µr | 224 | ĭ | ĸ | M | C I | C I | CI | 00 | 00 | | | | חח | חח | | חח | חח | 00 | | | FO | FO | FO | FO | FR | FM | | | FO | FO | FO | FO | FO | FX | FP | FP |
| 0.27 µF | 334 | ĭ | ĸ | M | C I | C I | CI | | | | | | DG | DG | DG | DG | חח | | | | FO | FO | FO | FO | FR | FII | | | FX | FX | FX | FX | FX | FX | FM | FM |
| 0.00 µF | 394 | i i | K | M | CI | CL | CI | | | | | | DG | DG | DG | DG | DS | | | | FO | FO | FO | FO | FR | FII | | | FX | FX | FX | FX | FX | FX | FK | FK |
| 0.05 µr | 474 | Ĭ | ĸ | M | C I | CI | CI | C I | | | | | DG | DG | DG | DG | | | | | FR | FR | FR | FR | FR | FII | | | FX | FX | FX | FX | FX | FX | FS | FS |
| 0.56 µF | 564 | J | ĸ | M | 00 | 00 | 00 | 00 | | | | | | חח | חח | DG | DH | | | | FS | FS | ES | ES | FR | FM | | | FX | FX | FX | FX | FX | FΔ | 10 | 10 |
| 0.68 µF | 684 | J | ĸ | M | | | | | | | | | | חח | חח | DG | DH | | | | FT | FT | FT | FT | ES | FM | | | FX | FX | FX | FX | FX | F7 | | |
| 0.00 µr | 824 | .i | ĸ | M | | | | | | | | | חח | חח | חח | DG | | | | | FF | FF | FF | FF | FS | FII | | | FA | FA | FA | FA | FΔ | FI | | |
| 10 uF | 105 | J | K | M | сJ | сJ | C.J | | | | | | | DD | | DG | DV | | | | FF | EF | FF | FU | FS | FU | | | FU | FU | FU | FU | FU | FM | | |
| 1.0 µľ | 125 | J | ĸ | M | 00 | | 00 | | | | | | DS | DS | DS | 00 | | | | | FS | ES | ES | FII | FH | 20 | | | FII | FII | FII | FII | F7 | FH | | |
| 1.5 µF | 155 | J | ĸ | M | | | | | | | | | DG | DG | DG | | | | | | FF | FF | FF | FII | FH | | | | FII | FII | FII | FII | F7 | FM | | |
| 1.8 µF | 185 | Ĵ | ĸ | M | | | | | | | | | DG | DG | DG | | | | | | FS | FS | ES. | FF | FH | | | | FU | FU | FU | FU | F7 | F.J | | |
| 2.2 µF | 225 | Ĵ | ĸ | M | | | | | | | | | DV | DV | DV | עס | рт | | | | FA | FA | FA | EH | FH | | | | F.J | FJ | F.J | F.J | F7 | FK | | |
| 2.7 µF | 275 | J | K | M | | | | | | | | | | | | | | | | | FN | FN | FN | FH | | | | | FF | FF | FF | F7 | FU | | | |
| 3.3 uF | 335 | Ĵ | ĸ | M | | | | | | | | | | | | | | | | | FS | FS | FS | FH | | | | | FA | FA | FA | FM | FM | | | |
| 3.9 µF | 395 | J | K | M | i i | | | | | | | | 1 | | | | | | | | EF | EF | EF | EH | | | | | FZ | FZ | FZ | FZ | FK | | | |
| 47 uF | 475 | Ĵ | ĸ | M | | | | | | | | | DΗ | DΗ | DH | DH | | | | | FA | FA | FA | FA | FA | | | | FO | FO | FO | F7 | FS | | | |
| 5.6 uF | 565 | J | K | M | 1 | | | | | | | | | | | | | | | | EH | EH | EH | | | | | | FA | FA | FA | FU | | | | |
| 6.8 µF | 685 | J | ĸ | M | | | | | | | | | | _ | | _ | | | | | FH | FH | FH | | | _ | _ | | F7 | F7 | F7 | FM | | | | |
| 8.2 µF | 825 | Ĵ | K | M | | | | | | | | | | | | | | | | | ЕН | EH | EH | | | | | | FU | FU | FU | FK | | | | |
| 10 uF | 106 | J | K | M | | | | | | | | | DT | DT | | | | | | | EA | EA | EA | EA | | | | | FS | FS | FS | FS | | | | |
| 22 µF | 226 | J | K | M | | | | | | | | | [. | · · | | | | | | | | | | | | | | | FS | FS | | - | | | | |
| | | Rat | ed Vo | tage | e. | • | 9 | 2 | | 8 | 8 | 20 | m. | 0 | 9 | 2 | | 8 | 8 | 20 | m. | • | 9 | 2 | | 8 | 8 | 20 | m. | • | 9 | S | 0 | 8 | 0 | ß |
| | Can | | (VDC |) | 9 | - | - | 7 | 2 | = | 5 | 5 | ° ا | - | - | 1 | 2 | = | 3 | 5 | 9 | - | - | 7 | 2 | = | 5 | 5 | 9 | - | - | 7 | 2 | 7 | 21 | 5 |
| Cap | Code | Vol | tage (| Code | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A |
| | | | | ze/ s | | | | C06 | 03X | | | | | | | C08 | 05X | | | | | | | C12 | 06X | | | | | | | C12 | 10X | | | |



Table 1B - Capacitance Range/Selection Waterfall (1808 - 2225 Case Sizes)

| | | Cas S | se S Serie | ize/ es | | C18 | 08X | | | C | 1812 | X | | | C18 | 25X | | | C | 2220 | X | | | C22 | 25X | |
|----------------|------------|----------|-----------------|------------|----|-----|-----|------|--------|--------|---------|--------|---------|-------|------|--------|--------|--------|--------|-------|--------|-------|-------|-----|-----|-----|
| Сар | Сар | Vol | tage (| Code | 5 | 1 | 2 | A | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A |
| | Code | Rate | ed Vol (VDC | ltage) | 50 | 100 | 200 | 250 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 |
| | | Cap | Toler | ance | | | | Prod | uct Av | ailabi | lity an | d Chip | o Thicl | kness | Code | s – Se | e Tabl | e 2 fo | r Chip | Thick | ness I | Dimen | sions | | | |
| 4,700 pF | 472 | J | K | М | LD | LD | LD | | | | | | | | | | | | | | | | | | | |
| 5,600 pF | 562 | J | K | M | LD | LD | LD | | | | | | | | | | | | | | | | | | | |
| 6,800 pF | 682 | J | K | M | LD | LD | LD | | GB | GB | GB | GB | GB | | | | | | | | | | | | | |
| 8,200 pF | 822 | J | K | M | LD | LD | LD | | GB | GB | GB | GB | GB | | | | | | | | | | | | | |
| 10,000 pF | 103 | J | K | M | LD | LD | LD | | GB | GB | GB | GB | GB | | | | | | | | | | | | | |
| 12,000 pF | 123 | J | K | M | LD | LD | LD | | GB | GB | GB | GB | GB | | | | | | | | | | | | | |
| 15,000 pF | 153 | J | K | M | LD | LD | LD | | GB | GB | GB | GB | GB | | | | | | | | | | | | | |
| 18,000 pF | 183 | J | K | M | LD | LD | LD | | GB | GB | GB | GB | GB | | | | | | | | | | | | | |
| 22,000 pF | 223 | J | K | M | | LD | | | GB | GB | GB | GB | GB | HB | HB | HB | HB | | | | | | | | | |
| 27,000 pF | 2/3 | J | K | M | | LD | | | GB | GB | GB | GB | GB | HB | HB | HB | HB | | | | | | | | | |
| 33,000 pF | 333 | J | N N | | | | | | | GB | GB | GB | GB | | | | | | | | | | | | | |
| 47 000 pF | 393 172 | J | r v | M | | | | | CP | GR | GD | GB | GD | пр | | пр | | | | | | | | | | |
| 56 000 pF | 473 563 | | K | M | | | | | GB | GB | GB | GB | GB | HR | HR | HB | HB | | | | | | | | | |
| 68 000 pF | 683 | | K | M | | | | | GR | GB | GB | GB | GB | HR | HR | HR | HR | | | | | | | | | |
| 82 000 pF | 823 | | K | M | | | | | GB | GB | GB | GB | GB | HB | HB | HB | HB | JC | JC | JC | JC | JC | | | | |
| 0 10 uF | 104 | Ĵ | ĸ | M | | | | | GB | GB | GB | GB | GB | HB | HB | HB | HB | JC | JC | JC | JC | JC | кс | кс | кс | кс |
| 0.12 µF | 124 | Ĵ | K | M | LD | | | | GB | GB | GB | GB | GB | HB | HB | НВ | НВ | JC | JC | JC | JC | JC | KC | KC | KC | KC |
| 0.15 µF | 154 | Ĵ | K | M | LD | | | | GB | GB | GB | GE | GE | HB | HB | НВ | НВ | JC | JC | JC | JC | JC | KC | KC | KC | KC |
| 0.18 µF | 184 | Ĵ | K | M | LD | | | | GB | GB | GB | GF | GG | НВ | HB | НВ | НВ | JC | JC | JC | JC | JC | KC | KC | KC | KC |
| 0.22 µF | 224 | J | K | М | | | | | GB | GB | GB | GG | GG | HB | HB | HB | HB | JC | JC | JC | JC | JC | KC | KC | KC | KC |
| 0.27 μF | 274 | J | К | М | | | | | GB | GB | GG | GG | GG | HB | HB | HB | HB | JC | JC | JC | JC | JC | KB | KC | KC | KC |
| 0.33 µF | 334 | J | K | M | | | | | GB | GB | GG | GG | GG | HB | HB | HB | HB | JC | JC | JC | JC | JC | KB | KC | KC | KC |
| 0.39 µF | 394 | J | K | M | | | | | GB | GB | GG | GG | GG | HB | HB | HD | HD | JC | JC | JC | JC | JC | KB | KC | KC | KC |
| 0.47 µF | 474 | J | K | M | | | | | GB | GB | GG | GJ | GJ | HB | HB | HD | HD | JC | JC | JC | JC | JC | KB | KC | KD | KD |
| 0.56 µF | 564 | J | K | M | | | | | GC | GC | GG | | | HB | HD | HD | HD | JC | JC | JC | JD | JD | KB | KC | KD | KD |
| 0.68 µF | 684 | J | K | M | | | | | GC | GC | GG | | | HB | HD | HD | HD | JC | JC | JD | JD | JD | KB | KC | KD | KD |
| 0.82 µF | 824 | J | K | M | | | | | GE | GE | GG | | | HB | HF | HF | HF | JC | JC | JF | JF | JF | KB | KC | KE | KE |
| 1.0 µF | 105 | J | K | M | | | | | GE | GE | GG | | | HB | HF | HF | HF | JC | JC | JF | JF | JF | KB | KD | KE | KE |
| 1.2 μF | 125 | J | K | M | | | | | GB | GB | GB | | | HB | | | | JC | JC | | | | KB | KE | KE | KE |
| 1.5 µF | 155 | J | K | M | | | | | GC | GC | GC | | | HC | | | | JC | JC | | | | KC | | | |
| 1.8µ⊦ | 185 | J | K | M | | | | | GE | GE | GE | | | HD | | | | JD | JD | | | | KD | | | |
| 2.2µ⊦ | 225 | J | K | M | | | | | 66 | GG | 66 | | | HF | | | | J⊦ | J⊦ | | | | KD | | | |
| 2.7µF | 2/5 | J | K | | | | | | GJ | GJ | GJ | | | | | | | | | | | | | | | |
| 3.3 µF | 330 | J | N K | M | | | | | GL | GL | GL | | | | | | | | | | | | | | | |
| 4.7μr 10 μF | 4/0 | | R K | M | | | | | GK | UN | | | | | | | | IE | 10 | | | | | | | |
| 15 µF | 156 | | ĸ | M | | | | | | | | | | | | | | .10 | .10 | | | | | | | |
| 22 µF | 226 | Ĵ | ĸ | M | | | | | | | | | | | | | | JO | 00 | | | | | | | |
| | | Rate | ed Vol (VDC) | tage | 50 | 100 | 200 | 250 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 |
| Сар | Cap | Vol | tage (| , Code | 5 | 1 | 2 | A | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A |
| | Coae | Ca | se Si Serie | ze/ s | | C18 | 08X | | | C | 21812 | ĸ | | | C18 | 25X | | | C | 2220 | x | | | C22 | 25X | |

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Table 2A - Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic | Quantity |
|-----------|-------------------|------------------------------------|---------|----------------------|---------|----------|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| CJ | 0603 | 0.80 ±0.15* | 4,000 | 15,000 | 0 | 0 |
| DR | 0805 | 0.78 ±0.20 | 0 | 0 | 4,000 | 10,000 |
| DD | 0805 | 0.90 ±0.10 | 0 | 0 | 4,000 | 10,000 |
| DS | 0805 | 1.00 ±0.20 | 0 | 0 | 2,500 | 10,000 |
| DG | 0805 | 1.25 ±0.15 | 0 | 0 | 2,500 | 10,000 |
| | 0805 | 1.25 ±0.20 | 0 | 0 | 2,500 | 10,000 |
| | 0805 | 1.25 ± 0.25 | 0 | 0 | 2,500 | 10,000 |
| | 1206 | 1.25 ± 0.30 | | | 2,500 | |
| | 1200 | 0.78 ±0.20 | 0 | 0 | 4,000 | 10,000 |
| EN | 1200 | 0.90 ±0.20 | 0 | 0 | 4,000 | 10,000 |
| EN | 1200 | 1 00 +0 20 | 0 | 0 | 2 500 | 10,000 |
| FT | 1200 | 1 10 +0 20 | Ő | Ő | 2,500 | 10,000 |
| EF | 1206 | 1.20 ±0.15 | 0 0 | 0 0 | 2,500 | 10,000 |
| EM | 1206 | 1.25 ±0.15 | 0 | 0 | 2,500 | 10.000 |
| EH | 1206 | 1.60 ±0.20 | 0 | 0 | 2,000 | 8,000 |
| EU | 1206 | 1.60 ±0.25 | 0 | 0 | 2,000 | 8,000 |
| EA | 1206 | 1.60 ±0.35 | 0 | 0 | 2,000 | 8,000 |
| FN | 1210 | 0.78 ±0.20 | 0 | 0 | 4,000 | 10,000 |
| FQ | 1210 | 0.90 ±0.20 | 0 | 0 | 4,000 | 10,000 |
| FX | 1210 | 0.95 ±0.20 | 0 | 0 | 4,000 | 10,000 |
| FE | 1210 | 1.00 ±0.10 | 0 | 0 | 2,500 | 10,000 |
| FA | 1210 | 1.10 ±0.15 | 0 | 0 | 2,500 | 10,000 |
| FZ | 1210 | 1.25 ±0.20 | 0 | 0 | 2,500 | 10,000 |
| FL | 1210 | 1.40 ±0.15 | 0 | 0 | 2,000 | 8,000 |
| | 1210 | 1.55 ±0.15 | 0 | 0 | 2,000 | 8,000 |
| | 1210 | 1.55 ±0.20 | 0 | 0 | 2,000 | 8,000 |
| FP EM | 1210 | 1.00 ±0.20 | | 0 | 2,000 | |
| FI | 1210 | 1.70 ±0.20 | 0 | 0 | 2,000 | 8 000 |
| FK | 1210 | 2 10 +0 20 | 0 | 0 | 2,000 | 8,000 |
| FS | 1210 | 2.50 +0.30 | Ő | Ő | 1.000 | 4.000 |
| LD | 1808 | 0.90 ±0.10 | 0 | 0 | 2.500 | 10.000 |
| GB | 1812 | 1.00 ±0.10 | 0 | 0 | 1,000 | 4,000 |
| GC | 1812 | 1.10 ±0.10 | 0 | 0 | 1,000 | 4,000 |
| GE | 1812 | 1.30 ±0.10 | 0 | 0 | 1,000 | 4,000 |
| GF | 1812 | 1.50 ±0.10 | 0 | 0 | 1,000 | 4,000 |
| GG | 1812 | 1.55 ±0.10 | 0 | 0 | 1,000 | 4,000 |
| GK | 1812 | 1.60 ±0.20 | 0 | 0 | 1,000 | 4,000 |
| GJ | 1812 | 1.70 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| GL | 1812 | 1.90 ±0.20 | 0 | 0 | 500 | 2,000 |
| HB | 1825 | 1.10 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| | 1825 | 1.15 ± 0.15 1.20 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| | 1025 | 1.50 ±0.15 1.50 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| | 2220 | 1.30 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| JD | 2220 | 1 30 +0 15 | 0 | 0 | 1,000 | 4,000 |
| JF | 2220 | 1.50 +0.15 | Ő | ő | 1,000 | 4,000 |
| JO | 2220 | 2.40 ±0.15 | Ő | Ő | 500 | 2.000 |
| KB | 2225 | 1.00 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| KC | 2225 | 1.10 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| KD | 2225 | 1.30 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| KE | 2225 | 1.40 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size1 | Range (mm) | Paper Q | uantity ¹ | Plastic | Quantity |

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape & Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information."

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Table 2B – Bulk Packaging Quantities

| Deekee | | Loose Pa | ackaging |
|----------|------------------------|------------------------|------------------------|
| Раскау | ing type | Bulk Bag | (default) |
| Packagii | ng C-Spec ¹ | N/ | /A ² |
| Cas | e Size | Packaging Quantities (| pieces/unit packaging) |
| EIA (in) | Metric (mm) | Minimum | Maximum |
| 0402 | 1005 | | |
| 0603 | 1608 | | |
| 0805 | 2012 | | 50,000 |
| 1206 | 3216 | | |
| 1210 | 3225 | 1 | |
| 1808 | 4520 | | |
| 1812 | 4532 | | |
| 1825 | 4564 | | 20,000 |
| 2220 | 5650 | | |
| 2225 | 5664 | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for automotive grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding anti-static Bulk Bag and automotive grade products.) The 15th through 22nd character positions of the ordering code should be left blank. All products ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Metric Size Size | | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | |
|-------------------------|------|--|------|------|------|--|------|------|------|---|------|------|------|------|------|------|
| Coue | Coue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0603 | 1608 | 0.85 | 1.25 | 1.10 | 4.00 | 2.10 | 0.75 | 1.05 | 1.00 | 3.10 | 1.50 | 0.65 | 0.85 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 0.99 | 1.44 | 1.66 | 4.47 | 2.71 | 0.89 | 1.24 | 1.56 | 3.57 | 2.11 | 0.79 | 1.04 | 1.46 | 2.42 | 1.81 |
| 1206 | 3216 | 1.59 | 1.62 | 2.06 | 5.85 | 3.06 | 1.49 | 1.42 | 1.96 | 4.95 | 2.46 | 1.39 | 1.22 | 1.86 | 4.25 | 2.16 |
| 1210 | 3225 | 1.59 | 1.62 | 3.01 | 5.90 | 4.01 | 1.49 | 1.42 | 2.91 | 4.95 | 3.41 | 1.39 | 1.22 | 2.81 | 4.25 | 3.11 |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 |
| 1812 | 4532 | 2.10 | 1.80 | 3.60 | 7.00 | 4.60 | 2.00 | 1.60 | 3.50 | 6.10 | 4.00 | 1.90 | 1.40 | 3.40 | 5.40 | 3.70 |
| 1825 | 4564 | 2.15 | 1.80 | 6.90 | 7.10 | 7.90 | 2.05 | 1.60 | 6.80 | 6.20 | 7.30 | 1.95 | 1.40 | 6.70 | 5.50 | 7.00 |
| 2220 | 5650 | 2.85 | 2.10 | 5.50 | 8.80 | 6.50 | 2.75 | 1.90 | 5.40 | 7.90 | 5.90 | 2.65 | 1.70 | 5.30 | 7.20 | 5.60 |
| 2225 | 5664 | 2.85 | 2.10 | 6.90 | 8.80 | 7.90 | 2.75 | 1.90 | 6.80 | 7.90 | 7.30 | 2.65 | 1.70 | 6.70 | 7.20 | 7.00 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805, and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations, the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

The KEMET families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. The KEMET recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Termination Finish | | | |
|--|-----------------------|-----------------------|--|--|
| Tomeredure | SnPb | 100% Matte Sn | | |
| Preheat/Soak | | | | |
| Temperature Minimum (T _{smin}) | 100°C | 150°C | | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | | |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds | | |
| Ramp-Up Rate (T_L to T_P) | 3°C/second maximum | 3°C/second maximum | | |
| Liquidous Temperature (T _L) | 183°C | 217°C | | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | | |
| Peak Temperature (T _P) | 235°C | 260°C | | |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 30 seconds maximum | | |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | 6°C/second maximum | | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | | |

Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method |
|------------------------|-----------------------------------|--|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds. |
| Board Flex | JIS-C-6429 | Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm for COG. Flexible termination system – 3.0 mm (minimum). |
| | | Magnification 50 X, conditions: |
| Soldorobility | 1-STD-002 | a) Method B, 4 hours at 155°C, dry heat at 235°C |
| Solderability | J-31D-002 | b) Method B, category 3 at 215°C |
| | | c) Method D, category 3 at 260°C |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to +125°C). Measurement at 24 hours ±4 hours after test conclusion. |
| Dissod Humidity | MIL-STD-202 | Load humidity: 1,000 hours 85°C/85% RH and rated voltage. Add 100 K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. |
| Blased Humany | Method 103 | Low volt humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours ±4 hours after test conclusion. |
| Thermal Shock | MIL-STD-202 Method 107 | -55°C/+125°C. Note: Number of cycles required – 300. Maximum transfer time – 20 seconds. Dwell time – 15 minutes. Air – air. |
| High Temperature Life | MIL-STD-202 Method 108/EIA-198 | 1,000 hours at 125°C (85°C for X5R, Z5U and Y5V) with 2 X rated voltage applied. |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC for 1,000 hours. |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Condition F. |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. |

Storage & Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction





Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a "K" to identify KEMET, followed by two characters (per EIA–198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the "K" character only.

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.
- X7R dielectric products in capacitance values outlined below.

| EIA Case Size | Metric Size Code | Capacitance |
|---------------|------------------|-------------|
| 0603 | 1608 | ≤ 170 pF |
| 0805 | 2012 | ≤ 150 pF |
| 1206 | 3216 | ≤ 910 pF |
| 1210 | 3225 | ≤ 2,000 pF |
| 1808 | 4520 | ≤ 3,900 pF |
| 1812 | 4532 | ≤ 6,700 pF |
| 1825 | 4564 | ≤ 0.018 µF |
| 2220 | 5650 | ≤ 0.027 µF |
| 2225 | 5664 | ≤ 0.033 µF |

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 μ F. Orientation of marking is vendor optional.





Capacitor Marking (Optional) cont.

| | Capacitance (pF) For Various Alpha/Numeral Identifiers | | | | | | | | | | | | |
|-----------|--|------------------|----|-----|-------|--------|---------|-----------|------------|-------------|--|--|--|
| Alaba | | | | | | Numera | d I | | | | | | |
| Alpha | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | |
| Character | | Capacitance (pF) | | | | | | | | | | | |
| A | 0.10 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 | | | |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 | | | |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 | | | |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 | | | |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 | | | |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 | | | |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 | | | |
| Н | 0.20 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 | | | |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 | | | |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 | | | |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 | | | |
| М | 0.30 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 | | | |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 | | | |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 | | | |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 | | | |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 | | | |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 | | | |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 | | | |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 | | | |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 | | | |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 | | | |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 | | | |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 | | | |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 | | | |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 | | | |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 | | | |
| d | 0.40 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 | | | |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 | | | |
| f | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 | | | |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 | | | |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 | | | |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 | | | |
| у | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 | | | |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punched Paper | | |
|----------------------|------|---------|--------------------|--------------------------|----------|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | (W)* | Pitch | (P ₁)* | Pitch (P ₁)* | | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 | |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | |
| Array 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions — Millimeters (Inches) | | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | |
| 16 mm | | (0.059) | | | | (1.181) | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | te 5 | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|-----------|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|--|--|
| Tape Size | D _o | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|-----------|--|---------------------------------------|--|--|--|--|--|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | | | | | |
| 8 mm | 178 ±0.20 | | | | | | | | | | |
| 12 mm | Or 220 10 20 | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | | | | | |
| 16 mm | (13.000 ±0.008) | | | | | | | | | | |
| | Variable Dimensions — Millimeters (Inches) | | | | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | | | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber


Floating Electrode Design (FE-CAP), X7R Dielectric, 6.3 – 250 VDC (Commercial & Automotive Grade)



Overview

KEMET's Floating Electrode (FE-CAP) multilayer ceramic capacitor in X7R dielectric utilizes a cascading internal electrode design configured to form multiple capacitors in series within a single monolithic structure. This unique configuration results in enhanced voltage and ESD performance over standard capacitor designs while allowing for a fail-open condition if mechanically damaged (cracked). If damaged, the device may experience a drop in capacitance but a short is unlikely. The FE-CAP is designed to reduce the likelihood of a low IR or short circuit condition and the chance for a catastrophic and potentially costly failure event.

Driven by the demand for a more robust and reliable component, the FE-CAP was designed for critical applications where higher operating temperatures and mechanical stress are a concern. These capacitors are manufactured in state of the art ISO/TS 16949:2009 certified facilities and are widely used in power supplies (input and output filters) and general electronic applications. Combined with the stability of an X7R dielectric, the FE-CAP complements KEMET's "Open Mode" devices by providing a fail-safe design optimized for low to mid range capacitance values. These devices exhibit a predictable change in capacitance with respect to time and voltage and boast a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to $\pm 15\%$ from -55° C to $+125^{\circ}$ C.

In addition to Commercial Grade, Automotive Grade devices are available which meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.



Ordering Information

| С | 0805 | S | 104 | K | 5 | R | Α | C | TU |
|---------|--|---------------------------|--|---------------------------------|--|------------|----------------------------|---|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ¹ | Packaging/ Grade (C-Spec) |
| | 0402 0603 0805 1206 1210 1812 | S = Floating Electrode | Two significant digits and number of zeros | J = ±5% K = ±10% M = ±20% | 9 = 6.3 8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 2 = 200 A = 250 | R = X7R | A = N/A | C = 100% Matte Sn L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ Additional termination finish options may be available. Contact KEMET for details.

¹ SnPb termination finish option is not available on automotive grade product.

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1



Packaging C-Spec Ordering Options Table

| Packaging Type | Packaging/Grade Ordering Code (C-Spec) | | | | | | |
|---|---|--|--|--|--|--|--|
| Commerc | ial Grade ¹ | | | | | | |
| Bulk Bag | Not Required (Blank) | | | | | | |
| 7" Reel/Unmarked | TU | | | | | | |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) | | | | | | |
| 7" Reel/Marked | TM | | | | | | |
| 13" Reel/Marked | 7040 (EIA 0603) 7215 (EIA 0805 and larger case sizes) | | | | | | |
| 7" Reel/Unmarked/2 mm pitch ² | 7081 | | | | | | |
| 13" Reel/Unmarked/2 mm pitch ² | 7082 | | | | | | |
| Automoti | ve Grade ³ | | | | | | |
| 7" Reel | AUTO | | | | | | |
| 13" Reel/Unmarked | AUTO7411 (EIA 0603 and smaller case sizes) AUTO7210 (EIA 0805 and larger case sizes) | | | | | | |
| 7" Reel/Unmarked/2 mm pitch ² | 3190 | | | | | | |
| 13" Reel/Unmarked/2 mm pitch ² | 3191 | | | | | | |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked.

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

³ Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information".

³ For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information".

³ All Automotive packaging C-Specs listed exclude the option to laser mark components. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking".

Benefits

- -55°C to +125°C operating temperature range
- · Floating Electrode/fail open design
- Low to mid capacitance flex mitigation
- Lead (Pb)-free, RoHS and REACH compliant
- EIA 0402, 0603, 0805, 1206, 1210, and 1812 case sizes
- DC voltage ratings of 6.3 V, 10 V, 16 V, 25 V, 50 V, 100 V, 200 V, and 250 V
- Capacitance offerings ranging from 150 pF to 0.22 μF

- Available capacitance tolerances of ±5%, ±10%, and ±20%
- Commercial and Automotive (AEC-Q200) grades available
- · Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish allowing for excellent solderability
- SnPb termination finish option available upon request (5% Pb minimum)

Applications

Typical applications include circuits with a direct battery or power source connection, critical and safety relevant circuits without (integrated) current limitation and any application that is subject to high levels of board flexure or temperature cycling. Examples include raw power input side filtering (power plane/bus), high current applications (automobile battery line) and circuits that cannot be fused to open. Markets include consumer, medical, industrial (power supply), automotive, aerospace and telecom.



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | tion Due To: | Days Prior To |
|-----------------------------|----------------------------------|----------------|------------------|
| C-Spec | Process/Product change | Implementation | |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum |
| AUTO | Yes (without approval) | Yes | 90 days minimum |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | | PPAP (Product Part Approval Process) Level | | | | | | | | | | | |
|-----------------------------|---|--|---|---|---|--|--|--|--|--|--|--|--|
| C-Spec | 1 | 2 | 3 | 4 | 5 | | | | | | | | |
| KEMET assigned ¹ | • | • | • | • | • | | | | | | | | |
| AUTO | | | 0 | | | | | | | | | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|-------------------------------|-----------------|-------------------------------|----------------------------|---------------------------------|
| 0402 | 1005 | 1.00 (0.040) ±0.05 (0.002) | 0.50 (0.020) ±0.05 (0.002) | | 0.30 (0.012) ±0.10 (0.004) | 0.30 (0.012) | Solder Reflow Only |
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | |
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | See Table 2 for | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave or Solder Reflow |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | Thickness | 0.50 (0.02) ±0.25 (0.010) | | |
| 1210 | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | N/A | Solder Reflow |
| 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | | 0.60 (0.024) ±0.35 (0.014) | | Only |



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|--|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 Vdc Applied (TCC) | ±15% |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| ² Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5±1 seconds and charge/discharge not exceeding 50mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | 5%(6.3V & 10V), 3.5%(16V & 25V) and 2.5%(50V to 250V) |
| ^₄ Insulation Resistance (IR) Minimum Limit at 25°C | See Insulation Resistance Limit Table (Rated voltage applied for 120±5 seconds at 25°C) |

¹ Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours.

² DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

 $^{\scriptscriptstyle 3}$ Capacitance and dissipation factor (DF) measured under the following conditions:

1kHz \pm 50Hz and 1.0 \pm 0.2 Vrms if capacitance ${\leq}10\mu F$

120Hz ± 10Hz and 0.5 ± 0.1 Vrms if capacitance >10μF

⁴ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 & Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON".

Post Environmental Limits

| High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | | | | |
|---|---------------------|----------------------|-----------------------------------|----------------------|--------------------------|--|--|--|--|--|--|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | | | | | | |
| | > 25 | | 3.0 | | 10% of Initial | | | | | | |
| X7R | 16/25 | All | 5.0 | ±20% | | | | | | | |
| | < 16 | | 7.5 | | 2 | | | | | | |



Insulation Resistance Limit Table (X7R Dielectric)

| EIA Case Size | 1,000 Megohm Microfarads or 100 GΩ | 500 Megohm Microfarads or 10 GΩ |
|---------------|---------------------------------------|------------------------------------|
| 0201 | N/A | ALL |
| 0402 | < 0.012 µF | ≥ 0.012 µF |
| 0603 | < 0.047 µF | ≥ 0.047 µF |
| 0805 | < 0.15 µF | ≥ 0.15 µF |
| 1206 | < 0.47 µF | ≥ 0.47 µF |
| 1210 | < 0.39 µF | ≥ 0.39 µF |
| 1808 | ALL | N/A |
| 1812 | < 2.2 µF | ≥ 2.2 µF |
| 1825 | ALL | N/A |
| 2220 | < 10 µF | ≥ 10 µF |
| 2225 | ALL | N/A |



Table 1A - Capacitance Range/Selection Waterfall (0402 - 0805 Case Sizes)

| | | Cas S | se S Serie | ize/ es | | C | 0402 | 2S | | | | C | 0603 | ß | | | | | | C08 | 05S | | | |
|---------------------------|-------------|--------------|-----------------|------------|-----|-------|------|----|----|-----|-------|---------|---------|--------|--------|-------|-------|-------|-----|-----|-----|-----|-----|-----|
| Canacitanco | Сар | Vol | tage C | ode | 9 | 8 | 4 | 3 | 5 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A |
| Gapacitance | Code | Rat | ed Vol | tage | 6.3 | 2 | 16 | 25 | 20 | 5.3 | 2 | 16 | 25 | 20 | 8 | 00 | | 10 | 16 | 25 | 20 | 8 | 00 | 50 |
| | | | (VDC) |) | | | | | | | Drodu | ict Ave | ailahil | ity an | d Chin | | | Codes | | | | - | 7 | 7 |
| | | | oleran | ce | | | | | | | See | Table | 2 for | Chip 1 | Chickn | ess D | imens | ions | | | | | | |
| 150 pF | 151 | J | K | М | BB | BB | BB | BB | BB | | | | | | | | | | | | | | | |
| 180 pF | 181 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 220 pF | 221 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 270 pF | 271 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 330 pF | 331 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 390 pF | 391 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 470 pF | 471 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 560 pF | 561 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 680 pF | 681 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 820 pF | 821 | J | K | М | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 1,000 pF | 102 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 1,200 pF | 122 | J | K | M | | | | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 1,500 pF | 152 | J | K | M | | | | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 1,800 pF | 182 | J | K | M | | | | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 2,200 pF | 222 | J | K | M | | | | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 2,700 pF | 272 | J | K | M | | | | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 3,300 pF | 332 | J | K | M | | | | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 3,900 pF | 392 | J | K | M | | | | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 4,700 pF | 472 | J | K | M | | | | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 5,600 pF | 562 | J | K | М | | | | | | CF | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DN | DN | DN | DN |
| 6,800 pF | 682 | J | K | M | | | | | | CF | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DN | DN | DN | DN |
| 8,200 pF | 822 | J | K | M | | | | | | CF | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DN | DN | DN | DN |
| 10,000 pF | 103 | J | K | M | | | | | | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DN | DN | DN |
| 12,000 pF | 123 | J | K | M | | | | | | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DN | DN | DN |
| 15,000 pF | 153 | J | K | М | | | | | | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DP | | |
| 18,000 pF | 183 | J | K | M | | | | | | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DP | | |
| 22,000 pF | 223 | J | K | M | | | | | | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DP | | |
| 27,000 pF | 273 | J | K | M | | | | | | | | | | | | | DN | DN | DN | DN | DN | | | |
| 33,000 pF | 333 | J | K | M | | | | | | | | | | | | | DN | DN | DN | DN | DN | | | |
| 39,000 pF | 393 | J | K | Μ | | | | | | | | | | | | | DN | DN | DN | DN | DN | | | |
| 47,000 pF | 473 | J | K | M | | | | | | | | | | | | | DN | DN | DN | DN | DN | | | |
| 56,000 pF | 563 | J | K | M | | | | | | | | | | | | | DP | DP | DP | DP | DP | | | |
| 68,000 pF | 683 | J | K | M | | | | | | | | | | | | | DP | DP | DP | DP | DP | | | |
| 82,000 pF | 823 | J | K | M | | | | | | | | | | | | | DG | DG | DG | DG | DG | | | |
| 0.10 µF | 104 | J | K | M | | | | | | | | | | | | | DG | DG | DG | DG | DG | | | |
| | | Rat | ed Vol (VDC) | tage) | 6.3 | 10 | 16 | 25 | 50 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 |
| Capacitance | Cap Code | Voltage Code | | 9 | 8 | 4 | 3 | 5 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | |
| Code Case Size/ Series | | | | | C | :0402 | S | | | - | C | :0603 | S | | | | - | | C08 | 055 | | | | |



Table 1B - Capacitance Range/Selection Waterfall (1206 - 1812 Case Sizes)

| | | Cas | se Si Serie | ize/ s | | | | C12 | 06S | | | | | | | C12 | 1 0 S | | | | | C | 1812 | 2 S | |
|----------------------|----------|----------------|------------------|-----------|-----|----------|----|-----|-----|-----|------|----------------|--------|--------------------|----------------|-----------------|---------------|-----------------|-----|-------|----|----|------|------------|-----|
| Canacitanoo | Сар | Vo | ltage C | ode | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 3 | 5 | 1 | 2 | A |
| Capacitance | Code | | ed Volt | tage | m. | <u> </u> | 9 | 32 | | 8 | 8 | 50 | m. | • | 9 | 32 | | 8 | 8 | 20 | 5 | .0 | 8 | 00 | 20 |
| | | 0. | (VDC) | | 6 | • | | | | - | | ~ | | ` • : : • · · | , , | | lieke | - | ~ | 7 | | | - | 2 | 7 |
| | | Са | oleran | nce re | | | | | | | Proc | uci A e Tah | le 2 f | onity or Chi | anu C n Thi | nıp II cknes | nckn s Dim | ess Ci ensin | nes | | | | | | |
| 1.000 pF | 102 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | | 011 | <u>p 1111</u> | UKIICS | | | | | | | | | |
| 1.200 pF | 122 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | | | | | | | | | | | | | |
| 1.500 pF | 152 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | | | | | | | | | | | | | |
| 1,800 pF | 182 | J | К | м | EB | EB | EB | EB | EB | EB | EB | EB | | | | | | | | | | | | | |
| 2,200 pF | 222 | J | к | м | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | | | | | |
| 2,700 pF | 272 | J | K | М | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | | | | | |
| 3,300 pF | 332 | J | к | М | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | | | | | |
| 3,900 pF | 392 | J | К | М | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | | | | | |
| 4,700 pF | 472 | J | ĸ | М | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | | | | | |
| 5,600 pF | 562 | J | ĸ | М | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | | | | | |
| 6,800 pF | 682 | J | K | М | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | GB |
| 8,200 pF | 822 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | GB |
| 10,000 pF | 103 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | GB |
| 12,000 pF | 123 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | GB |
| 15,000 pF | 153 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | GB |
| 18,000 pF | 183 | J | K | М | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | GB |
| 22,000 pF | 223 | J | ĸ | M | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | GB |
| 27,000 pF | 273 | J | ĸ | M | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | GB |
| 33,000 pF | 333 | J | ĸ | M | EB | EB | EB | EB | EB | EB | | | FB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | GB |
| 39,000 pF | 393 | J | ĸ | M | EB | EB | EB | EB | EB | EC | | | FB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | GB |
| 47,000 pF | 473 | J | K | М | EB | EB | EB | EB | EB | EC | | | FB | FB | FB | FB | FB | FB | FC | FC | GB | GB | GB | GB | GB |
| 56,000 pF | 563 | J | K | M | EB | EB | EB | EB | EB | EB | | | FB | FB | FB | FB | FB | FB | FC | FC | GB | GB | GB | GB | GB |
| 68,000 pF | 683 | J | K | M | EB | EB | EB | EB | EB | | | | FB | FB | FB | FB | FB | FB | | | GB | GB | GB | GB | GB |
| 82,000 pF | 823 | J | K | M | EB | EB | EB | EB | EB | | | | FB | FB | FB | FB | FB | FC | | | GB | GB | GB | GB | GB |
| 0.10 µF | 104 | J | K | M | EB | EB | EB | EB | EB | | | | FB | FB | FB | FB | FB | FC | | | GB | GB | GB | GB | GB |
| 0.12 µF | 124 | J | K | M | EC | EC | EC | EC | EC | | | | FB | FB | FB | FB | FB | | | | GB | GB | GB | GB | GB |
| 0.15 µF | 154 | J | K | M | | | | | | | | | FC | FC | FC | FC | FC | | | | GB | GB | GB | GB | GB |
| 0.18 µF | 184 | J | K | M | | | | | | | | | FC | FC | FC | FC | FC | | | | GB | GB | GB | GB | GB |
| 0.22 µF | 224 | J | K | M | | | | | | | | | FC | FC | FC | FC | FC | | | | GB | GB | GB | GB | GB |
| | | Rat | ed Volt (VDC) | tage | 6.3 | 9 | 16 | 25 | 20 | 100 | 200 | 250 | 6.3 | 9 | 16 | 25 | 20 | 100 | 200 | 250 | 25 | 20 | 100 | 200 | 250 |
| Capacitance | Cap Code | e Voltage Code | | 9 | 8 | 4 | 3 | 5 | 1 | 2 | Α | 9 | 8 | 4 | 3 | 5 | 1 | 2 | Α | 3 | 5 | 1 | 2 | Α | |
| Case Size/ Series | | | | L | C12 | 06S | | | | | | | C12 | 10S | | | | | C | :1812 | S | | | | |



| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic Quantity | | | | |
|-----------|-------------------|--------------|---------|----------------------|------------------|----------|--|--|--|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | | |
| BB | 0402 | 0.50 ± 0.05 | 10,000 | 50,000 | 0 | 0 | | | |
| CF | 0603 | 0.80 ± 0.07* | 4,000 | 15,000 | 0 | 0 | | | |
| DN | 0805 | 0.78 ± 0.10* | 4,000 | 15,000 | 0 | 0 | | | |
| DP | 0805 | 0.90 ± 0.10* | 4,000 | 15,000 | 0 | 0 | | | |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | | | |
| EB | 1206 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 | | | |
| EC | 1206 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 | | | |
| FB | 1210 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 | | | |
| FC | 1210 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 | | | |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 | | | |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel 13" Ree | | | | |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic Quantity | | | | |

Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

Table 2B – Bulk Packaging Quantities

| Dookog | ing Type | Loose Packaging | | | | | | | |
|----------|------------------------|--|---------|--|--|--|--|--|--|
| Packay | шу туре | Bulk Bag (default) | | | | | | | |
| Packagir | ng C-Spec ¹ | N/A ² | | | | | | | |
| Case | e Size | Packaging Quantities (pieces/unit packaging) | | | | | | | |
| EIA (in) | Metric (mm) | Minimum | Maximum | | | | | | |
| 0402 | 1005 | | | | | | | | |
| 0603 | 1608 | | | | | | | | |
| 0805 | 2012 | | 50,000 | | | | | | |
| 1206 | 3216 | | | | | | | | |
| 1210 | 3225 | 1 | | | | | | | |
| 1808 | 4520 | | | | | | | | |
| 1812 | 4532 | | | | | | | | |
| 1825 | 4564 | | 20,000 | | | | | | |
| 2220 | 5650 | | | | | | | | |
| 2225 | 5664 | | | | | | | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial Grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive Grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size Code | Metric Size | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | |
|---------------------|----------------|--|------|------|------|--|------|------|------|---|------|------|------|------|------|------|
| Coue | Coue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 |
| 1210 ¹ | 3225 | 1.50 | 1.60 | 2.90 | 5.60 | 3.90 | 1.40 | 1.40 | 2.80 | 4.70 | 3.30 | 1.30 | 1.20 | 2.70 | 4.00 | 3.00 |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 |

¹ Only for capacitance values $\ge 22 \ \mu F$

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Terminat | ion Finish | | |
|--|-----------------------|-----------------------|--|--|
| Tomeredure | SnPb | 100% Matte Sn | | |
| Preheat/Soak | | | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C | | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | | |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds | | |
| Ramp-Up Rate $(T_L to T_P)$ | 3°C/second maximum | 3°C/second maximum | | |
| Liquidous Temperature (T_L) | 183°C | 217°C | | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | | |
| Peak Temperature (T _P) | 235°C | 260°C | | |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum | 30 seconds maximum | | |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | 6°C/second maximum | | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | | |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method | | | | |
|------------------------|---------------------------|---|--|--|--|--|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds. | | | | |
| Board Flex | JIS-C-6429 | Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm for COG. Flexible termination system – 3.0 mm (minimum). | | | | |
| | | Magnification 50 X. Conditions: | | | | |
| Soldorability | 1-STD-002 | a) Method B, 4 hours at 155°C, dry heat at 235°C | | | | |
| Solderability | J-31D-002 | b) Method B at 215°C category 3 | | | | |
| | | c) Method D, category 3 at 260°C | | | | |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 Cycles (-55°C to +125°C). Measurement at 24 hours +/- 4 hours after test conclusion. | | | | |
| Biased Humidity | MIL-STD-202 Method | Load Humidity: 1,000 hours 85°C/85% RH and rated voltage. Add 100 K ohm resistor. Measurement at 24 hours +/- 4 hours after test conclusion. | | | | |
| | 103 | Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours +/- 4 hours after test conclusion. | | | | |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours +/- 4 hours after test conclusion. | | | | |
| Thermal Shock | MIL-STD-202 Method 107 | –55°C/+125°C. Note: Number of cycles required – 300, maximum transfer time – 20 seconds, dwell time – 15 minutes. Air – Air. | | | | |
| | MIL-STD-202 Method | | | | | |
| High Temperature Life | 108 /EIA-198 | 1,000 hours at 125°C (85°C for X5R, 250 and Y5V) with 2 X rated voltage applied. | | | | |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC for 1,000 hours. | | | | |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 min., 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz | | | | |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Condition F. | | | | |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. | | | | |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature-reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction





Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a "K" to identify KEMET, followed by two characters (per EIA–198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the "K" character only.

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.
- X7R dielectric products in capacitance values outlined below.

| EIA Case Size | Metric Size Code | Capacitance |
|---------------|------------------|-------------|
| 0603 | 1608 | ≤ 170 pF |
| 0805 | 2012 | ≤ 150 pF |
| 1206 | 3216 | ≤ 910 pF |
| 1210 | 3225 | ≤ 2,000 pF |
| 1808 | 4520 | ≤ 3,900 pF |
| 1812 | 4532 | ≤ 6,700 pF |
| 1825 | 4564 | ≤ 0.018 µF |
| 2220 | 5650 | ≤ 0.027 µF |
| 2225 | 5664 | ≤ 0.033 µF |

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 μ F. Orientation of marking is vendor optional.





Capacitor Marking (Optional) cont.

| | C | apacita | ance (p | F) For \ | /arious | Alpha/ | Numera | al Identif | iers | | | | |
|-----------|------|------------------|---------|----------|---------|--------|---------|------------|------------|-------------|--|--|--|
| Alaba | | | | | | Numera | d I | | | | | | |
| Alpila | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | |
| Character | | Capacitance (pF) | | | | | | | | | | | |
| A | 0.10 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 | | | |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 | | | |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 | | | |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 | | | |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 | | | |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 | | | |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 | | | |
| Н | 0.20 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 | | | |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 | | | |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 | | | |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 | | | |
| М | 0.30 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 | | | |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 | | | |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 | | | |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 | | | |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 | | | |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 | | | |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 | | | |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 | | | |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 | | | |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 | | | |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 | | | |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 | | | |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 | | | |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 | | | |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 | | | |
| d | 0.40 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 | | | |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 | | | |
| f | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 | | | |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 | | | |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 | | | |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 | | | |
| у | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 | | | |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punched Paper | | |
|----------------------|------|---------|--------------------|--------------------------|----------|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | (W)* | Pitch | (P ₁)* | Pitch (P ₁)* | | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 | |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | |
| Array 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | | |
|-----------|--|--|---------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|--|--|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum | | | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 +0.10/-0.0 0.059 +0.004/-0.0) 1.5 | | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | | |
| 16 mm | | (0.059) | | | | (1.181) | | | | | | |
| | | , | Variable Dime | ensions – Mil | limeters (Incl | nes) | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ | | | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | Note 5 | | | | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_a and B_a are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|-----------|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|--|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|-----------|--|--|--|--|--|--|--|--|--|--|--|
| Tape Size | А | B Minimum | C | D Minimum | | | | | | | |
| 8 mm | 178 ±0.20 | | | | | | | | | | |
| 12 mm | Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | | | | | |
| 16 mm | (13.000 ±0.008) | | X | 、 | | | | | | | |
| | Variable Dimensions — Millimeters (Inches) | | | | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | | | | | |
| 12 mm | 50 (1.969) | 50 12.4 +2.0/-0.0 (1.969) (0.488 +0.078/-0.0) | | Shall accommodate tape width without interference | | | | | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Floating Electrode Design with Flexible Termination System (FF-CAP), X7R Dielectric, 6.3 – 250 VDC (Commercial & Automotive Grade)

Overview

KEMET's Floating Electrode with Flexible Termination capacitor (FF-CAP) combines two existing KEMET technologies - Floating Electrode and Flexible Termination. The floating electrode component utilizes a cascading internal electrode design configured to form multiple capacitors in series within a single monolithic structure. This unique configuration results in enhanced voltage and ESD performance over standard capacitor designs while allowing for a fail-open condition if mechanically damaged (cracked). The flexible termination component utilizes a conductive silver epoxy between the base metal and nickel barrier layers of KEMET's standard termination system in order to establish pliability while maintaining terminal strength, solderability and electrical performance. Both technologies address the primary failure mode of MLCCsflex cracks, which are typically the result of excessive tensile and shear stresses produced during board flexure and thermal cycling.

Although neither technology can eliminate the potential for mechanical damage that may propagate during extreme environmental and/or handling conditions, the combination of these two technologies provide the ultimate level of protection against a low IR or short circuit condition. The FF-CAP complements KEMET's Open Mode, Floating Electrode (FE-CAP), Flexible Termination (FT-CAP) and KEMET Power Solutions (KPS) product lines by providing an ultimate fail-safe design optimized for low to mid range capacitance values. These devices exhibit a predictable change in capacitance with respect to time and voltage and boast a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to ±15% from -55°C to +125°C.

In addition to Commercial Grade, Automotive Grade devices are available which meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.



Ordering Information

| С | 0805 | Y | 104 | K | 5 | R | Α | С | TU |
|---------|--------------------------------------|--|---|---------------------------------|--|------------|-------------------------|--|--|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ¹ | Packaging/ Grade (C-Spec) |
| | 0603 0805 1206 1210 1812 | Y = Floating Electrode with Flexible Termination | Two significant digits and number of zeros | J = ±5% K = ±10% M = ±20% | 9 = 6.3 8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 2 = 200 A = 250 | R = X7R | A = N/A | C = 100% Matte Sn L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ Additional termination finish options may be available. Contact KEMET for details.

¹ SnPb termination finish option is not available on automotive grade product.

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1



Packaging C-Spec Ordering Options Table

| Packaging Type | Packaging/Grade Ordering Code (C-Spec) | | | | | | |
|---|---|--|--|--|--|--|--|
| Commerc | ial Grade ¹ | | | | | | |
| Bulk Bag | Not Required (Blank) | | | | | | |
| 7" Reel/Unmarked | TU | | | | | | |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) | | | | | | |
| 7" Reel/Marked | ТМ | | | | | | |
| 13" Reel/Marked | 7040 (EIA 0603) 7215 (EIA 0805 and larger case sizes) | | | | | | |
| 7" Reel/Unmarked/2 mm pitch ² | 7081 | | | | | | |
| 13" Reel/Unmarked/2 mm pitch ² | 7082 | | | | | | |
| Automoti | ve Grade ³ | | | | | | |
| 7" Reel | AUTO | | | | | | |
| 13" Reel/Unmarked | AUT07411 (EIA 0603 and smaller case sizes) AUT07210 (EIA 0805 and larger case sizes) | | | | | | |
| 7" Reel/Unmarked/2 mm pitch ² | 3190 | | | | | | |
| 13" Reel/Unmarked/2 mm pitch ² | 3191 | | | | | | |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

- ¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked.
- ² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".
- ³ Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information".
- ³ For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information".

³ All Automotive packaging C-Specs listed exclude the option to laser mark components. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking".

Benefits

- -55°C to +125°C operating temperature range
- Superior flex performance (up to 5 mm)
- · Floating Electrode/fail open design
- · Low to mid capacitance flex mitigation
- Lead (Pb)-free, RoHS and REACH compliant
- EIA 0603, 0805, 1206, 1210, and 1812 case sizes
- DC voltage ratings of 6.3 V, 10 V, 16 V, 25 V, 50 V, 100 V, 200 V, and 250 V

- Capacitance offerings ranging from 180 pF to 0.22 μ F
- Available capacitance tolerances of ±5%, ±10%, and ±20%
- Commercial and Automotive (AEC-Q200) grades available
- · Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish allowing for excellent solderability
- SnPb termination finish option available upon request (5% Pb minimum)

Applications

Typical applications include circuits with a direct battery or power source connection, critical and safety relevant circuits without (integrated) current limitation and any application that is subject to high levels of board flexure or temperature cycling. Examples include raw power input side filtering (power plane/bus), high current applications (automobile battery line) and circuits that cannot be fused to open. Markets include consumer, medical, industrial (power supply), automotive, aerospace and telecom.



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | tion Due To: | Days Prior To |
|-----------------------------|----------------------------------|----------------|------------------|
| C-Spec | Process/Product change | Implementation | |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum |
| AUTO | Yes (without approval) | Yes | 90 days minimum |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive C-Spec | PPAP (Product Part Approval Process) Level | | | | | | | | | | | |
|-----------------------------|--|---|---|---|---|--|--|--|--|--|--|--|
| | 1 | 2 | 3 | 4 | 5 | | | | | | | |
| KEMET assigned ¹ | • | • | • | • | • | | | | | | | |
| AUTO | | | 0 | | | | | | | | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|----------------------------|---------------------------------|
| 0603 | 1608 | 1.60 (0.063) ±0.17 (0.007) | 0.80 (0.032) ±0.15 (0.006) | | 0.45 (0.018) ±0.15 (0.006) | 0.58 (0.023) | |
| 0805 | 2012 | 2.00 (0.079) ±0.30 (0.012) | 1.25 (0.049) ±0.30 (0.012) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave or Solder Reflow |
| 1206 | 3216 | 3.30 (0.130) ±0.40 (0.016) | 1.60 (0.063) ±0.35 (0.013) | See Table 2 for Thickness | 0.60 (0.024) ±0.25 (0.010) | | |
| 1210 | 3225 | 3.30 (0.130) ±0.40 (0.016) | 2.60 (0.102) ±0.30 (0.012) | | 0.60 (0.024) ±0.25 (0.010) | N/A | Solder Reflow |
| 1812 | 4532 | 4.50 (0.178) ±0.40 (0.016) | 3.20 (0.126) ±0.30 (0.012) | | 0.70 (0.028) ±0.35 (0.014) | | Only |



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|--|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 Vdc Applied (TCC) | ±15% |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| ² Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5±1 seconds and charge/discharge not exceeding 50mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | 5%(6.3V & 10V), 3.5%(16V & 25V) and 2.5%(50V to 250V) |
| ^₄ Insulation Resistance (IR) Minimum Limit at 25°C | See Insulation Resistance Limit Table (Rated voltage applied for 120±5 seconds at 25°C) |

¹ Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours.

² DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

 $^{\scriptscriptstyle 3}$ Capacitance and dissipation factor (DF) measured under the following conditions:

1kHz ± 50Hz and 1.0 ± 0.2 Vrms if capacitance \leq 10 μ F

120Hz \pm 10Hz and 0.5 \pm 0.1 Vrms if capacitance >10 μF

⁴ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 & Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON".

Post Environmental Limits

| | High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | | | | | | |
|------------|---|----------------------|-----------------------------------|----------------------|--------------------------|--|--|--|--|--|--|--|--|--|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | | | | | | | | | |
| | > 25 | | 3.0 | | 10% of luitial | | | | | | | | | |
| X7R | 16/25 All | | 5.0 | ±20% | 10% of Initial | | | | | | | | | |
| | < 16 | | 7.5 | | Limit | | | | | | | | | |

Insulation Resistance Limit Table (X7R Dielectric)

| EIA Case Size | 1,000 Megohm Microfarads or 100 GΩ | 500 Megohm Microfarads or 10 GΩ |
|---------------|---------------------------------------|------------------------------------|
| 0201 | N/A | ALL |
| 0402 | < 0.012 µF | ≥ 0.012 µF |
| 0603 | < 0.047 µF | ≥ 0.047 µF |
| 0805 | < 0.15 µF | ≥ 0.15 µF |
| 1206 | < 0.47 µF | ≥ 0.47 µF |
| 1210 | < 0.39 µF | ≥ 0.39 µF |
| 1808 | ALL | N/A |
| 1812 | < 2.2 μF | ≥ 2.2 µF |
| 1825 | ALL | N/A |
| 2220 | < 10 µF | ≥ 10 µF |
| 2225 | ALL | N/A |



Table 1A - Capacitance Range/Selection Waterfall (0603 - 0805 Case Sizes)

| | | Ca | se Siz Series | ze/ S | | | C | 0603 | Y | | | | | | C08 | 05Y | | | |
|-------------|------------------|-----------------|--------------------|-----------|-----|----|----|--------|--------------|--------------------|--------------------|-------------------|-------------------|------------------|----------------|-----|-----|-----|-----|
| Osmasitanaa | Capacitance | Va | ltage Co | de | 9 | 8 | 4 | 3 | 5 | 1 | 2 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A |
| Capacitance | Code | Ra | ted Volta (VDC) | age | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 6.3 | 1 | 16 | 25 | 50 | 100 | 200 | 250 |
| | | Ca T | pacitan oleranc | ice :e | | | | | Produ See | ct Avai Table 2 | lability for Ch | and Cl ip Thic | nip Thio kness | ckness Dimens | Codes sions | | | | |
| 180 pF | 181 | J | K | М | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR |
| 220 pF | 221 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR |
| 270 pF | 271 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR |
| 330 pF | 331 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR |
| 390 pF | 391 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR |
| 470 pF | 471 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR |
| 560 pF | 561 | J | K | М | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR |
| 680 pF | 681 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR |
| 820 pF | 821 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR |
| 1,000 pF | 102 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR |
| 1,200 pF | 122 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR |
| 1,500 pF | 152 | J | K | М | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR |
| 1,800 pF | 182 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR |
| 2,200 pF | 222 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR |
| 2,700 pF | 272 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR |
| 3,300 pF | 332 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR |
| 3,900 pF | 392 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR |
| 4,700 pF | 472 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR |
| 5,600 pF | 562 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | DR | DR |
| 6,800 pF | 682 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | DR | DR |
| 8,200 pF | 822 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | DR | DR |
| 10,000 pF | 103 | J | K | M | CJ | CJ | CJ | CJ | CJ | | | DR | DR | DR | DR | DR | DR | DR | DR |
| 12,000 pF | 123 | J | K | M | CJ | CJ | CJ | CJ | CJ | | | DR | DR | DR | DR | DR | DR | DR | DR |
| 15,000 pF | 153 | J | K | M | CJ | CJ | CJ | CJ | CJ | | | DR | DR | DR | DR | DR | DD | | |
| 18,000 pF | 183 | J | K | М | CJ | CJ | CJ | CJ | CJ | | | DR | DR | DR | DR | DR | DD | | |
| 22,000 pF | 223 | J | K | M | CJ | CJ | CJ | CJ | CJ | | | DR | DR | DR | DR | DR | DD | | |
| 27,000 pF | 273 | J | K | M | | | | | | | | DR | DR | DR | DR | DR | | | |
| 33,000 pF | 333 | J | K | M | | | | | | | | DR | DR | DR | DR | DR | | | |
| 39,000 pF | 393 | J | K | M | | | | | | | | DR | DR | DR | DR | DR | | | |
| 47,000 pF | 473 | J | K | М | | | | | | | | DR | DR | DR | DR | DR | | | |
| 56,000 pF | 563 | J | K | M | | | | | | | | DD | DD | DD | DD | DD | | | |
| 68,000 pF | 683 | J | K | М | | | | | | | | DD | DD | DD | DD | DD | | | |
| 82,000 pF | 823 | J | K | М | | | | | | | | DG | DG | DG | DG | DG | | | |
| 0.10 µF | 104 | J | K | М | | | | | | | | DG | DG | DG | DG | DG | | | |
| | | Ra | ted Volta (VDC) | age | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 |
| Capacitance | Capacitance Code | le Voltage Code | | | | 8 | 4 | 3 | 5 | 1 | 2 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | Α |
| | | Case | Size/S | eries | | | | C06031 | (| | | | | | C08 | 05Y | | | |



Table 1B - Capacitance Range/Selection Waterfall (1206 - 1812 Case Sizes)

| | | Cas | se S Serie | ize/ es | | | | C12 | 06Y | | | | | | | C12 | 10Y | | | | | C | 1812 | 2 Y | |
|-------------|----------------------|-----------|---|-------------|------------|----|----|-----|-----|-----|-----------|------------------|----------|------------------|-----------------|-----------------|-----------------|-----------------|------------|-----|----------|----|------|------------|-----|
| Canacitance | Сар | Vol | ltage C | ode | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 3 | 5 | 1 | 2 | A |
| Gapacitance | Code | Rat | ed Vol (VDC) | tage | 6.3 | 10 | 16 | 25 | 20 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 20 | 100 | 200 | 250 | 25 | 20 | 100 | 200 | 250 |
| | | Caj To | pacita | ince ice | | 1 | 1 | | 1 | 1 | Pro Se | duct A ee Tab | vaila | bility or Chi | and C p Thio | hip Tł cknes | nickne s Dim | ess Co ensio | odes ns | | | | 1 | | |
| 1,000 pF | 102 | J | K | M | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | | | | | | | | | | | | | |
| 1,200 pF | 122 | J | K | M | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | | | | | | | | | | | | | |
| 1,500 pF | 152 | J | K | M | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | | | | | | | | | | | | | |
| 1,800 pF | 182 | J | K | M | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | | | | | | | | | | | | | |
| 2,200 pF | 222 | J | K | M | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN | | | | | |
| 2,700 pF | 272 | J | K | М | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN | | | | | |
| 3,300 pF | 332 | J | К | М | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN | | | | | |
| 3,900 pF | 392 | J | К | М | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN | | | | | |
| 4,700 pF | 472 | J | К | М | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN | | | | | |
| 5,600 pF | 562 | J | К | М | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN | | | | | |
| 6,800 pF | 682 | J | K | М | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | GB |
| 8,200 pF | 822 | J | K | М | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | GB |
| 10,000 pF | 103 | J | K | М | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | GB |
| 12,000 pF | 123 | J | K | М | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | GB |
| 15,000 pF | 153 | J | K | М | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | GB |
| 18,000 pF | 183 | J | K | М | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | GB |
| 22,000 pF | 223 | J | K | М | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | GB |
| 27,000 pF | 273 | J | K | М | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | GB |
| 33,000 pF | 333 | J | к | М | EQ | EQ | EQ | EQ | EQ | EQ | | | FN | FN | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | GB |
| 39,000 pF | 393 | J | к | М | EQ | EQ | EQ | EQ | EQ | ER | | | FN | FN | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | GB |
| 47,000 pF | 473 | J | K | М | EQ | EQ | EQ | EQ | EQ | ER | | | FN | FN | FN | FN | FN | FN | FQ | FQ | GB | GB | GB | GB | GB |
| 56,000 pF | 563 | J | К | м | EQ | EQ | EQ | EQ | EQ | EQ | | | FN | FN | FN | FN | FN | FN | FQ | FQ | GB | GB | GB | GB | GB |
| 68,000 pF | 683 | J | К | м | EQ | EQ | EQ | EQ | EQ | | | | FN | FN | FN | FN | FN | FN | | | GB | GB | GB | GB | GB |
| 82,000 pF | 823 | J | К | м | EQ | EQ | EQ | EQ | EQ | | | | FN | FN | FN | FN | FN | FQ | | | GB | GB | GB | GB | GB |
| 0.10 µF | 104 | J | к | м | EO | EO | EO | EO | EO | | | | FN | FN | FN | FN | FN | FX | | | GB | GB | GB | GB | GB |
| 0.12 µF | 124 | J | К | М | ER | ER | ER | ER | ER | | | | FN | FN | FN | FN | FN | | | | GB | GB | GB | GB | GB |
| 0.15 µF | 154 | J | к | М | | | | | | | | | FQ | FQ | FQ | FQ | FQ | | | | GB | GB | GB | GB | GB |
| 0.18 µF | 184 | J | к | М | | | | | | | | | FQ | FQ | FQ | FQ | FQ | | | | GB | GB | GB | GB | GB |
| 0.22 µF | 224 | J | к | М | | | | | | | | | FQ | FQ | FQ | FQ | FQ | | | | GB | GB | GB | GB | GB |
| | | Rat | Rated Voltage (VIC) 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 | | | | | 50 | 6.3 | 6 | 16 | 25 | 50 | 00 | 00 | 50 | 25 | 50 | 00 | 00 | 50 | | | | |
| Canaditance | Can Code | Va | |) | - - | 0 | 4 | 2 | 5 | 1 | 2 | ~ | • | 0 | 4 | 2 | 5 | 1 | 2 | ~ | 2 | 5 | 1 | 2 | ~ |
| Capacitance | cap code | v0 | aye t | oue | " | 0 | 4 | 3 | 3 | | 2 | A | " | 0 | 4 | 3 | 3 | | 4 | A | <u>،</u> | J | | 4 | A |
| | Case Size/ Series | | | | | | | C12 | 06Y | | | | | | | C12 | 10Y | | | | C1812Y | | | | |



| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic Quantity | | | |
|-----------|-------------------|-------------|---------|----------------------|------------------|----------|--|--|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | |
| CJ | 0603 | 0.80 ± 0.15 | 4,000 | 15,000 | 0 | 0 | | |
| DR | 0805 | 0.78 ± 0.20 | 0 | 0 | 4,000 | 10,000 | | |
| DD | 0805 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 | | |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | | |
| EQ | 1206 | 0.78 ± 0.20 | 0 | 0 | 4,000 | 10,000 | | |
| ER | 1206 | 0.90 ± 0.20 | 0 | 0 | 4,000 | 10,000 | | |
| FN | 1210 | 0.78 ± 0.20 | 0 | 0 | 4,000 | 10,000 | | |
| FQ | 1210 | 0.90 ± 0.20 | 0 | 0 | 4,000 | 10,000 | | |
| FX | 1210 | 0.95 ± 0.20 | 0 | 0 | 4,000 | 10,000 | | |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 | | |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic Quantity | | | |

Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

Table 2B – Bulk Packaging Quantities

| Dookog | | Loose Pa | ackaging | | | | | |
|----------|------------------------|---|-----------|--|--|--|--|--|
| Раскау | ing type | Bulk Bag | (default) | | | | | |
| Packagii | ng C-Spec ¹ | N/A ² | | | | | | |
| Case | e Size | Packaging Quantities (pieces/unit packaging | | | | | | |
| EIA (in) | Metric (mm) | Minimum | Maximum | | | | | |
| 0402 | 1005 | | | | | | | |
| 0603 | 1608 | | | | | | | |
| 0805 | 2012 | | 50,000 | | | | | |
| 1206 | 3216 | | | | | | | |
| 1210 | 3225 | 1 | | | | | | |
| 1808 | 4520 | | | | | | | |
| 1812 | 4532 | | | | | | | |
| 1825 | 4564 | | 20,000 | | | | | |
| 2220 | 5650 | | | | | | | |
| 2225 | 5664 | | | | | | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial Grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive Grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size | Metric Size | | Dens Maxi Land P | sity Lev mum (I rotrusio | vel A: Most) on (mm |) | | Dens Media Land Pi | sity Lev an (Nor rotrusio | vel B: minal) on (mm |) | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | |
|-------------|----------------|------|------------------------|--------------------------------|---------------------------|------|------|--------------------------|---------------------------------|----------------------------|------|---|------|------|------|------|--|
| Coue | Coue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | |
| 0603 | 1608 | 0.85 | 1.25 | 1.10 | 4.00 | 2.10 | 0.75 | 1.05 | 1.00 | 3.10 | 1.50 | 0.65 | 0.85 | 0.90 | 2.40 | 1.20 | |
| 0805 | 2012 | 0.99 | 1.44 | 1.66 | 4.47 | 2.71 | 0.89 | 1.24 | 1.56 | 3.57 | 2.11 | 0.79 | 1.04 | 1.46 | 2.42 | 1.81 | |
| 1206 | 3216 | 1.59 | 1.62 | 2.06 | 5.85 | 3.06 | 1.49 | 1.42 | 1.96 | 4.95 | 2.46 | 1.39 | 1.22 | 1.86 | 4.25 | 2.16 | |
| 1210 | 3225 | 1.59 | 1.62 | 3.01 | 5.90 | 4.01 | 1.49 | 1.42 | 2.91 | 4.95 | 3.41 | 1.39 | 1.22 | 2.81 | 4.25 | 3.11 | |
| 1812 | 4532 | 2.10 | 1.80 | 3.60 | 7.00 | 4.60 | 2.00 | 1.60 | 3.50 | 6.10 | 4.00 | 1.90 | 1.40 | 3.40 | 5.40 | 3.70 | |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.



Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/ J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Termination Finish | | | |
|--|-----------------------|-----------------------|--|--|
| Tomeredure | SnPb | 100% Matte Sn | | |
| Preheat/Soak | | | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C | | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | | |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds | | |
| Ramp-Up Rate $(T_L to T_P)$ | 3°C/second maximum | 3°C/second maximum | | |
| Liquidous Temperature (T_L) | 183°C | 217°C | | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | | |
| Peak Temperature (T _P) | 235°C | 260°C | | |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum | 30 seconds maximum | | |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | 6°C/second maximum | | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | | |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.







Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method | | |
|------------------------|---------------------------|---|--|--|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds. | | |
| Board Flex | JIS-C-6429 | Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm for COG. Flexible termination system – 3.0 mm (minimum). | | |
| | J-STD-002 | Magnification 50 X. Conditions: | | |
| Coldorobility | | a) Method B, 4 hours at 155°C, dry heat at 235°C | | |
| Solderability | | b) Method B at 215°C category 3 | | |
| | | c) Method D, category 3 at 260°C | | |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 Cycles (-55°C to +125°C). Measurement at 24 hours +/- 4 hours after test conclusion. | | |
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and rated voltage. Add 100 K ohm resistor. Measurement at 24 hours +/- 4 hours after test conclusion. | | |
| | | Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours +/- 4 hours after test conclusion. | | |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours +/− 4 hours after test conclusion. | | |
| Thermal Shock | MIL-STD-202 Method 107 | –55°C/+125°C. Note: Number of cycles required – 300, maximum transfer time – 20 seconds, dwell time – 15 minutes. Air – Air. | | |
| | MIL-STD-202 Method | | | |
| High Temperature Life | 108 /EIA-198 | 1,000 hours at 125°C (85°C for X5R, 250 and Y5V) with 2 X rated voltage applied. | | |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC for 1,000 hours. | | |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 min., 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz | | |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Condition F. | | |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. | | |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction





Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a "K" to identify KEMET, followed by two characters (per EIA–198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the "K" character only.

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.
- X7R dielectric products in capacitance values outlined below.

| EIA Case Size | Metric Size Code | Capacitance |
|---------------|------------------|-------------|
| 0603 | 1608 | ≤ 170 pF |
| 0805 | 2012 | ≤ 150 pF |
| 1206 | 3216 | ≤ 910 pF |
| 1210 | 3225 | ≤ 2,000 pF |
| 1808 | 4520 | ≤ 3,900 pF |
| 1812 | 4532 | ≤ 6,700 pF |
| 1825 | 4564 | ≤ 0.018 µF |
| 2220 | 5650 | ≤ 0.027 µF |
| 2225 | 5664 | ≤ 0.033 µF |

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 μ F. Orientation of marking is vendor optional.





Capacitor Marking (Optional) cont.

| Capacitance (pF) For Various Alpha/Numeral Identifiers | | | | | | | | | | |
|--|------------------|-----|----|-----|-------|--------|---------|-----------|------------|-------------|
| Numeral | | | | | | | | | | |
| Alpha | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Character | Capacitance (pF) | | | | | | | | | |
| A | 0.10 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 |
| Н | 0.20 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 |
| М | 0.30 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 |
| d | 0.40 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 |
| f | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 |
| у | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | | Embosse | ed Plastic | Punched Paper | |
|----------------------|--------------------|---------|--------------------|--------------------------|----------|
| EIA Case Size | EIA Case Size (W)* | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| | | Pitch | (P ₁)* | Pitch (P ₁)* | |
| 01005 - 0402 | 8 | | | 2 | 2 |
| 0603 | 8 | | | 2/4 | 2/4 |
| 0805 | 8 | 4 | 4 | 4 | 4 |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 |
| 1805 - 1808 | 12 | 4 | 4 | | |
| ≥ 1812 | 12 | 8 | 8 | | |
| KPS 1210 | 12 | 8 | 8 | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | |
| Array 0612 | 8 | 4 | 4 | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size. 2 mm pitch reel for 0805 EIA case size under development.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.


Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|--|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum | | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | |
| 16 mm | | (0.059) | | | | (1.181) | | | | | |
| | | , | Variable Dime | ensions – Mil | limeters (Incl | nes) | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ | | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | te 5 | | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_a and B_a are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | | |
|-----------|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|--|--|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | | | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | | | | |
| | | Variable D | imensions – M | illimeters (Inche | es) | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | | | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | | | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | | | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|-----------|--|---------------------------------------|--|--|--|--|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | | | | |
| 8 mm | 178 ±0.20 | | | | | | | | | |
| 12 mm | (7.008 ±0.008) Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | | | | |
| 16 mm | (13.000 ±0.008) | | | | | | | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Overview

KEMET's Ceramic Chip Capacitor Array in COG dielectric is an advanced passive technology, where multiple capacitor elements are integrated into one common monolithic structure. Array technology promotes reduced placement costs and increased throughput. This is achieved by alternatively placing one device rather than two or four discrete devices. Use of capacitor arrays also saves board space, which translates into increased board density and more functions per board. Arrays consume only a portion of the space required for standard chips, resulting in savings in inventory and pick/place machine positions.

For added reliability, KEMET's Flexible Termination technology has been incorporated in order to provide superior flex performance. This technology was developed to address flex cracks, which are the primary failure mode of MLCCs and typically the result of excessive tensile and shear stresses produced during board flexure and thermal cycling. Flexible Termination technology inhibits the transfer of board stress to the rigid body of the MLCC, therefore mitigating flex cracks which can result in low IR or short circuit failures. KEMET's COG dielectric features a 125°C maximum operating temperature and is considered "stable." The Electronics Industries Alliance (EIA) characterizes COG dielectric as a Class I material. Components of this classification are temperature compensating and are suited for resonant circuit applications or those where Q and stability of capacitance characteristics are required. COG exhibits no change in capacitance with respect to time and voltage and boasts a negligible change in capacitance with reference to ambient temperature. Capacitance change is limited to ±30 ppm/°C from -55°C to +125°C.

KEMET automotive grade array capacitors meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.



Ordering Information

| CA | 06 | 4 | X | 104 | K | 4 | G | Α | C | TU |
|------------------|-------------------------|-------------------------|-----------------------------|--|---------------------------------|--|------------|----------------------------|---|---|
| Ceramic Array | Case Size (L" x W")1 | Number of Capacitors | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ² | Packaging/ Grade (C-Spec) |
| | 06 = 0612 | 4 = 4 | X = Flexible Termination | Two significant digits and number of zeros | J = ±5% K = ±10% M = ±20% | 8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 2 = 200 | G = COG | A = N/A | C = 100% Matte Sn L = SnPb (5% minimum Pb content) | See "Packaging C-Spec Ordering Options Table" |

¹ All previous reference to metric case dimension "1632" has been replaced with an inch standard reference of "0612". Please reference all new designs using the "0612" nomenclature. "CA064" replaces "C1632" in the ordering code.

 $^{\rm 2}$ Additional termination finish options may be available. Contact KEMET for details.

² SnPb termination finish option is not available on automotive grade product.

Built Into Tomorrow



Packaging C-Spec Ordering Options Table

| Packaging Type | Packaging/Grade Ordering Code (C-Spec) | | | | |
|-------------------|---|--|--|--|--|
| Commerc | ial Grade ¹ | | | | |
| Bulk Bag | Not Required (Blank) | | | | |
| 7" Reel/Unmarked | TU | | | | |
| 13" Reel/Unmarked | 7210 | | | | |
| Automoti | ve Grade ² | | | | |
| 7" Reel | AUTO | | | | |
| 13" Reel/Unmarked | AUT07210 | | | | |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices. For more information see "Capacitor Marking".

² Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information".

² For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information".

² All Automotive packaging C-Specs listed exclude the option to laser mark components. The option to laser mark is not available on these devices. For more information see "Capacitor Marking".

Benefits

- -55°C to +125°C operating temperature range
- Superior flex performance (up to 5 mm)
- · Saves both circuit board and inventory space
- · Reduces placement costs and increases throughput
- Lead (Pb)-free, RoHS and REACH compliant
- 0612 (4-element) case size
- DC voltage ratings of 10 V, 16 V, 25 V, 50 V, 100 V, and 200 V

- · Capacitance offerings ranging from 10 to 470 pF
- Available capacitance tolerances of ±5%, ±10%, and ±20%
- · Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish allowing for excellent solderability
- SnPb termination finish option available upon request (5% Pb minimum)
- · Commercial and Automotive (AEC-Q200) grades available

Applications

Typical applications include those that can benefit from board area savings, cost savings, and overall volumetric reduction such as telecommunications, computers, handheld devices and automotive. Flexible termination technology benefits applications subject to high levels of board flexure or temperature cycling.



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | tion Due To: | Days Prior To | |
|-----------------------------|----------------------------------|---------------|------------------|--|
| C-Spec | Process/Product change | Obsolescence* | Implementation | |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum | |
| AUTO | Yes (without approval) | Yes | 90 days minimum | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | | PPAP (Product Part Approval Process) Level | | | | | | | | | |
|-----------------------------|---|--|---|---|---|--|--|--|--|--|--|
| C-Spec | 1 | 2 | 3 | 4 | 5 | | | | | | |
| KEMET assigned ¹ | • | • | • | • | • | | | | | | |
| AUTO | | | 0 | | | | | | | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)



| EIA Size | Metric Size | L | W | BW | BL | T | P | P |
|----------|-------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|-------------------------------|
| Code | Code | Length | Width | Bandwidth | Bandlength | Thickness | Pitch | Reference |
| 0612 | 1632 | 1.60 (0.063) ±0.20 (0.008) | 3.20 (0.126) ±0.20 (0.008) | 0.40 (0.016) ±0.20 (0.008) | 0.30 (0.012) ±0.20 (0.008) | See Table 2 for Thickness | 0.80 (0.031) ±0.10 (0.004) | 0.40 (0.016) ±0.05 (0.002) |



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|--|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±30 ppm/°C |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 0% |
| ¹ Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA) |
| ² Dissipation Factor (DF) Maximum Limit at 25°C | 0.1% |
| ³ Insulation Resistance (IR) Limit at 25°C | 1,000 megohm microfarads or 100 GΩ (Rated voltage applied for 120 ±5 seconds at 25°C) |

¹ DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

² Capacitance and dissipation factor (DF) measured under the following conditions:

1 MHz ±100 kHz and 1.0 Vrms ±0.2 V if capacitance \leq 1,000 pF

1 kHz ±50 Hz and 1.0 Vrms ±0.2 V if capacitance > 1,000 pF

³ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Capacitance and Dissipation Factor (DF) measured under the following conditions:

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

Post Environmental Limits

| High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | | | | |
|--|-----|-----|-----|------------------|-------------------------|--|--|--|--|--|--|
| Dielectric Rated DC Capacitance Dissipation Factor Capacitance Insulation Voltage Value (Maximum %) Shift Resistance | | | | | | | | | | | |
| COG | All | All | 0.5 | 0.3% or ±0.25 pF | 10% of Initial Limit | | | | | | |



Table 1 – Capacitance Range/Selection Waterfall (0612 Case Size)

| 0 | | Case Size/ Series | | | C0612X (CA064X 4-Cap Case Size) | | | | | | |
|-------------|---------------------|----------------------|---------------------|-----------|---------------------------------|--|----|----|-----|-----|--|
| | Capacitance | Voltage Code | | | 8 | 4 | 3 | 5 | 1 | 2 | |
| Capacitance | Code | Rated | Rated Voltage (VDC) | | | 16 | 25 | 50 | 100 | 200 | |
| | | Ca | apacita Foleran | nce ce | Pro Se | Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions | | | | | |
| 10 pF | 100 | J | K | М | MA | MA | MA | MA | MA | MA | |
| 12 pF | 120 | J | K | М | MA | MA | MA | MA | MA | MA | |
| 15 pF | 150 | J | K | M | MA | MA | MA | MA | MA | MA | |
| 18 pF | 180 | J | K | M | MA | MA | MA | MA | MA | MA | |
| 22 pF | 220 | J | K | М | MA | MA | MA | MA | MA | MA | |
| 27 pF | 270 | J | K | M | MA | MA | MA | MA | MA | MA | |
| 33 pF | 330 | J | K | M | MA | MA | MA | MA | MA | MA | |
| 39 pF | 390 | J | K | M | MA | MA | MA | MA | MA | MA | |
| 47 pF | 470 | J | K | M | MA | MA | MA | MA | MA | MA | |
| 56 pF | 560 | J | K | M | MA | MA | MA | MA | MA | MA | |
| 68 pF | 680 | J | K | M | MA | MA | MA | MA | MA | MA | |
| 82 pF | 820 | J | K | M | MA | MA | MA | MA | MA | MA | |
| 100 pF | 101 | J | K | M | MA | MA | MA | MA | MA | | |
| 120 pF | 121 | J | K | M | MA | MA | MA | MA | MA | | |
| 150 pF | 151 | J | K | M | MA | MA | MA | MA | MA | | |
| 180 pF | 181 | J | K | M | MA | MA | MA | MA | MA | | |
| 220 pF | 221 | J | K | M | MA | MA | MA | MA | | | |
| 270 pF | 271 | J | K | M | MA | MA | MA | MA | | | |
| 330 pF | 331 | J | K | M | MA | MA | MA | MA | | | |
| 390 pF | 391 | J | K | М | MA | MA | MA | MA | | | |
| 470 pF | 471 | J | K | M | MA | MA | MA | MA | | | |
| | | Rated | l Voltage | e (VDC) | 10 | 16 | 25 | 50 | 100 | 200 | |
| Capacitance | Capacitance Code | V | oltage Co | ode | 8 | 4 | 3 | 5 | 1 | 2 | |
| | Coue | Case | e Size/S | Series | C0612X (CA064X 4-Cap Case Size) | | | | | | |

KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).

These products are protected under US Patents 7,172,985 and 7,670,981, other patents pending, and any foreign counterparts.



Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper C |)uantity | Plastic Quantity | | |
|-----------|------|-------------|---------|----------|------------------|----------|--|
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| MA | 0612 | 0.80 ±0.10 | 4,000 | 10,000 | 0 | 0 | |

Package quantity based on finished chip thickness specifications.

Table 3 – Chip Capacitor Array Land Pattern Design Recommendations per IPC-7351

| EIA SIZE CODE | METRIC SIZE | Density Level A: Maximum (Most) Land Protrusion (mm) | | | I | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | | | | |
|------------------|----------------|--|------|------|------|--|------|------|------|---|------|------|------|------|------|------|------|------|------|
| | OODL | C | Y | X | Р | V1 | V2 | C | Y | X | Р | V1 | V2 | C | Y | X | Р | V1 | V2 |
| 0612/CA064 | 1632 | 1.80 | 1.10 | 0.50 | 0.80 | 3.90 | 4.40 | 1.80 | 0.95 | 0.50 | 0.80 | 3.30 | 3.90 | 1.70 | 0.85 | 0.40 | 0.80 | 2.80 | 3.60 |

Density Level A: For low-density product applications. Provides a wider process window for reflow solder processes. **Density Level B:** For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations, the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 0612 case size.





Soldering Process

Recommended Soldering Technique:

Solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/ J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Terminat | ion Finish |
|--|-----------------------|-----------------------|
| Trome reduire | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate ($T_L to T_P$) | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T _L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |

Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods & Conditions

| Stress | Reference | Test or Inspection Method |
|------------------------|---------------------------|---|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds. |
| Board Flex | JIS-C-6429 | Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm for COG. Flexible termination system – 3.0 mm (minimum). |
| | | Magnification 50 X. Conditions: |
| Soldorobility | 1-STD-002 | a) Method B, 4 hours at 155°C, dry heat at 235°C |
| Solderability | J-31D-002 | b) Method B at 215°C category 3 |
| | | c) Method D, category 3 at 260°C |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 Cycles (-55°C to +125°C). Measurement at 24 hours \pm 4 hours after test conclusion. |
| Discol Humiditu | MIL-STD-202 Method | Load Humidity: 1,000 hours 85°C/85% RH and rated voltage. Add 100 K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. |
| Blased Humidity | 103 | Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours ±4 hours after test conclusion. |
| Thermal Shock | MIL-STD-202 Method 107 | –55°C/+125°C. Note: Number of cycles required – 300, maximum transfer time – 20 seconds, dwell time – 15 minutes. Air – Air. |
| High Temperature Life | MIL-STD-202 Method | 1 000 hours at 125°C (85°C for X5R 75U and Y5V) with 2 X rated voltage applied |
| | /EIA-198 | |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC for 1,000 hours. |
| Vibration | MIL-STD-202 Method | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts |
| | 204 | mounted within 2" from any secure point. Test from 10 – 2,000 Hz |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Condition F. |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. |

Storage & Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction



Capacitor Marking (Optional):

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Tape Embossed Plastic | | Punche | d Paper | |
|----------------------|------|-----------------------|--------------------|--------------------------|----------|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | (W)* | Pitch | (P ₁)* | Pitch (P ₁)* | | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 | |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | |
| Array 0612 | 8 | | | 4 | 4 | |

*Refer to Figures 1 and 2 for W and P₁ carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size. 2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- · Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 16 mm | | (0.059) | | | | (1.181) | | | |
| | Variable Dimensions — Millimeters (Inches) | | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | te 5 |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | |
|-----------|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) |
| | Variable Dimensions – Millimeters (Inches) | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | |
|-----------|--|---------------------------------------|--|--|--|--|--|--|
| Tape Size | А | B Minimum | C | D Minimum | | | | |
| 8 mm | 178 ±0.20 | | | | | | | |
| 12 mm | Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | | |
| 16 mm | (13.000 ±0.008) | | X | · · · · · | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Overview

KEMET's Ceramic Chip Capacitor Array in X7R dielectric is an advanced passive technology where multiple capacitor elements are integrated into one common monolithic structure. Array technology promotes reduced placement costs and increased throughput. This is achieved by alternatively placing one device rather than two or four discrete devices. Use of capacitor arrays also saves board space, which translates into increased board density and more functions per board. Arrays consume only a portion of the space required for standard chips resulting in savings in inventory and pick/place machine positions.

For added reliability, KEMET's Flexible Termination technology has been incorporated in order to provides superior flex performance. This technology was developed to address flex cracks, which are the primary failure mode of MLCCs and typically the result of excessive tensile and shear stresses produced during board flexure and thermal cycling. Flexible Termination technology inhibits the transfer of board stress to the rigid body of the MLCC, therefore mitigating flex cracks which can result in low IR or short circuit failures. KEMET's X7R dielectric features a 125°C maximum operating temperature and is considered "temperature stable." The Electronics Industries Alliance (EIA) characterizes X7R dielectric as a Class II material. Components of this classification are fixed, ceramic dielectric capacitors suited for bypass and decoupling applications, or for frequency discriminating circuits where Q and stability of capacitance characteristics are not critical. X7R exhibits a predictable change in capacitance with respect to time and voltage and boasts a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to $\pm 15\%$ from -55° C to $\pm 125^{\circ}$ C.

KEMET automotive grade array capacitors meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.



Ordering Information

| CA | 06 | 4 | X | 104 | K | 4 | R | Α | C | TU |
|------------------|-------------------------------------|-------------------------|-----------------------------|--|---------------------------------|--|------------|----------------------------|---|---|
| Ceramic Array | Case Size (L" x W") ¹ | Number of Capacitors | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ² | Packaging/ Grade (C-Spec) |
| | 06 = 0612 | 4 = 4 | X = Flexible Termination | Two significant digits and number of zeros | J = ±5% K = ±10% M = ±20% | 8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 2 = 200 | R = X7R | A = N/A | C = 100% Matte Sn L = SnPb (5% minimum Pb content) | See "Packaging C-Spec Ordering Options Table" |

¹ All previous reference to metric case dimension "1632" has been replaced with an inch standard reference of "0612". Please reference all new designs using the "0612" nomenclature. "CA064" replaces "C1632" in the ordering code.

² Additional termination finish options may be available. Contact KEMET for details.

² SnPb termination finish option is not available on automotive grade product.



Packaging C-Spec Ordering Options Table

| Packaging Type | Packaging/Grade Ordering Code (C-Spec) | | | |
|-------------------|---|--|--|--|
| Commerc | ial Grade ¹ | | | |
| Bulk Bag | Not Required (Blank) | | | |
| 7" Reel/Unmarked | TU | | | |
| 13" Reel/Unmarked | 7210 | | | |
| Automoti | ve Grade ² | | | |
| 7" Reel | AUTO | | | |
| 13" Reel/Unmarked | AUT07210 | | | |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices. For more information see "Capacitor Marking."

² Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information."

² For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information."

² All Automotive packaging C-Specs listed exclude the option to laser mark components. The option to laser mark is not available on these devices. For more information see "Capacitor Marking."

Benefits

- -55°C to +125°C operating temperature range
- Superior flex performance (up to 5 mm)
- · Saves both circuit board and inventory space
- · Reduces placement costs and increases throughput
- Lead (Pb)-free, RoHS and REACH compliant
- 0612 (4-element) case size
- DC voltage ratings of 10 V, 16 V, 25 V, 50 V, 100 V, and 200 V

- Capacitance offerings ranging from 330 pF 0.10 μF
- Available capacitance tolerances of ±5%, ±10%, and ±20%
- · Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish allowing for excellent solderability
- SnPb termination finish option available upon request (5% Pb minimum)
- Commercial and Automotive (AEC-Q200) grades available

Applications

Typical applications include those that can benefit from board area savings, cost savings and overall volumetric reduction such as telecommunications, computers, handheld devices and automotive. Flexible termination technology benefits applications subject to high levels of board flexure or temperature cycling.



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | Days Prior To | | |
|-----------------------------|----------------------------------|----------------|------------------|--|
| C-Spec | Process/Product change | Implementation | | |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum | |
| AUTO | Yes (without approval) | Yes | 90 days minimum | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | | PPAP (Product Part Approval Process) Level | | | | | | | | |
|-----------------------------|---|--|---|---|---|--|--|--|--|--|
| C-Spec | 1 | 2 | 3 | 4 | 5 | | | | | |
| KEMET assigned ¹ | • | • | • | • | • | | | | | |
| AUTO | | | 0 | | | | | | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)



| EIA Size | Metric Size | L | W | BW | BL | T | P | P |
|----------|-------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|-------------------------------|
| Code | Code | Length | Width | Bandwidth | Bandlength | Thickness | Pitch | Reference |
| 0612 | 1632 | 1.60 (0.063) ±0.20 (0.008) | 3.20 (0.126) ±0.20 (0.008) | 0.40 (0.016) ±0.20 (0.008) | 0.30 (0.012) ±0.20 (0.008) | See Table 2 for Thickness | 0.80 (0.031) ±0.10 (0.004) | 0.40 (0.016) ±0.05 (0.002) |



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±15% |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| ² Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | See Dissipation Factor Limit Table |
| ⁴Insulation Resistance (IR) Minimum Limit at 25°C | 1,000 MΩ μF or 100GΩ (Rated voltage applied for 120 ±5 seconds at 25°C) |

¹ Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours.

² DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

³ Capacitance and dissipation factor (DF) measured under the following conditions:

1 kHz ±50Hz and 1.0 ±0.2 V $_{\rm rms}$ if capacitance \leq 10 μF

120 Hz ±10Hz and 0.5 ±0.1 V_{rms} if capacitance > 10 μ F

⁴ To obtain IR limit, divide $M\Omega^{-\mu}F$ value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

Post Environmental Limits High Temperature Life, Biased H

| High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | |
|---|---------------------|---|-----|----------------------|--------------------------|--|--|--|
| Dielectric | Rated DC Voltage | Capacitance Dissipation Factor Value (Maximum %) | | Capacitance Shift | Insulation Resistance | | | |
| | < 16 | All | 7.5 | | | | | |
| | 16/25 | 16/25 All | | | 10% of Initial Limit | | | |
| X7R | 50 | ≤ 0.02 µF | | ±20% | | | | |
| | 50 | > 0.02 µF | 5.0 | | | | | |
| | > 50 | All | 3.0 | | | | | |

Dissipation Factor Limit Table

| Rated DC Voltage | Capacitance | Dissipation Factor (Maximum %) |
|---------------------|-------------|-----------------------------------|
| < 16 | All | 5.0 |
| 16/25 | All | 3.5 |
| 50 | ≤ 0.022 µF | 2.5 |
| 50 | > 0.022 µF | 3.5 |
| > 50 | All | 2.5 |



Table 1 – Capacitance Range/Selection Waterfall (0612 Case Size)

| | | Cas | Case Size/Series | | | (CA064 | C061 IC/X 4- | 2C/X Cap Cas | se Size) | |
|-------------|------------------|------|---------------------|----------|-------------------------------------|--|-----------------|-----------------|-----------|------|
| Capacitance | Capacitance | | Voltage | Code | 8 | 4 | 3 | 5 | 1 | 2 |
| | Code | Rate | Rated Voltage (VDC) | | 10 | 16 | 25 | 50 | 100 | 200 |
| | | | Capacit | ance | Produ | Product Availability and Chip Thickness Code | | | | |
| | | | Tolera | nce | See | Table 2 | for Chip 1 | hickness | s Dimensi | ions |
| 330 pF | 331 | J | K | M | MA | MA | MA | MA | MA | MA |
| 390 pF | 391 | J | K | M | MA | MA | MA | MA | MA | MA |
| 470 pF | 471 | J | K | M | MA | MA | MA | MA | MA | MA |
| 560 pF | 561 | J | K | M | MA | MA | MA | MA | MA | MA |
| 680 pF | 681 | J | K | M | MA | MA | MA | MA | MA | MA |
| 820 pF | 821 | J | K | M | MA | MA | MA | MA | MA | MA |
| 1,000 pF | 102 | J | K | M | MA | MA | MA | MA | MA | MA |
| 1,200 pF | 122 | J | K | M | MA | MA | MA | MA | MA | MA |
| 1,500 pF | 152 | J | K | M | MA | MA | MA | MA | MA | MA |
| 1,800 pF | 182 | J | K | М | MA | MA | MA | MA | MA | MA |
| 2,200 pF | 222 | J | K | М | MA | MA | MA | MA | MA | MA |
| 2,700 pF | 272 | J | K | М | MA | MA | MA | MA | MA | MA |
| 3,300 pF | 332 | J | K | М | MA | MA | MA | MA | MA | MA |
| 3,900 pF | 392 | J | K | М | MA | MA | MA | MA | MA | MA |
| 4,700 pF | 472 | J | K | М | MA | MA | MA | MA | MA | MA |
| 5,600 pF | 562 | J | K | М | MA | MA | MA | MA | MA | MA |
| 6,800 pF | 682 | J | К | М | MA | MA | MA | MA | MA | MA |
| 8,200 pF | 822 | J | К | М | MA | MA | MA | MA | MA | MA |
| 10,000 pF | 103 | J | К | м | MA | MA | MA | MA | MA | MA |
| 12,000 pF | 123 | J | К | м | MA | MA | MA | MA | MA | |
| 15,000 pF | 153 | J | K | М | MA | MA | MA | MA | MA | |
| 18,000 pF | 183 | J | К | М | MA | MA | MA | MA | MA | |
| 22,000 pF | 223 | J | К | М | MA | MA | MA | MA | MA | |
| 27,000 pF | 273 | J | К | М | MA | MA | MA | MA | | |
| 33.000 pF | 333 | J | К | м | МА | MA | MA | MA | | |
| 39,000 pF | 393 | J | К | М | MA | MA | MA | MA | | |
| 47,000 pF | 473 | J | К | М | MA | MA | MA | MA | | |
| 56,000 pF | 563 | J | К | М | MA | MA | MA | | | |
| 68.000 pF | 683 | Ĵ | K | М | MA | MA | | | | |
| 82.000 pF | 823 | Ĵ | K | М | MA | MA | | | | |
| 0.10 µF | 104 | J | К | М | MA | MA | | | | |
| | | Rate | ed Volta | ge (VDC) | 10 | 16 | 25 | 50 | 100 | 200 |
| Capacitance | Capacitance Code | , | Voltage | Code | 8 | 4 | 3 | 5 | 1 | 2 |
| | | Ca | se Size/ | Series | C0612C/X (CA064C/X 4-Cap Case Size) | | | | | |



Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper C |)uantity | Plastic | Quantity |
|-----------|------|-------------|---------|----------|---------|----------|
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| MA | 0612 | 0.80 ±0.10 | 4,000 | 10,000 | 0 | 0 |

Package quantity based on finished chip thickness specifications.

Table 3 – Chip Capacitor Array Land Pattern Design Recommendations per IPC-7351

| EIA SIZE CODE | METRIC SIZE | | Density Level A: Maximum (Most) Land Protrusion (mm) | | | I | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | | | |
|------------------|----------------|------|--|------|------|------|--|------|------|------|---|------|------|------|------|------|------|------|------|
| | OODL | C | Y | X | Р | V1 | V2 | C | Y | X | Р | V1 | V2 | C | Y | X | Р | V1 | V2 |
| 0612/CA064 | 1632 | 1.80 | 1.10 | 0.50 | 0.80 | 3.90 | 4.40 | 1.80 | 0.95 | 0.50 | 0.80 | 3.30 | 3.90 | 1.70 | 0.85 | 0.40 | 0.80 | 2.80 | 3.60 |

Density Level A: For low-density product applications. Provides a wider process window for reflow solder processes. **Density Level B:** For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations, the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 0612 case size.





Soldering Process

Recommended Soldering Technique:

Solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/ J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Terminat | ion Finish |
|--|-----------------------|-----------------------|
| i rome reduite | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate (T_L to T_P) | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T _L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |

Note : All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method |
|------------------------|-----------------------------------|---|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds. |
| Board Flex | JIS-C-6429 | Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm for COG. Flexible termination system – 3.0 mm (minimum). |
| | | Magnification 50 X. Conditions: |
| Soldorability | I-STD-002 | a) Method B, 4 hours at 155°C, dry heat at 235°C |
| Solderability | J-31D-002 | b) Method B at 215°C category 3 |
| | | c) Method D, category 3 at 260°C |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 Cycles (-55°C to +125°C). Measurement at 24 hours \pm 4 hours after test conclusion. |
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and rated voltage. Add 100 K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours ±4 hours after test conclusion. |
| Thermal Shock | MIL-STD-202 Method 107 | -55°C/+125°C. Note: Number of cycles required – 300, maximum transfer time – 20 seconds, dwell time – 15 minutes. Air – air. |
| High Temperature Life | MIL-STD-202 Method 108/EIA-198 | 1,000 hours at 125°C (85°C for X5R, Z5U and Y5V) with 2 X rated voltage applied. |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC for 1,000 hours. |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 min., 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Condition F. |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM clean or equivalent. |

Storage & Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction





Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a "K" to identify KEMET, followed by two characters (per EIA–198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the "K" character only.

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.
- X7R dielectric products in capacitance values outlined below.

| EIA Case Size | Metric Size Code | Capacitance |
|---------------|------------------|-------------|
| 0603 | 1608 | ≤ 170 pF |
| 0805 | 2012 | ≤ 150 pF |
| 1206 | 3216 | ≤ 910 pF |
| 1210 | 3225 | ≤ 2,000 pF |
| 1808 | 4520 | ≤ 3,900 pF |
| 1812 | 4532 | ≤ 6,700 pF |
| 1825 | 4564 | ≤ 0.018 µF |
| 2220 | 5650 | ≤ 0.027 µF |
| 2225 | 5664 | ≤ 0.033 µF |

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 μ F. Orientation of marking is vendor optional.





Capacitor Marking (Optional) cont.

| Capacitance (pF) For Various Alpha/Numeral Identifiers | | | | | | | | | | |
|--|------------------|-----|----|-----|-------|--------|---------|-----------|------------|-------------|
| Alaba | Numeral | | | | | | | | | |
| Alpha | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Character | Capacitance (pF) | | | | | | | | | |
| A | 0.10 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 |
| Н | 0.20 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 |
| М | 0.30 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 |
| d | 0.40 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 |
| f | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 |
| у | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | | Embosse | ed Plastic | Punched Paper | | |
|----------------------|--------------|---------|--------------------|--------------------------|----------|--|
| EIA Case Size | Size (W)* | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | | Pitch | (P ₁)* | Pitch (P ₁)* | | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 | |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | |
| Array 0612 | 8 | | | 4 | 4 | |

*Refer to Figures 1 and 2 for W and P₁ carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size. 2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- · Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|--|---------------------------------------|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|---|---------------------------|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 (0.059) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 (1.181) | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | |
| 16 mm | | | | | | | | | | |
| Variable Dimensions — Millimeters (Inches) | | | | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B ₀ & K ₀ | | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | te 5 | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S. < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{α} , B_{α} and K_{α} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_a and B_a are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | | | |
|--|---------------------------------------|------------------------------|--|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|
| Tape Size | D _o | E ₁ | Po | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 0 4.0 ±0.10 2.0 ±0.05 (0.157 ±0.004) (0.079 ±0.002) | | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | |
| Variable Dimensions – Millimeters (Inches) | | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 (0.138 ±0.002) | 2.0 ±0.05 (0.079 ±0.002) | 1.1 (0.098) | 8.3 (0.327) | Noto 1 | | |
| 8 mm | Single (4 mm) | (0.246) | | 4.0 ±0.10 (0.157 ±0.004) | | 8.3 (0.327) | NOLE I | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)


Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant | Dimensions — Millimete | rs (Inches) | |
|-----------|-----------------|---------------------------------------|--|--|
| Tape Size | А | B Minimum | C | D Minimum |
| 8 mm | 178 ±0.20 | | | |
| 12 mm | or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) |
| 16 mm | (13.000 ±0.008) | | (, | |
| | Variable | Dimensions — Millimeter | rs (Inches) | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Overview

The KEMET Commercial "L" surface mount capacitors with tin and lead termination in X7R dielectric are designed to meet the needs of critical applications, where tin and lead end metallization is required. KEMET's tin and lead electroplating process is designed to meet a 5% minimum lead content, as well as address concerns for a more robust and reliable lead containing termination system. As the bulk of the electronics industry moves towards RoHS compliance, KEMET continues to provide tin and lead terminated products for the military, aerospace and industrial applications, and will ensure customers have a stable and long-term source of supply. The KEMET X7R dielectric features a 125°C maximum operating temperature and is considered temperature stable. The Electronics Industries Alliance (EIA) characterizes X7R dielectric as a Class II material. Components of this classification are fixed, ceramic dielectric capacitors suited for bypass and decoupling applications or for frequency discriminating circuits, where Q and stability of capacitance characteristics are not critical. X7R exhibits a predictable change in capacitance with respect to time and voltage, boasting a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to $\pm 15\%$ from -55° C to $+125^{\circ}$ C.

Benefits

- -55°C to +125°C operating temperature range
- · Temperature stable dielectric
- · Reliable and robust termination system
- EIA 0402, 0603, 0805, 1206, 1210, 1808, 1812, 1825, 2220 and 2225 case sizes
- DC voltage ratings of 6.3 V, 10 V, 16 V, 25 V, 50 V, 100 V, 200 V and 250 V
- Capacitance offerings ranging from 10 pF to 22 μ F
- Available capacitance tolerances of ±5%, ±10% and ±20%
- · Non-polar device, minimizing installation concerns
- SnPb plated termination finish (5% Pb minimum)
- · Flexible termination option available upon request
- Available for other surface mount products, additional dielectrics and higher voltage ratings upon request



Applications

Typical applications include military, aerospace and other high reliability applications.



Ordering Information

| С | 1210 | C | 226 | K | 8 | R | Α | L | TU |
|---------|--|--------------------------|--|---------------------------------|--|------------|----------------------------|---------------------------------|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ¹ | Packaging/Grade (C-Spec) |
| | 0402 0603 0805 1206 1210 1805 1808 1812 1825 2220 2225 | C = Standard | Two Significant Digits and Number of Zeros | J = ±5% K = ±10% M = ±20% | 9 = 6.3 8 = 10 4 = 16 3 = 25 6 = 35 5 = 50 1 = 100 2 = 200 A = 250 | R = X7R | A = N/A | L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ Additional termination finish options may be available. Contact KEMET for details.

Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) |
|---|---|
| Bulk Bag/Unmarked | Not required (Blank) |
| 7" Reel/Unmarked | TU |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) |
| 7" Reel/Marked | ТМ |
| 13" Reel/Marked | 7040 (EIA 0603) 7215 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2 mm pitch ² | 7081 |
| 13" Reel/Unmarked/2 mm pitch ² | 7082 |

¹ Default packaging is "Bulk Bag." An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking."

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information."



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|-------------------|---------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|----------------------------|---------------------------------|
| 0402 | 1005 | 1.00 (0.040) ±0.05 (0.002) | 0.50 (0.020) ±0.05 (0.002) | | 0.30 (0.012) ±0.10 (0.004) | 0.30 (0.012) | Solder reflow only |
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | |
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder wave or Solder reflow |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | | |
| 1210 ¹ | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | | |
| 1805 | 4513 | 4.50 (0.177) ±0.50 (0.020) | 1.27 (0.050) ±0.38 (0.015) | See Table 2 for Thickness | 0.60 (0.024) ±0.35 (0.014) | - | |
| 1808 | 4520 | 4.70 (0.185) ±0.50 (0.020) | 2.00 (0.079) ±0.20 (0.008) | | 0.60 (0.024) ±0.35 (0.014) | N1/A | |
| 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | - | 0.60 (0.024) ±0.35 (0.014) | N/A | Solder reflow only |
| 1825 | 4564 | 4.50 (0.177) ±0.30 (0.012) | 6.40 (0.252) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | - | |
| 2220 | 5650 | 5.70 (0.224) ±0.40 (0.016) | 5.00 (0.197) ±0.40 (0.016) | - | 0.60 (0.024) ±0.35 (0.014) | - | |
| 2225 | 5664 | 5.60 (0.220) ±0.40 (0.016) | 6.40 (0.248) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | |

¹ For capacitance values $\ge 2.2 \ \mu$ F add 0.10 (0.004) to the length tolerance dimension.



Qualification/Certification

Commercial grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance & Reliability.

Environmental Compliance

These devices do not meet RoHS criteria due to the concentration of Lead (Pb) in the termination finish.

Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 Vdc Applied (TCC) | ±15% |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| ² Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | 5% (6.3 V and 10 V), 3.5% (16 V and 25 V) and 2.5% (50 V to 250 V) |
| ^₄ Insulation Resistance (IR) Minimum Limit at 25°C | See Insulation Resistance Limit Table (Rated voltage applied for 120 ±5 seconds at 25°C) |

¹ Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours.

² DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

³ Capacitance and dissipation factor (DF) measured under the following conditions:

1 kHz ±50 Hz and 1.0 ±0.2 V_{rms} if capacitance \leq 10 μ F

120 Hz ±10 Hz and 0.5 ±0.1 V_{rms} if capacitance > 10 μ F

⁴ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."



Post Environmental Limits

| | High Temperatu | ure Life, Biased | l Humidity, Mois | ture Resistance | 9 |
|------------|---------------------|----------------------|-----------------------------------|----------------------|--------------------------|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance |
| | > 25 | | 3.0 | | 10% of heitigh |
| X7R | 16/25 | All | 5.0 | ±20% | 10% of Initial |
| | < 16 | | 7.5 | | |

Insulation Resistance Limit Table

| EIA Case Size | Rated DC Voltage | 1,000 megohm microfarads or 100 GΩ | 500 megohm microfarads or 10 GΩ | 100 megohm microfarads or 10 GΩ |
|---------------|------------------|---------------------------------------|------------------------------------|------------------------------------|
| 0201 | ALL | N/A | ALL | N/A |
| 0402 | ALL | < .012 µF | ≥ .012 µF | N/A |
| 0600 | ≤ 200 V | < .047 µF | ≥ .047 µF | N/A |
| 0003 | 250 V | N/A | N/A | ALL |
| 0005 | ≤ 200 V | < 0.15 µF | ≥ 0.15 µF | N/A |
| 0805 | 250 V | < .027 µF | N/A | ≥ .027 µF |
| 1000 | ≤200 V | < 0.47 µF | ≥ 0.47 µF | N/A |
| 1206 | 250 V | < 0.12 µF | N/A | ≥ 0.12 µF |
| 1010 | ≤200 V | < 0.39 µF | ≥ 0.39 µF | N/A |
| 1210 | 250 V | < 0.27 µF | N/A | ≥ 0.27 µF |
| 1808 | ALL | ALL | N/A | N/A |
| 1812 | ALL | < 2.2 µF | ≥ 2.2 µF | N/A |
| 1825 | ALL | ALL | N/A | N/A |
| 2220 | ALL | < 10 µF | ≥ 10 µF | N/A |
| 2225 | ALL | ALL | N/A | N/A |



Table 1A – Capacitance Range/Selection Waterfall (0402 – 1206 Case Sizes)

| | | Ca | ise Sei | Si rie | ze/ s | CO402C 9 8 4 3 5 | | | | | | C | :06 | 03 | С | | | | | | C |)80 | 5C | | | | C1206C | | | | | | | | | |
|--------------------|-------------|----|---------------|--------------|-----------|--|----|------|----|-----|------|-----|------|-------|-----|-------|------|-------|------|----|-------|------|------|----------|-------|-----|--------|-----------|----------|----------|------|----------|----------|-----|----------|-----|
| Сар | Cap | Va | ltag | e C | ode | 9 | 8 | 4 | 3 | 5 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 6 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 6 | 5 | 1 | 2 | A |
| | Code | Ra | ted ۱ VI) | Volt DC) | age | 6.3 | 2 | 16 | 25 | 50 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 9 | 16 | 25 | 35 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 35 | 50 | 100 | 200 | 250 |
| | | Ca | apac Folei | ita: ranc | nce ce | | 1 | | | Pro | duct | Ava | ilab | ility | and | l Chi | p Th | nickı | iess | Co | les · | - Se | e Ta | ble 2 | 2 for | Chi | p Th | , ickr | ness | Dim | nens | ions | ; | | | |
| 10 - 91 pF* | 100 - 910* | J | | K | М | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DN | DN | DN | DN | | EB | EB | EB | EB | EB | EB | EB | EB | |
| 180 - 820 pF** | 181 - 821** | J | | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB | |
| 1000pF | 102 | J | 1 | к | М | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB | EB |
| 1200 pF | 122 | J | | K v | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | | | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB | EB |
| 1800 pF | 182 | J | li | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB | EB |
| 2200 pF | 222 | J | 1 | К | М | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB | EB |
| 2700 pF | 272 | J | | K | М | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB | EB |
| 3300 pF 3900 pF | 332 | J | | ĸ | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB | EB |
| 4700 pF | 472 | J | | K | М | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB | EB |
| 5600 pF | 562 | J | | K | М | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB | EB |
| 6800 pF | 682 822 | J | | K K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | CF | | | | | | DN DN | | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB | EB |
| 10000 pF | 103 | J | | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB | EB |
| 12000 pF | 123 | J | 1 | К | М | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB | EB |
| 15000 pF | 153 | J | | K | М | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB | EB |
| 22000 pF | 223 | J | | K K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | | | | | | | | DN DN | | | | FB | FB | FB | FB | FB | FB | FB | FB | FB |
| 27000 pF | 273 | J | | K | М | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DN | DP | DE | DG | EB | EB | EB | EB | EB | EB | EB | EB | EB |
| 33000 pF | 333 | J | | K | М | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DN | DP | DE | DG | EB | EB | EB | EB | EB | EB | EB | EB | EB |
| 39000 pF | 393 | J | | K v | M | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | | | | DN | | | | | DP | DE | DG | EB | EB | EB | EB | EB | EB | EC | EB | EB |
| 56000 pF | 563 | J | | K | M | BB | BB | BB | DD | | CF | CF | CF | CF | CF | UF | | | DP | DN | DN | DN | DP | DP | DE | DG | DG | EB | EB | EB | EB | EB | EB | EB | ED | ED |
| 68000 pF | 683 | J | 1 | K | М | BB | BB | BB | | | CF | CF | CF | CF | CF | | | | DP | DP | DP | DP | DP | DP | DE | DG | DG | EB | EB | EB | EB | EB | EB | EB | ED | ED |
| 82000 pF | 823 | J | | K | М | BB | BB | BB | | | CF | CF | CF | CF | CF | | | | DP | DP | DP | DP | DP | DP | DE | | | EB | EB | EB | EB | EB | EB | EB | ED | ED |
| 0.1 µF | 104 | J | | K K | M | RR | RR | RR | | | CF | CF | CF | CF | CF | | | | | | | | | | DE | | | EC | EB | EB | EB | EB | EC | EB | EM EG | EM |
| 0.15 μF | 154 | J | i | K | M | | | | | | CF | CF | CF | CF | CF | | | | DN | DN | DN | DN | DP | DP | DG | | | EC | EC | EC | EC | EC | EC | EC | EG | EG |
| 0.18 µF | 184 | J | 1 | K | М | | | | | | CF | CF | CF | CF | | | | | DN | DN | DN | DN | DG | DG | DG | | | EC | EC | EC | EC | EC | EC | EC | EM | EM |
| 0.22 µF | 224 | J | | K | M | | | | | | CF | CF | CF | CF | | | | | DN | DN | DN | DN | DG | | DG | | | EC | EC | EC | EC | EC | EC | EC | EG | EG |
| 0.27 µF | 334 | J | | K | M | | | | | | CF | CF | CF | | | | | | DF | DF | DP | DF | DP | DP | | | | EB | EB | EB | EB | EC | EC | EG | | |
| 0.39 µF | 394 | J | 1 | К | М | | | | | | CF | CF | CF | | | | | | DG | DG | DG | DG | DE | DE | | | | EB | EB | EB | EB | EC | EC | EG | | |
| 0.47 µF | 474 | J | | K | М | | | | | | CF | CF | CF | | | | | | DG | DG | DG | DG | DE | DE | | | | EC | EC | EC | EC | EC | EC | EG | | |
| 0.56 µF | 564 684 | J | | K K | M | | | | | | | | | | | | | | DP | | | DG | | DH | | | | FF | ED FF | ED FF | FF | EC FD | EC FD | EM | | |
| 0.82 µF | 824 | J | i | ĸ | М | | | | | | | | | | | | | | DP | DP | DP | DG | | 511 | | | | EF | EF | EF | EF | ED | ED | EH | | |
| 1 µF | 105 | J | 1 | K | М | | | | | | | | | | | | | | DP | DP | DP | DG | | | | | | EF | EF | EF | EH | ED | ED | EH | | |
| 1.2 µF | 125 | J | | K v | M | | | | | | | | | | | | | | DE | DE | DE | | | | | | | ED | ED | ED | EG | EH | EH | | | |
| 1.8 µF | 185 | J | | K | M | | | | | | | | | | | | | | DG | DG | DG | | | | | | | ED | ED | ED | EF | EH | EH | | | |
| 2.2 µF | 225 | J | 1 | К | М | | | | | | | | | | | | | | DG | DG | DG | | | | | | | ED | ED | ED | EF | EH | EH | | | |
| 2.7 µF | 275 | J | 1 | K | М | | | | | | | | | | | | | | | | | | | | | | | EN | EN | EN | EH | | | | | |
| 3.3 µF 3 9 µF | 335 | J | | K K | M | | | | | | | | | | | | | | | | | | | | | | | FF | FF | FF | FH | | | | | |
| 4.7 μF | 475 | J | i | K | М | | | | | | | | | | | | | | | | | | | | | | | EF | EF | EF | EH | | | | | |
| 5.6 µF | 565 | J | | к | М | | | | | | | | | | | | | | | | | | | | | | | EH | EH | EH | | | | | | |
| 6.8µF | 685 825 | J | | K | M | | | | | | | | | | | | | | | | | | | | | | | EH | EH | EH | | | | | | |
| 10 μF | 106 | J | | K | M | | | | | | | | | | | | | | | | | | | | | | | EH | EH | EH | | | | | | |
| | | Ra | ted \ (VI | Volt DC) | age | 6.3 | 9 | 16 | 25 | 50 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 2 | 16 | 25 | 35 | 50 | 100 | 200 | 250 | 6.3 | 9 | 16 | 25 | 35 | 50 | 100 | 200 | 250 |
| Cap | Cap Code | Vo | ltag | e C | ode | 9 | 8 | 4 | 3 | 5 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 6 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 6 | 5 | 1 | 2 | A |
| | | C | ase Sei | Siz ries | ze/ | | C | 0402 | 2C | | | | | C06 | 030 | ; | | | | | | C | 0805 | 5C | | | | | | | C | 1206 | 5C | | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91). **Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, and 82).



Table 1B - Capacitance Range/Selection Waterfall (1210 - 1812 Case Sizes)

| | | Ca | se Siz Series | ze/ | | | | C12 | 10C | | | | C | 1805 | 5C | C | 1808 | C | | C | 1812 | C | |
|----------------|----------------------------|--------------|--------------------------|-------|-----|--------------------------------------|--------|--------|----------|--------|--------|--------|-------------|------------|--------------------|--------------|---------|--------|-------|--------|-------|------|-----|
| 0 | 00 | Vo | ltage Co | de | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | 5 | 1 | 2 | 3 | 5 | 1 | 2 | A |
| Сар | Cap Code | Rated | Voltage | (VDC) | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 50 | 100 | 200 | 25 | 50 | 100 | 200 | 250 |
| | | Ca | Capacitance Tolerance | | | Proc | luct A | vailal | oility a | and Cl | nip Th | ickne | l ess Co | l des - | · See ⁻ | l Fable : | 2 for C | Chip T | hickn | ess Di | imens | ions | |
| 10 - 91 pF* | 100 - 910* | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | | | | | | |
| 100 - 180 pF** | 101 - 181** | J | К | М | FB | FB | FB | FB | FB | FB | FB | | | | | | | | | | | | |
| 220 pF | 221 | J | К | М | FB | FB | FB | FB | FB | FB | FB | | NC | NC | NC | | | | | | | | |
| 270 pF | 271 | J | K | М | FB | FB | FB | FB | FB | FB | FB | | NC | NC | NC | | | | | | | | |
| 330 pF | 331 | J | К | М | FB | FB | FB | FB | FB | FB | FB | | NC | NC | NC | LF | LF | LF | | | | | |
| 390 pF | 391 | J | K | М | FB | FB | FB | FB | FB | FB | FB | | NC | NC | NC | LF | LF | LF | | | | | |
| 470 pF | 471 | J | K | М | FB | FB | FB | FB | FB | FB | FB | | NC | NC | NC | LF | LF | LF | GB | GB | GB | GB | |
| 560 pF | 561 | J | К | М | FB | FB | FB | FB | FB | FB | FB | | NC | NC | NC | LF | LF | LF | GB | GB | GB | GB | |
| 680 pF | 681 | J | K | М | FB | FB | FB | FB | FB | FB | FB | | NC | NC | NC | LF | LF | LF | GB | GB | GB | GB | |
| 820 pF | 821 | J | K | М | FB | FB | FB | FB | FB | FB | FB | | NC | NC | NC | LF | LF | LF | GB | GB | GB | GB | |
| 1,000 pF | 102 | J | K | М | FB | FB | FB | FB | FB | FB | FB | | NC | NC | NC | LF | LF | LF | GB | GB | GB | GB | |
| 1,200 pF | 122 | J | K | М | FB | FB | FB | FB | FB | FB | FB | | NC | NC | | LF | LF | LF | GB | GB | GB | GB | |
| 1,500 pF | 152 | J | К | М | FB | FB | FB | FB | FB | FB | FE | | NC | NC | | LF | LF | LF | GB | GB | GB | GB | |
| 1,800 pF | 182 | J | к | М | FB | FB | FB | FB | FB | FB | FE | | NC | NC | | LF | LF | LF | GB | GB | GB | GB | |
| 2,200 pF | 222 | J | к | М | FB | FB | FB | FB | FB | FB | FB | FB | NC | NC | | LF | LF | LF | GB | GB | GB | GB | |
| 2,700 pF | 272 | J | К | М | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | NA | LF | LF | LF | GB | GB | GB | GB | |
| 3,300 pF | 332 | J | к | М | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | NA | LF | LF | | GB | GB | GB | GB | |
| 3,900 pF | 392 | J | к | М | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | NA | LF | LF | | GB | GB | GB | GB | |
| 4,700 pF | 472 | J | к | М | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | NA | LD | LD | LD | GB | GB | GB | GD | |
| 5,600 pF | 562 | J | к | М | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | NA | LD | LD | LD | GB | GB | GB | GH | |
| 6,800 pF | 682 | J | К | М | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | LD | GB | GB | GB | GB | GB |
| 8,200 pF | 822 | J | К | М | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | LD | GB | GB | GB | GB | GB |
| 10,000 pF | 103 | J | к | М | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | LD | GB | GB | GB | GB | GB |
| 12,000 pF | 123 | J | к | М | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | LD | GB | GB | GB | GB | GB |
| 15,000 pF | 153 | J | К | М | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | LD | GB | GB | GB | GB | GB |
| 18,000 pF | 183 | J | К | М | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | LD | GB | GB | GB | GB | GB |
| 22,000 pF | 223 | J | к | М | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | | GB | GB | GB | GB | GB |
| 27.000 pF | 273 | Ĵ | к | м | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | | GB | GB | GB | GB | GB |
| 33,000 pF | 333 | J | к | М | FB | FB | FB | FB | FB | FB | FB | FB | NA | | | LD | LD | | GB | GB | GB | GB | GB |
| 39,000 pF | 393 | J | к | М | FB | FB | FB | FB | FB | FB | FB | FB | NA | | | LD | LD | | GB | GB | GB | GB | GB |
| 47.000 pF | 473 | J | К | М | FB | FB | FB | FB | FB | FB | FC | FC | NA | | | LD | LD | | GB | GB | GB | GB | GB |
| 56.000 pF | 563 | J | к | м | FB | FB | FB | FB | FB | FB | FC | FC | NA | | | LD | LD | | GB | GB | GB | GB | GB |
| 68,000 pF | 683 | J | К | М | FB | FB | FB | FB | FB | FB | FC | FC | NA | | | LD | | | GB | GB | GB | GB | GB |
| 82,000 pF | 823 | J | К | М | FB | FB | FB | FB | FB | FC | FF | FF | NA | | | LD | | | GB | GB | GB | GB | GB |
| 0.10 µF | 104 | J | К | М | FB | FB | FB | FB | FB | FD | FG | FG | NA | | | LD | | | GB | GB | GB | GB | GB |
| | | Rated | Voltage | (VDC) | 6.3 | 5 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 50 | 100 | 200 | 25 | 50 | 100 | 200 | 250 |
| Сар | Cap Code | Voltage Code | | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | 5 | 1 | 2 | 3 | 5 | 1 | 2 | A | |
| | Cap Code Case Size/ Series | | | | | de 9 8 4 3 5 1 2 A 5 eries C1210C | | | | | | C1805C | | | C1808C | | C | C1812C | | | | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91). **Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, and 82).



Table 1B – Capacitance Range/Selection Waterfall (1210 – 2225 Case Sizes) cont.

| | | Ca | se Si: Series | ze/ s | | | | C12 | 10C | | | | C | 1805 | iC | C | 1808 | C | | C | 1812 | C | |
|---------|-------------------------------------|---------|----------------------|----------|-----|------|--------|--------|----------|-------|--------|-------|--------|-------|-------|-------|---------|--------|-------|--------|-------|------|-------|
| 0 | | Vo | ltage Co | ode | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | 5 | 1 | 2 | 3 | 5 | 1 | 2 | Α |
| Cap | Cap Code | Rated | Voltage | (VDC) | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 50 | 100 | 200 | 25 | 50 | 100 | 200 | 250 |
| | | Ca 1 | apacitan Foleranc | ce e | | Proc | luct A | vailat | oility a | and C | nip Th | ickne | ess Co | des - | See ' | Table | 2 for (| Chip T | hickn | ess Di | imens | ions | |
| 0.12 µF | 124 | J | К | М | FB | FB | FB | FB | FB | FD | FH | FH | | | | LD | | | GB | GB | GB | GB | GB |
| 0.15 µF | 154 | J | K | M | FC | FC | FC | FC | FC | FD | FM | FM | | | | LD | | | GB | GB | GB | GE | GE |
| 0.18 µF | 184 | J | K | M | FC | FC | FC | FC | FC | FD | FK | FK | | | | LD | | | GB | GB | GB | GG | GG |
| 0.22 µF | 224 | J | К | М | FC | FC | FC | FC | FC | FD | FK | FK | | | | | | | GB | GB | GB | GG | GG |
| 0.27 µF | 274 | J | K | М | FC | FC | FC | FC | FC | FD | FP | FP | | | | | | | GB | GB | GG | GG | GG |
| 0.33 µF | 334 | J | K | M | FD | FD | FD | FD | FD | FD | FM | FM | | | | | | | GB | GB | GG | GG | GG |
| 0.39 µF | 394 | J | K | M | FD | FD | FD | FD | FD | FD | FK | FK | | | | | | | GB | GB | GG | GG | GG |
| 0.47 µF | 474 | J | K | M | FD | FD | FD | FD | FD | FD | FS | FS | | | | | | | GB | GB | GG | GJ | GJ |
| 0.56 µF | 564 | J | K | M | FD | FD | FD | FD | FD | FF | | | | | | | | | GC | GC | GG | | |
| 0.68 µF | 684 | J | K | M | FD | FD | FD | FD | FD | FG | | | | | | | | | GC | GC | GG | | |
| 0.82 µF | 824 | J | K | М | FF | FF | FF | FF | FF | FL | | | | | | | | | GE | GE | GG | | |
| 1.0 µF | 105 | J | K | М | FH | FH | FH | FH | FH | FM | | | | | | | | | GE | GE | GG | | |
| 1.2 µF | 125 | J | K | М | FH | FH | FH | FH | FG | FH | | | | | | | | | GB | GB | GB | | |
| 1.5 µF | 155 | J | K | М | FH | FH | FH | FH | FG | FM | | | | | | | | | GC | GC | GC | | |
| 1.8 µF | 185 | J | К | М | FH | FH | FH | FH | FG | FJ | | | | | | | | | GE | GE | GE | | |
| 2.2 µF | 225 | J | K | М | FJ | FJ | FJ | FJ | FG | FK | | | | | | | | | GO | GO | GG | | |
| 2.7 µF | 275 | J | К | М | FE | FE | FE | FG | FH | | | | | | | | | | GJ | GJ | GJ | | |
| 3.3 µF | 335 | J | К | М | FF | FF | FF | FM | FM | | | | | | | | | | GL | GL | GL | | |
| 3.9 µF | 395 | J | К | М | FG | FG | FG | FG | FK | | | | | | | | | | GK | GK | | | |
| 4.7 μF | 475 | J | к | м | FC | FC | FC | FG | FS | | | | | | | | | | GK | GK | | | |
| 5.6 µF | 565 | J | К | М | FF | FF | FF | FH | | | | | | | | | | | | | | | |
| 6.8 µF | 685 | J | к | м | FG | FG | FG | FM | | | | | | | | | | | | | | | |
| 8.2 uF | 825 | J | к | м | FH | FH | FH | FK | | | | | | | | | | | | | | | |
| 10 µF | 106 | J | к | м | FH1 | FH1 | FH1 | FS | | | | | | | | | | | GK | | | | |
| 15 uF | 156 | J | к | м | FM | FM | | | | | | | | | | | | | | | | | |
| 22 µF | 226 | J | К | М | FS | FS | | | | | | | | | | | | | | | | | |
| | | Rated | Voltage | (VDC) | 6.3 | 9 | 16 | 25 | 50 | 8 | 200 | 250 | 50 | 0 | 200 | 50 | 8 | 200 | 25 | 50 | 8 | 200 | 250 |
| Can | Can Codo | Vo | Itage Co | ode | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | 5 | 1 | 2 | 3 | 5 | 1 | 2 | A |
| Cap | Cap Cap Code Code Case Size/ Series | | | | | | 1 | C12 | 10C | 1 | | | c | 1805 | с | 0 | 1808 | C | | C | 1812 | 5 | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91). **Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, and 82).



Table 1C - Capacitance Range/Selection Waterfall (1825 - 2225 Case Sizes)

| | | Case | Size/ S | Series | | C18 | 25C | | | С | 2220 | С | | | C22 | 25C | | |
|-------------|----------|------|-------------------------|--------|----|-----|-----|------------|----------------------|------------------------|----------------------|-------------------------|--------------------|-------------|-----|-----|-----|--|
| 0 | | v | oltage Cod | le | 5 | 1 | 2 | A | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | |
| Сар | Cap Code | Rate | Rated Voltage (VDC) | | 50 | 100 | 200 | 250 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | |
| | | | Capacitanc Tolerance | e | | ļ | I | Prod Se | uct Avai ee Table | lability a 2 for Ch | and Chip ip Thick |) Thickn (ness Di | iess Coo mensio | les – ns | 1 | | 1 | |
| 3,900 pF | 392 | J | K | М | HB | HB | HB | | | | | | | | | | | |
| 4,700 pF | 472 | J | K | М | HB | HB | HB | | | | | | | KE | KE | KE | | |
| 5,600 pF | 562 | J | K | М | HB | HB | HB | | | | | | | KE | KE | KE | | |
| 6,800 pF | 682 | J | K | М | HB | HB | HB | | JE | JE | JE | | | KE | KE | KE | | |
| 8,200 pF | 822 | J | K | М | HB | HB | HB | | JE | JE | JE | | | KE | KE | KE | | |
| 10,000 pF | 103 | J | K | M | HB | HB | HE | | JE | JE | JE | | | KE | KE | KE | | |
| 12,000 pF | 123 | J | K | M | HB | HB | HE | | JE | JE | JE | | | KE | KE | KE | | |
| 15,000 pF | 153 | J | K | M | HB | HB | | | JE | JE | JE | | | KE | KE | KE | | |
| 18,000 pF | 183 | J | K | M | HB | HE | | | JE | JE | JE | | | KE | KE | | | |
| 22,000 pF | 223 | J | K | M | HB | HB | HB | HB | JE | JE | JE | | | KE | KE | | | |
| 27,000 pF | 273 | J | K | М | HB | HB | HB | HB | JE | JE | JE | | | KE | KE | | | |
| 33,000 pF | 333 | J | K | М | HB | HB | HB | HB | JB | JB | JB | | | KE | | | | |
| 39,000 pF | 393 | J | K | M | HB | HB | HB | HB | JB | JB | JB | | | | | | | |
| 47,000 pF | 473 | J | K | М | HB | HB | HB | HB | JB | JB | JB | | | | | | | |
| 56,000 pF | 563 | J | K | M | HB | HB | HB | HB | JB | JB | JB | | | | | | | |
| 68,000 pF | 683 | J | K | М | HB | HB | HB | HB | JB | JB | JB | | | | | | | |
| 82,000 pF | 823 | J | К | M | НВ | НВ | НВ | HB | JC | JC | JC | JC | JC | | | | | |
| 0.10 µF | 104 | J | К | м | НВ | НВ | НВ | НВ | JC | JC | JC | JC | JC | кс | кс | кс | кс | |
| 0.12 µF | 124 | J | к | м | НВ | НВ | НВ | НВ | JC | JC | JC | JC | JC | кс | кс | кс | кс | |
| 0.15 µF | 154 | J | к | м | НВ | НВ | НВ | НВ | JC | JC | JC | JC | JC | кс | кс | кс | кс | |
| 0.18 µF | 184 | J | К | М | НВ | НВ | НВ | HB | JC | JC | JC | JC | JC | кс | КС | KC | КС | |
| 0.22 uF | 224 | J | к | м | НВ | НВ | НВ | НВ | JC | JC | JC | JC | JC | кс | кс | KC | кс | |
| 0.27 uF | 274 | J | K | M | HB | HB | HB | HB | JC | JC | JC | JC | JC | KB | KC | KC | KC | |
| 0.33 uF | 334 | J | K | M | HB | HB | HB | HB | JC | JC | JC | JC | JC | KB | KC | KC | KC | |
| 0.39 µF | 394 | J | ĸ | M | HB | HB | HD | HD | JC | JC | JC | JC | JC | KB | KC | KC | KC | |
| 0.47 µF | 474 | J | ĸ | M | HB | HB | HD | HD | JC | JC | JC | JC | JC | KB | KC | KD | KD | |
| 0.56 µF | 564 | | ĸ | M | HB | HD | НD | HD | JC | JC | JC | JD | JD | KB | KC | KD | KD | |
| 0.68 µF | 684 | | ĸ | M | HB | HD | НD | HD | JC | JC | JD | JD | JD | KB | KC | KD | KD | |
| 0.82 µF | 824 | | ĸ | M | HB | HF | HF | HF | JC | JC | JE | JE | JF | KB | KC | KF | KF | |
| 1.0 µF | 105 | | ĸ | M | HB | HF | HE | HE | JC | JC | JE | JE | JF | KB | KD | KE | KE | |
| 12 µF | 125 | J | K | M | HB | | | | JC | JC | 0. | | 0. | KB | KE | KE | KE | |
| 1.5 µF | 155 | J | ĸ | M | нс | | | | JC | JC | | | | кс | | | | |
| 1.8 µF | 185 | , i | ĸ | M | НП | | | | JD | JD | | | | KD | | | | |
| 2.2 µF | 225 | , i | ĸ | M | HF | | | | JE | JE | | | | KD | | | | |
| 4.7 uF | 475 | Ŭ | , N | | | | | | JE | JE | | | | | | | | |
| 10 µF | 106 | | | | | | | | JF | J0 | | | | | | | | |
| 15 µF | 156 | | | | | | | | .10 | 10 | | | | | | | | |
| 22 µF | 226 | | | | | | | | JO | | | | | | | | | |
| F. | | Rate | d Voltage (| (VDC) | 50 | 100 | 200 | 250 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | |
| Cap | Cap Code | v | oltage Cod | le | 5 | 1 | 2 | A | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | |
| - -r | | Cas | e Size/ Se | eries | | C18 | 25C | | C2220C | | | | | C2225C | | | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82 and 91). **Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68 and 82).



| Thickness | Case | Thickness ± | Paper Quantity ¹ | | Plastic Quantity | | |
|-----------|-------------------|-------------|-----------------------------|----------------------|------------------|----------|--|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| BB | 0402 | 0.50 ± 0.05 | 10,000 | 50,000 | 0 | 0 | |
| CF | 0603 | 0.80 ± 0.07 | 4,000 | 15,000 | 0 | 0 | |
| DN | 0805 | 0.78 ± 0.10 | 4,000 | 15,000 | 0 | 0 | |
| DP | 0805 | 0.90 ± 0.10 | 4,000 | 15,000 | 0 | 0 | |
| DE | 0805 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 | |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | |
| DH | 0805 | 1.25 ± 0.20 | 0 | 0 | 2,500 | 10,000 | |
| EB | 1206 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 | |
| EC | 1206 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 | |
| EN | 1206 | 0.95 ± 0.10 | 0 | 0 | 4,000 | 10,000 | |
| ED | 1206 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 | |
| EE | 1206 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 | |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 | |
| EM | 1206 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | |
| EG | 1206 | 1.60 ± 0.15 | 0 | 0 | 2,000 | 8,000 | |
| EH | 1206 | 1.60 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| FB | 1210 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 | |
| FC | 1210 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 | |
| FD | 1210 | 0.95 ± 0.10 | 0 | 0 | 4,000 | 10,000 | |
| FE | 1210 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 | |
| FF | 1210 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 | |
| FG | 1210 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | |
| FL | 1210 | 1.40 ± 0.15 | 0 | 0 | 2,000 | 8,000 | |
| FH | 1210 | 1.55 ± 0.15 | 0 | 0 | 2,000 | 8,000 | |
| FP | 1210 | 1.60 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| FJ | 1210 | 1.85 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| FK | 1210 | 2.10 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1,000 | 4,000 | |
| NA | 1805 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 | |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic | Quantity | |

Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information."



Table 2A - Chip Thickness/Tape & Reel Packaging Quantities cont.

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic | Quantity |
|-----------|-------------------|-------------|---------|----------------------|---------|----------|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| NC | 1805 | 1.00 ± 0.15 | 0 | 0 | 4,000 | 10,000 |
| LD | 1808 | 0.90 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| LF | 1808 | 1.00 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GC | 1812 | 1.10 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GD | 1812 | 1.25 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GE | 1812 | 1.30 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GH | 1812 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GG | 1812 | 1.55 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GK | 1812 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GJ | 1812 | 1.70 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GL | 1812 | 1.90 ± 0.20 | 0 | 0 | 500 | 2,000 |
| GO | 1812 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| HB | 1825 | 1.10 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| HC | 1825 | 1.15 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| HD | 1825 | 1.30 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| HE | 1825 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| HF | 1825 | 1.50 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JB | 2220 | 1.00 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JC | 2220 | 1.10 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JD | 2220 | 1.30 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JE | 2220 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JF | 2220 | 1.50 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JO | 2220 | 2.40 ± 0.15 | 0 | 0 | 500 | 2,000 |
| KB | 2225 | 1.00 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| KC | 2225 | 1.10 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| KD | 2225 | 1.30 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| KE | 2225 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic | Quantity |

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information."



Table 2B – Bulk Packaging Quantities

| Deeker | ing Tune | Loose Packaging | | | | |
|----------|------------------------|---|-----------------|--|--|--|
| Раскау | ing type | Bulk Bag (default) | | | | |
| Packagir | ng C-Spec ¹ | N/ | /A ² | | | |
| Case | e Size | Packaging Quantities (pieces/unit packaging | | | | |
| EIA (in) | Metric (mm) | Minimum | Maximum | | | |
| 0402 | 1005 | | | | | |
| 0603 | 1608 | | | | | |
| 0805 | 2012 | | 50,000 | | | |
| 1206 | 3216 | | | | | |
| 1210 | 3225 | 1 | | | | |
| 1808 | 4520 | | | | | |
| 1812 | 4532 | | | | | |
| 1825 | 4564 | | 20,000 | | | |
| 2220 | 2220 5650 | | | | | |
| 2225 | 5664 | 1 | | | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for automotive grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding anti-static Bulk Bag and automotive grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Metric Size Size | | | Density Level A:Density Level B:Density LeMaximum (Most)Median (Nominal)Minimum (Land Protrusion (mm)Land Protrusion (mm)Land Protrusion (| | | Density Level B:Density Level C:Median (Nominal)Minimum (Least)Land Protrusion (mm)Land Protrusion (mm) | | | |) | | | | | | |
|-------------------------|------|------|--|------|------|---|------|------|------|------|------|------|------|------|------|------|
| Goue | Coue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 |
| 1210 ¹ | 3225 | 1.50 | 1.60 | 2.90 | 5.60 | 3.90 | 1.40 | 1.40 | 2.80 | 4.70 | 3.30 | 1.30 | 1.20 | 2.70 | 4.00 | 3.00 |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 |
| 1825 | 4564 | 2.15 | 1.60 | 6.90 | 6.90 | 7.90 | 2.05 | 1.40 | 6.80 | 6.00 | 7.30 | 1.95 | 1.20 | 6.70 | 5.30 | 7.00 |
| 2220 | 5650 | 2.75 | 1.70 | 5.50 | 8.20 | 6.50 | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | 2.55 | 1.30 | 5.30 | 6.60 | 5.60 |
| 2225 | 5664 | 2.70 | 1.70 | 6.90 | 8.10 | 7.90 | 2.60 | 1.50 | 6.80 | 7.20 | 7.30 | 2.50 | 1.30 | 6.70 | 6.50 | 7.00 |

¹ Only for capacitance values \geq 22 μ F

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

The KEMET families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Drofile Feature | Termination Finish | | | | |
|--|-----------------------|-----------------------|--|--|--|
| Fromereature | SnPb | 100% Matte Sn | | | |
| Preheat/Soak | | | | | |
| Temperature Minimum (T _{smin}) | 100°C | 150°C | | | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | | | |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds | | | |
| Ramp-Up Rate $(T_L to T_p)$ | 3°C/second maximum | 3°C/second maximum | | | |
| Liquidous Temperature (T _L) | 183°C | 217°C | | | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | | | |
| Peak Temperature (T _P) | 235°C | 260°C | | | |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 30 seconds maximum | | | |
| Ramp-Down Rate $(T_p to T_L)$ | 6°C/second maximum | 6°C/second maximum | | | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | | | |

Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method |
|-------------------------------------|-----------------------------------|---|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds. |
| Board Flex | JIS-C-6429 | Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm for COG. Flexible termination system – 3.0 mm (minimum). |
| | | Magnification 50 X, conditions: |
| Solderability | I-STD-002 | a) Method B, 4 hours at 155°C, dry heat at 235°C |
| Solderability | J-31D-002 | b) Method B, category 3 at 215°C |
| | | c) Method D, category 3 at 260°C |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 Cycles (-55°C to +125°C). Measurement at 24 hours \pm 4 hours after test conclusion. |
| Biased Humidity | MIL-STD-202 Method 103 | Load humidity: 1,000 hours 85°C/85% RH and rated voltage. Add 100 K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. Low volt humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours ±4 hours after test conclusion. |
| Thermal Shock | MIL-STD-202 Method 107 | -55°C/+125°C. Note: Number of cycles required – 300. Maximum transfer time – 20 seconds. Dwell time – 15 minutes. Air – air. |
| High Temperature Life | MIL-STD-202 Method 108/EIA-198 | 1,000 hours at 125°C (85°C for X5R, Z5U and Y5V) with 2 X rated voltage applied. |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC for 1,000 hours. |
| Vibration MIL-STD-202 Method 204 | | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Condition F. |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. |

Storage & Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction





Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a "K" to identify KEMET, followed by two characters (per EIA–198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the "K" character only.

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.
- X7R dielectric products in capacitance values outlined below.

| EIA Case Size | Metric Size Code | Capacitance |
|---------------|------------------|-------------|
| 0603 | 1608 | ≤ 170 pF |
| 0805 | 2012 | ≤ 150 pF |
| 1206 | 3216 | ≤ 910 pF |
| 1210 | 3225 | ≤ 2,000 pF |
| 1808 | 4520 | ≤ 3,900 pF |
| 1812 | 4532 | ≤ 6,700 pF |
| 1825 | 4564 | ≤ 0.018 µF |
| 2220 | 5650 | ≤ 0.027 µF |
| 2225 | 5664 | ≤ 0.033 µF |

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 μ F. Orientation of marking is vendor optional.





Capacitor Marking (Optional) cont.

| | C | apacita | ance (p | F) For \ | /arious | Alpha/ | Numera | al Identif | iers | |
|-----------|------|---------|---------|----------|---------|----------|---------|------------|------------|-------------|
| Alaba | | | | | | Numera | al | | | |
| Alpha | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Character | | | | | Сара | acitance | e (pF) | | | |
| A | 0.10 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 |
| Н | 0.20 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 |
| М | 0.30 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 |
| d | 0.40 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 |
| f | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 |
| у | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punche | d Paper | | |
|----------------------|------|---------|--------------------|---------|--------------------|--|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | |
| | (W)* | Pitch | (P ₁)* | Pitch | (P ₁)* | | |
| 01005 - 0402 | 8 | | | 2 | 2 | | |
| 0603 | 8 | | | 2/4 | 2/4 | | |
| 0805 | 8 | 4 | 4 | 4 | 4 | | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | | |
| 1805 - 1808 | 12 | 4 | 4 | | | | |
| ≥ 1812 | 12 | 8 | 8 | | | | |
| KPS 1210 | 12 | 8 | 8 | | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | | |
| Array 0612 | 8 | 4 | 4 | | | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size. 2 mm pitch reel for 0805 EIA case size under development.

2 mm pitch reel for U805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|--|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum | | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | |
| 16 mm | | (0.059) | | | | (1.181) | | | | | |
| | | , | Variable Dime | ensions – Mil | limeters (Incl | nes) | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ | | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | te 5 | | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|-----------|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|--|--|
| Tape Size | D _o | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | | | |
| | Variable Dimensions — Millimeters (Inches) | | | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant | Dimensions — Millimete | rs (Inches) | | | | | | | | | | |
|-----------|--|---------------------------------------|--|--|--|--|--|--|--|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | | | | | | | |
| 8 mm | 178 ±0.20 | | | | | | | | | | | | |
| 12 mm | Or 220 10 20 | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | | | | | | | |
| 16 mm | (13.000 ±0.008) | | | | | | | | | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | | | | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | | | | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | | | | | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | | | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Overview

KEMET's Commercial "L" Series with Tin/Lead Termination surface mount capacitors in COG dielectric are designed to meet the needs of critical applications where tin/lead end metallization is required. KEMET's tin/lead electroplating process is designed to meet a 5% minimum lead content and address concerns for a more robust and reliable lead containing termination system. As the bulk of the electronics industry moves towards RoHS compliance, KEMET continues to provide tin/lead terminated products for military, aerospace and industrial applications and will ensure customers have a stable and long-term source of supply.

Benefits

- -55°C to +125°C operating temperature range
- · Reliable and robust termination system
- EIA 0402, 0603, 0805, 1206, 1210, 1808, 1812, 1825, 2220, and 2225 case sizes
- DC voltage ratings of 10 V, 16 V, 25 V, 50 V, 100 V, 200 V and 250 V
- Capacitance offerings ranging from 0.5 pF up to 0.47 μF
- Available capacitance tolerances of ±0.10 pF, ±0.25 pF, ±0.5 pF, ±1%, ±2%, ±5%, ±10%, and ±20%

Ordering Information

| С | 1206 | С | 104 | J | 3 | G | Α | L | TU |
|---------|--|--------------------------|--|---|---|------------|-------------------------|------------------------------------|--|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance ¹ | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ² | Packaging/ Grade (C-Spec) |
| | 0402 0603 0805 1206 1210 1805 1808 1812 1825 2220 2225 | C = Standard | Two significant digits and number of zeros. Use 9 for 1.0 – 9.9 pF Use 8 for 0.5 – .99 pF e.g., 2.2 pF = 229 e.g., 0.5 pF = 508 | $B = \pm 0.10 \text{ pF}$ $C = \pm 0.25 \text{ pF}$ $D = \pm 0.5 \text{ pF}$ $F = \pm 1\%$ $G = \pm 2\%$ $J = \pm 5\%$ $K = \pm 10\%$ $M = \pm 20\%$ | 8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 2 = 200 A = 250 | G = COG | A = N/A | L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ Additional capacitance tolerance offerings may be available. Contact KEMET for details. ² Additional termination finish options may be available. Contact KEMET for details



KEMET's COG dielectric features a 125°C maximum

The Electronics Components, Assemblies & Materials

Association (EIA) characterizes COG dielectric as a Class I

material. Components of this classification are temperature

applications or those where Q and stability of capacitance

capacitance with respect to time and voltage and boasts a

negligible change in capacitance with reference to ambient

temperature. Capacitance change is limited to ±30 ppm/°C

characteristics are required. COG exhibits no change in

operating temperature and is considered "stable."

compensating and are suited for resonant circuit

from -55°C to +125°C.



Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) |
|---|---|
| Bulk Bag/Unmarked | Not required (Blank) |
| 7" Reel/Unmarked | TU |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2 mm pitch ² | 7081 |
| 13" Reel/Unmarked/2 mm pitch ² | 7082 |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices. For more information see "Capacitor Marking".

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

Benefits cont.

- No piezoelectric noise
- Extremely low ESR and ESL
- · High thermal stability
- High ripple current capability
- Preferred capacitance solution at line frequencies and into SnPb plated termination finish (5% Pb minimum) the MHz range
- · Negligible capacitance change with respect to temperature · Available for other surface mount products, additional from -55°C to +125°C
- No capacitance change with respect to applied rated DC voltage
- · No capacitance decay with time
- Non-polar device, minimizing installation concerns
- Flexible termination option available upon request
- dielectrics and higher voltage ratings upon request

Applications

Typical applications include military, aerospace and other high reliability applications.



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|-------------------------------|-----------------|-------------------------------|----------------------------|---------------------------------|
| 0201 | 0603 | 0.60 (0.024) ±0.03 (0.001) | 0.30 (0.012) ±0.03 (0.001) | | 0.15 (0.006) ±0.05 (0.002) | N/A | Solder Reflow |
| 0402 | 1005 | 1.00 (0.040) ±0.05 (0.002) | 0.50 (0.020) ±0.05 (0.002) | | 0.30 (0.012) ±0.10 (0.004) | 0.30 (0.012) | Only |
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | |
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave or Solder Reflow |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | | |
| 1210 | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | See Table 2 for | 0.50 (0.02) ±0.25 (0.010) | | |
| 1805 | 4513 | 4.50 (0.177) ±0.50 (0.020) | 1.27 (0.050) ±0.38 (0.015) | Thickness | 0.60 (0.024) ±0.35 (0.014) | | |
| 1808 | 4520 | 4.70 (0.185) ±0.50 (0.020) | 2.00 (0.079) ±0.20 (0.008) | | 0.60 (0.024) ±0.35 (0.014) | N/A | |
| 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | | 0.60 (0.024) ±0.35 (0.014) | N/A | Solder Reflow Only |
| 1825 | 4564 | 4.50 (0.177) ±0.30 (0.012) | 6.40 (0.252) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | |
| 2220 | 5650 | 5.70 (0.224) ±0.40 (0.016) | 5.00 (0.197) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | |
| 2225 | 5664 | 5.60 (0.220) ±0.40 (0.016) | 6.40 (0.248) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | |

Qualification/Certification

Commercial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance & Reliability.

Environmental Compliance

These devices do not meet RoHS criteria due to the concentration of Lead (Pb) in the termination finish.



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±30 ppm/°C |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 0% |
| ¹ Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5±1 seconds and charge/discharge not exceeding 50 mA) |
| ² Dissipation Factor (DF) Maximum Limit at 25°C | 0.1% |
| ³ Insulation Resistance (IR) Limit at 25°C | 1,000 megohm microfarads or 100 GΩ (Rated voltage applied for 120±5 seconds at 25°C) |

¹ DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

² Capacitance and dissipation factor (DF) measured under the following conditions:

1 MHz ±100 kHz and 1.0 Vrms ±0.2 V if capacitance \leq 1,000 pF

1 kHz ±50 Hz and 1.0 Vrms ±0.2 V if capacitance > 1,000 pF

³ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Capacitance and Dissipation Factor (DF) measured under the following conditions:

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

Post Environmental Limits

| | High Temperatu | ıre Life, Biased | Humidity, Mois | ture Resistance | • |
|------------|---------------------|----------------------|-----------------------------------|----------------------|--------------------------|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance |
| COG | All | All | 0.5 | 0.3% or ±0.25 pF | 10% of Initial Limit |



Table 1A - Capacitance Range/Selection Waterfall (0402 - 1206 Case Sizes)

| | Can | | С | as S | er | Si ie | izo es | e/ | | | | C |)40 | 2C | | | | | C |)60 | 3C | | | | | C |)80 | 5C | | | | | C 1 | 20 | 6C | | |
|----------------|---------------|----|-----|-------------------|-----|----------|-------------|----|-------|----------------|----------------|------------------|---------|----------|-------|-------|----------|---------|-------------------|----------|------|------|-----|----------|-------------------|----------|----------|------|-------|-----------|------|------------|------------|----------|-----------|-----|-------|
| Сар | Codo | Γ | V | /olt | age | e C | od | e | | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A |
| | Coue | R | ate | d V | olt | age | e (' | VD | C) | 10 | 16 | 25 | 50 | 8 | 500 | 250 | 5 | 16 | 25 | 50 | 8 | 200 | 250 | 5 | 16 | 25 | 50 | 100 | 500 | 250 | 10 | 16 | 25 | 50 | 100 | 200 | 250 |
| | | F | | Cap | aci | itaı | nce | 9 | | | | | Pro | oduc | t Ava | ailat | ilitv | and | Chir | , Thi | ckne | ss C | ode | s – S | ee T | Table | 2 fo | r Ch | in Tl | hick | ness | Dim | ensi | ons | . · | | |
| 0 50 & 0 75 pE | 508 & 758 | R | C | | ler | and | ce | | | RR | RR | RR | RR | | | | | CE | CE | CE. | CE | CF | CE | пи | | | | | | | | | | | | | |
| 0.30 & 0.75 pr | 109 - | Ľ | | 5 | | | | | | | DD | DD | | | | | | | | | | | | | | DN | | | | | | | | | | | |
| 1.0 - 9.1 pF* | 919* | R | C | ט | | | | | | RR | RR | RR | RR | | | | | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | ER | ER | EB | ER | FR | FR | FR |
| 10 - 20 pF* | 100 - 200* | | | | F | G | J | к | М | BB | BB | BB | BB | | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 22 pF | 220 | | | | F | G | J | к | М | BB | BB | BB | BB | | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 24 – 91 pF* | 240 - 910* | | | | F | G | J | к | м | BB | BB | BB | BB | | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 100 pF | 101 | Г | | | F | G | J | к | М | BB | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 110 - 180 pF* | 111 - 181* | | | | F | G | J | K | М | BB | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 200 – 270 pF | 201 - 271* | | | | F | G | J | к | м | BB | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 300 pF | 301 | | | | F | G | J | K | М | BB | BB | BB | BB | BB | BD | BD | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 330 pF | 331 | | | | F | G | J | Κ | М | BB | BB | BB | BB | BB | BD | BD | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 360 pF | 361 | | | | F | G | J | K | М | BB | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 390 pF | 391 | | | | F | G | J | K | М | BB | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 430 pF | 431 | | | | F | G | J | K | M | BB | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 470 pF | 471 | | | | F | G | J | K | M | BB | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DP | DP | EB | EB | EB | EB | EB | EB | EB |
| 510 pF | 511 | | | | F | G | J | K | M | BB | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 560 pF | 561 | | | | F | G | J | K | M | BB | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 620 pF | 621 | | | | F | G | J | K | M | BB | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 680 pF | 681 | | | | F | G | J | K | M | BB | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| /50 pF | /51 | | | | F | G | J | K | M | RR | BB | BB | BB | BB | | | | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 820 pF | 821 | | | | F | G | J | K | M | RR | RR | BB | RR | RR | | | | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 910 pF | 911 | | | | F | G | J | K | M | RR | RR | RR | RR | RR | | | | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DP | DP | EB | EB | EB | EB | EB | EB | EB |
| 1,000 pF | 102 | | | | F | G | J | K | M | RR | RR | RR | RR | RR | | | | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DP | DP | EB | EB | EB | EB | EB | EB | EB |
| 1,100 pF | 112 | | | | F | G | J | K | M | RR | RR | RR | RR | | | | | CF | CF | CF | CF | CH | CH | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 1,200 pF | 122 | | | | F | G | J | K | M | RR | RR | RR | RR | | | | | CF | CF | CF | CF | CH | CH | | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 1,300 pF | 132 | | | | F | G | J | K | M | RR | RR | RR | RR | | | | | CF | CF | CF | CF | CH | CH | DP | DP | DP | DP | DP | DN | DN | EB | EB | EB | EB | EC | EC | EC |
| 1,500 pF | 152 | | | | | G | J | K | M | RR | RR | RR | RB | | | | | CF | CF | CF | CF | CH | CH | DP | | UP DP | | | | | EB | EB | EB | EB | ED | EC | EC |
| 1,600 pF | 102 | | | | | G | J | K | M | RR | RR | RR | | | | | | | | | | | CH | UP DP | | | | 90 | | | EB | EB | EB | EB | ED | ED | ED |
| 1,800 pF | 182 | ┢┍ | | | | 6 | _ J _ (' | | _ IVI | о вв | д ВВ | го В В | 0 | 2 | 2 | 00 | | ۲ دو | <u>ل</u> ات دە | 0 | | | | 0 | <u>יי</u> ש פי | 0P 00 | 0 | 8 | 8 | 1014 | | 5 0 | EB LD | EB EB | | 8 | ED 00 |
| 0 | Cap | ⊢ | | ted Voltage (VDC) | | | | | 6) | - | - | 2 | - CO | 12 | 5 | 26 | <u> </u> | - | 5 | 5 | 1 | 50 | 5 | - | - | 5 | <u>د</u> | 1 | 50 | <u>نة</u> | - | - | 2 | ی د | 1 | 50 | 25 |
| Lap | Code | L | | Voltage Code | | | | | | ð | 4 | 3 | 5 | _ | 2 | A | L × | 4 | 3 | 2 | • | 2 | A | ŏ | 4 | 3 | 5 | | 2 | A | × | 4 | 3 | Ð | <u> </u> | 2 | A |
| | | 1 | Cas | se Size/Series | | | | | | | | C | 040 | 2C | | | | | C | 0603 | BC | | | | | С | 0805 | 5C | | | | | С | 1206 | ίC | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).

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Table 1A – Capacitance Range/Selection Waterfall (0402 – 1206 Case Sizes) cont.

| | Can | Case Size/ Series | | | CO | 40 | 2C | | | | | C |)60 | 3C | | | | | C | 80 | 5C | | | | | C 1 | 20 | 6C | | |
|-----------|------|--------------------------|----|---|----|------|------|-----|------|-------|-----|------|-------|------|-------|-----|-------|------|------|------|------|-------|-------|------|-----|------------|--------|-----|-----|-----|
| Сар | Code | Voltage Code | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A |
| | Coue | Rated Voltage (VDC) | 10 | 16 | 25 | 50 | 00 | 200 | 250 | 10 | 16 | 25 | 50 | 00 | 200 | 250 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 10 | 16 | 25 | 50 | 0 | 500 | 250 |
| | | Capacitance Tolerance | | | | Pro | duct | Ava | ilab | ility | and | Chip |) Thi | ckne | ess C | ode | s – S | ee T | able | 2 fo | r Ch | ip Tł | nickı | iess | Dim | ensi | ons | | | |
| 2,000 pF | 202 | F G J K M | BB | BB | BB | | | | | CF | CF | CF | CF | CF | СН | СН | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | ED | ED | ED |
| 2,200 pF | 222 | F G J K M | BB | BB | BB | | | | | CF | CF | CF | CF | CF | СН | СН | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EE | EE | EE |
| 2,400 pF | 242 | F G J K M | | | | | | | | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EC | EC | EC |
| 2,700 pF | 272 | FGJKM | | | | | | | | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EC | EC | EC |
| 3,000 pF | 302 | F G J K M | | | | | | | | CF | CF | CF | CF | CF | | | DP | DP | DP | DP | DN | DN | DN | EC | EC | EC | EC | EC | EB | EB |
| 3,300 pF | 332 | F G J K M | | | | | | | | CF | CF | CF | CF | CF | | | DP | DP | DP | DP | DN | DN | DN | EC | EC | EC | EC | EE | EB | EB |
| 3,600 pF | 362 | F G J K M | | | | | | | | CF | CF | CF | CF | CF | | | DP | DP | DP | DP | DN | DP | DP | EC | EC | EC | EC | EE | EB | EB |
| 3,900 pF | 392 | FGJKM | | | | | | | | CF | CF | CF | CF | CF | | | DE | DE | DE | DE | DN | DP | DP | EC | EC | EC | EC | EF | EB | EB |
| 4,300 pF | 432 | FGJKM | | | | | | | | CF | CF | CF | CF | CF | | | DE | DE | DE | DE | DN | DP | DP | EC | EC | EC | EC | EC | EB | EB |
| 4,700 pF | 472 | FGJKM | | | | | | | | CF | CF | CF | CF | CF | | | DE | DE | DE | DE | DN | DP | DP | EC | EC | EC | EC | EC | EB | EB |
| 5,100 pF | 512 | FGJKM | | | | | | | | CF | CF | CF | CF | | | | DE | DE | DE | DE | DN | DP | DP | ED | ED | ED | ED | ED | EB | EB |
| 5,600 pF | 502 | FGJKM | | | | | | | | | | | CF | | | | DN | DN | DN | DN | DN | DP | DP | ED | ED | ED | ED | ED | EB | EB |
| 6,200 pF | 602 | FGJKM | | | | | | | | | | | | | | | | | | | | DG | DG | EB | EB | EB | EB | EB | EB | EB |
| 0,800 pF | 082 | FGJKM | | | | | | | | | CF | | CF | | | | | | | | | | | | ED | ED | ED | | | ED |
| 7,500 pF | 022 | | | | | | | | | | | | | | | | | | | | | | | | ED | ED | ED | | | ED |
| 0,200 pF | 022 | FGIKM | | | | | | | | | CF | CF | | | | | | | | | | 00 | 00 | FC | FC | FC | FC | EB | EC | EC |
| 10 000 pF | 103 | F G J K M | | | | | | | | CE | CE | CF | | | | | | | | DN | DP | | | ED | ED | ED | ED | FR | EC | EC |
| 12 000 pF | 123 | FGJKM | | | | | | | | CF | CF | CF | | | | | DN | | | | DF | | | FR | FR | FR | FR | FB | FD | FD |
| 15 000 pF | 153 | FGJKM | | | | | | | | CF | CF | CF | | | | | DN | DN | DN | DP | DG | | | FB | FB | FB | FB | FB | FF | FF |
| 18.000 pF | 183 | FGJKM | | | | | | | | 0. | 0. | 0. | | | | | DN | DN | DN | DP | 20 | | | EB | EB | EB | EB | EB | EH | EH |
| 22.000 pF | 223 | FGJKM | | | | | | | | | | | | | | | DP | DP | DP | DF | | | | EB | EB | EB | EB | EC | EH | EH |
| 27,000 pF | 273 | F G J K M | | | | | | | | | | | | | | | DF | DF | DF | | | | | EB | EB | EB | EB | EE | | |
| 33,000 pF | 333 | FGJKM | | | | | | | | | | | | | | | DG | DG | DG | | | | | EB | EB | EB | EB | EE | | |
| 39,000 pF | 393 | F G J K M | | | | | | | | | | | | | | | DG | DG | DG | | | | | EC | EC | EC | EE | EH | | |
| 47,000 pF | 473 | F G J K M | | | | | | | | | | | | | | | DG | DG | DG | | | | | EC | EC | EC | EE | EH | | |
| 56,000 pF | 563 | F G J K M | | | | | | | | | | | | | | | | | | | | | | ED | ED | ED | EF | | | |
| 68,000 pF | 683 | F G J K M | | | | | | | | | | | | | | | | | | | | | | EF | EF | EF | EH | | | |
| 82,000 pF | 823 | F G J K M | | | | | | | | | | | | | | | | | | | | | | EH | EH | EH | EH | | | |
| 0.10 µF | 104 | F G J K M | | | | | | | | | | | | | | | | | | | | | | EH | EH | EH | | | | |
| 68,000 pF | 683 | F G J K M | | | | | | | | | | | | | | | | | | | | | | EF | EF | EF | EH | | | |
| 82,000 pF | 823 | F G J K M | | | | | | | | | | | | | | | | | | | | | | EH | EH | EH | EH | | | |
| 0.10 µF | 104 | F G J K M | | | | | | - | - | | | | | - | 6 | - | | | | | - | - | - | EH | EH | EH | | | | |
| | Con | Rated Voltage (VDC) | 2 | 10 16 25 50 100 250 250 | | | | | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 2 | 16 | 25 | 50 | 100 | 200 | 250 | 2 | 16 | 25 | 50 | j 0 | 200 | 250 | |
| Cap | Code | Voltage Code | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A |
| | | Case Size/Series | | | C | 0402 | 2C | | | | | C | 0603 | BC | | | | | C | 0805 | 5C | | | | | C | 1206 | C | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).

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Table 1B - Capacitance Range/Selection Waterfall (1210 - 1812 Case Sizes)

| | | C | ase | e S | Siz | e/S | Ser | ie | 5 | | | C | 1210 |)C | | - | C | 1805 | 5C | | C18 | 08C | - | | C18 | 12C | |
|---------------------------|------------|---|------|----------------|------|--------------|------|----|---|----|------|----------|-------|-----|-------|--------|--------------|--------|--------|--------|-------|-------|-----|-----|------------|-----------|------------|
| 0.00 | Oon Oodo | | | Volt | tage | e Co | de | | | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | 5 | 1 | 2 | A | 5 | 1 | 2 | A |
| Cap | Cap Code | | Rate | ed V | /olt | age | (VD | C) | | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 |
| | | | 2020 | oita | nor | . Т <i>с</i> | Jor | | • | | | | | | Produ | ct Ava | ilabil | ity an | d Chip | Thic | kness | Code | s | | | | |
| | 100 0101 | | apau | | | | | | - | 50 | 50 | | | 50 | See | Table | <u>2 for</u> | Chip 1 | Thickr | iess D | imen | sions | | | | | |
| 1.0 - 9.1 pF* | 109 - 919* | в | C | D | E | G | | ĸ | м | FB | FB | FB | FB | FB | FB | FB | | | | | | | | | | | |
| 100 - 300 nF* | 101 - 201* | | | | F | G | .1 | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | | | | | |
| 220 pF | 221 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | NC | NC | NC | | | | | | | | |
| 240 pF | 241 | | | | F | G | J | К | М | FB | FB | FB | FB | FB | FB | FB | NC | NC | NC | | | | | | | | |
| 270 pF | 271 | | | | F | G | J | К | М | FB | FB | FB | FB | FB | FB | FB | NC | NC | NC | | | | | | | | |
| 300 pF | 301 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | NC | NC | NC | | | | | | | | |
| 330 - 430 pF* | 331 - 431* | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | NC | NC | NC | | | | | CD. | CD | <u>op</u> | CD |
| 470 - 910 pF* 1 000 pF | 471-911* | | | | F | G | J | ĸ | M | FB | FB | FB | FB | FB | FB | FB | | NC | | | | | | GB | GB | GB | GB |
| 1,000 pr | 112 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | NC | NC | NO | LF | LF | LF | LF | GB | GB | GB | GB |
| 1,200 pF | 122 | | | | F | G | J | к | М | FB | FB | FB | FB | FB | FB | FB | NC | NC | | LF | LF | LF | LF | GB | GB | GB | GB |
| 1,300 pF | 132 | | | | F | G | J | К | М | FB | FB | FB | FB | FB | FC | FC | NC | NC | | LF | LF | LF | LF | GB | GB | GB | GB |
| 1,500 pF | 152 | | | | F | G | J | К | М | FB | FB | FB | FB | FB | FE | FE | NC | NC | | LF | LF | LF | LF | GB | GB | GB | GB |
| 1,600 pF | 162 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FE | FE | NC | NC | | | LF | | LF | GB | GB | GB | GB |
| 1,800 pF | 182 | | | | | G | J | ĸ | M | FB | - FR | FB | FB | FR | FE | | | NC | | | | | | GB | GB | GB | GB |
| 2,000 pF | 202 | | | | F | G | J | ĸ | M | FB | FB | FB | FB | FC | FG | FG | NC | NC | | | | | IF | GB | GB | GB | GB |
| 2,400 pF | 242 | | | | F | G | J | K | M | FB | FB | FB | FB | FC | FC | FC | NC | NC | | LF | LF | LF | LF | 05 | 0.5 | 0.5 | 0.5 |
| 2,700 pF | 272 | | | | F | G | J | К | М | FB | FB | FB | FB | FC | FC | FC | NC | NC | | LF | LF | LF | LF | GB | GB | GB | GB |
| 3,000 pF | 302 | | | | F | G | J | К | М | FB | FB | FB | FB | FC | FF | FF | | | | LF | LF | | | | | | |
| 3,300 pF | 332 | | | | F | G | J | K | M | FB | FB | FB | FB | FF | FF | FF | | | | | | | | GB | GB | GB | GB |
| 3,600 pF | 302 | | | | F | G | J | ĸ | M | FB | FB | FB | FB | FF | | | | | | | | | | GB | GB | GB | GB |
| 4.300 pF | 432 | | | | F | G | J | K | M | FB | FB | FB | FB | FF | FF | FF | | | | | LF | | | 60 | 60 | 00 | GD |
| 4,700 pF | 472 | | | Т | F | G | J | K | Μ | FF | FF | FF | FF | FG | FG | FG | | | | LF | LF | | | GB | GB | GD | GD |
| 5,100 pF | 512 | | | | F | G | J | К | м | FB | FB | FB | FB | FG | FG | FG | | | | | | | | | | | |
| 5,600 pF | 562 | | | | F | G | J | K | M | FB | FB | FB | FB | FG | FG | FG | | | | | | | | GB | GB | GH | GH |
| 6,200 pF | 622 | | | | F | G | J | K | M | FB | FB | FB | FB | FG | FB | FB | | | | | | | | CP | CP | <u> </u> | <u>с</u> т |
| 7 500 pF | 752 | | | | F | G | J | K | M | FC | FC | FC | FC | FC | FB | FB | | | | | | | | GD | GD | GJ | GJ |
| 8,200 pF | 822 | | | | F | G | J | K | M | FC | FC | FC | FC | FC | FB | FB | | | | | | | | GB | GH | GB | GB |
| 9,100 pF | 912 | | | | F | G | J | к | М | FE | FE | FE | FE | FE | FB | FB | | | | | | | | | | | |
| 10,000 pF | 103 | | | | F | G | J | К | М | FF | FF | FF | FF | FF | FB | FB | | | | | | | | GB | GH | GB | GB |
| 12,000 pF | 123 | | | | F | G | J | K | M | FG | FG | FG | FG | FB | FB | FB | | | | | | | | GB | GG | GB | GB |
| 15,000 pF | 153 | | | | F | G | J | ĸ | M | FG | FG | FG | FG | FB | FC | | | | | | | | | GB | GB | GB | GB |
| 22.000 pF | 223 | | | | F | G | J | ĸ | M | FB | FB | FB | FB | FB | FF | FF | | | | | | | | GB | GB | GB | GB |
| 27,000 pF | 273 | | | | F | G | J | ĸ | M | FB | FB | FB | FB | FB | FG | FG | | | | | | | | GB | GB | GB | GB |
| 33,000 pF | 333 | | | | F | G | J | К | М | FB | FB | FB | FB | FB | FH | FH | | | | | | | | GB | GB | GB | GB |
| 39,000 pF | 393 | | | | F | G | J | K | Μ | FB | FB | FB | FB | FE | FH | FH | | | | | | | | GB | GB | GB | GB |
| 47,000 pF | 473 | | | | F | G | J | K | M | FB | FB | FB | FB | FE | FJ | FJ | | | | | | | | GB | GB | GD | GD |
| 56,000 pF | 683 | | | | F | G | J | K | M | FB | FB | FB | FB | FG | | | | | | | | | | GB | GB | GN | GN |
| 82.000 pF | 823 | | | | F | G | J | ĸ | M | FC | FC | FC | FF | FH | | | | | | | | | | GB | GB | GM | GM |
| 0.10 µF | 104 | | | | F | G | J | К | М | FE | FE | FE | FG | FM | | | | | | | | | | GB | GD | GM | GM |
| 0.12 µF | 124 | | | | F | G | J | К | М | FG | FG | FG | FH | | | | | | | | | | | GB | GH | | |
| 0.15 µF | 154 | | | | F | G | J | K | M | FH | FH | FH | FM | | | | | | | | | | | GD | GN | | |
| 0.18 µF | 184 | | | | F | G | J | K | M | FJ | FJ | FJ EV | | | | | | | | | | | | GH | | | |
| 0.22 μF 0.27 μF | 274 | | | | F | G | J | K | M | ΓŇ | FN | ΓŇ | | | | | | | | | | | | GK | | | |
| 0.33 µF | 334 | | | | F | G | J | K | M | | | | | | | | | | | | | | | | | | |
| 0.39 µF | 394 | | | | F | G | J | Κ | М | | | | | | | | | | | | | | | | | | |
| 0.47 µF | 474 | | | | F | G | J | Κ | М | | | | | - | - | 5 | | 5 | - | | | | 5 | | - | - | |
| | | | Rate | ed V | /olt | age | (VD | C) | | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 |
| Cap | Cap Code | | | Voltage Code 8 | | | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | | | |
| | | | Ca | se S | Siz | e/S | erie | s | | | | | C1210 | C | | | 0 | C1805 | C | | C18 | 08C | | | C18 | 12C | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions). These products are protected under US Patents 7,172,985 and 7,670,981, other patents pending, and any foreign counterparts.



Table 1C - Capacitance Range/Selection Waterfall (1825 - 2225 Case Sizes)

| | | Ca | se S | ize, | /Ser | ies | | C18 | 25C | | | C22 | 20C | | | C22 | 25C | |
|-----------|----------|-----|----------------------------------|--------|--------|------|----|-----|------|------------------|------------------------|-------------------------|----------------------|---------------------|---------|-----|-----|----------|
| 0.00 | Osn Osda | | Vol | tage (| Code | | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 5 | 1 | 2 | A |
| Cap | Cap Code | R | ated \ | /oltag | je (VD | C) | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 |
| | | Cap | acita | nce | Folera | ance | | | | Product See T | t Availat able 2 fo | oility and or Chip 1 | d Chip T Thicknes | hicknes ss Dimer | s Codes | | | |
| 3,900 pF | 392 | F | G | J | K | М | HB | HB | HB | HB | | | | | | | | |
| 4,700 pF | 472 | F | G | J | K | M | HB | HB | HB | HB | | | | | KE | KE | KE | KE |
| 5,100 pF | 512 | F | G | J | K | M | | | | | | | | | KE | KE | KE | KE |
| 5,600 pF | 562 | F | G | J | K | M | HB | HB | HB | HB | | | | | KE | KE | KE | KE |
| 6,200 pF | 622 | F | G | J | K | M | | | | | | | | | KE | KE | KE | KE |
| 6,800 pF | 682 | F | G | J | K | M | HB | HB | HB | HB | JE | JE | JB | | KE | KE | KE | KE |
| 7,500 pF | 752 | F | G | J | K | М | | | | | | | | | KE | KE | KE | KE |
| 8,200 pF | 822 | F | G | J | K | M | НВ | HB | НВ | HB | JE | JE | JB | | KE | KE | KE | KE |
| 9,100 pF | 912 | F | G | J | К | М | | | | | | | | | KE | KE | KE | KE |
| 10,000 pF | 103 | F | G | J | К | М | НВ | HB | HE | HE | JE | JE | JB | | KE | KE | KE | KE |
| 12,000 pF | 123 | F | G | J | K | М | НВ | HB | HE | HE | JE | JE | JB | | KE | KE | KE | KE |
| 15,000 pF | 153 | F | G | J | к | м | НВ | HB | | | JE | JE | JB | | KE | KE | KE | KE |
| 18.000 pF | 183 | F | G | J | к | м | НВ | HE | | | JE | JE | JB | | КЕ | KE | | |
| 22.000 pF | 223 | F | G | J | к | м | НВ | HE | | | JE | JB | JB | | КЕ | KE | | |
| 27.000 pF | 273 | F | G | J | K | M | НВ | HG | | | JE | JB | JB | | KE | KE | | |
| 33.000 pF | 333 | F | G | J | K | M | | | | | JB | JB | JB | | KE | | | |
| 39.000 pF | 393 | F | G | J | ĸ | M | | | | | JB | JB | JB | | | | | |
| 47 000 pF | 473 | F | G | J. | ĸ | M | | | | | JB | JB | JB | | | | | |
| 56 000 pF | 563 | F | G | Ĵ | ĸ | M | | | | | JB | JB | JB | | | | | |
| 68 000 pF | 683 | F | G | J | ĸ | M | | | | | JB | JB | JB | | | | | |
| 82 000 pF | 823 | F | G | J | K | M | | | | | JB | JB | JB | | | | | |
| 0.10 µF | 104 | F | G | J | ĸ | M | | | | | JB | JB | JD | | | | | |
| 0.12 µF | 124 | F | G | J | ĸ | M | | | | | JB | JB | JD | | | | | |
| 0.15 µF | 154 | F | G | J | ĸ | M | | | | | JB | JB | JG | | | | | |
| 0.18 µF | 184 | F | G | Ĭ | ĸ | M | | | | | IR | ID | IG | | | | | |
| 0.22 µF | 224 | F | G | 1 | ĸ | M | | | | | IR | ID | 11 | | | | | |
| 0.22 µi | 224 | I F | G | Ĭ | ĸ | M | | | | | IB | IF | | | | | | |
| 0.27 µr | 334 | | G | Ĭ | ĸ | M | | | | | in | in | | | | | | |
| 0.30 µF | 304 | | G | | ĸ | M | | | | | 16 | 00 | | | | | | |
| 0.35 µl | 171 | | G | 1 | ĸ | M | | | | | 10 | | | | | | | |
| υ/ μι | | R | F G J K M Rated Voltage (VDC) | | | | 20 | 0 | 00 | 250 | 20 | 00 | 00 | 250 | 20 | 00 | 00 | 250 |
| Сар | Cap Code | | Voltage Code | | | | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 5 | 1 | 2 | A |
| | | | ase | Size/ | Serie | s | | C18 | 825C | 1 | | C22 | 20C | 1 | | C22 | 25C | <u> </u> |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).

These products are protected under US Patents 7,172,985 and 7,670,981, other patents pending, and any foreign counterparts.



Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic | Quantity |
|-----------|-------------------|------------------------------------|---------|----------------------|---------|----------|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| BB | 0402 | 0.50 ± 0.05 | 10,000 | 50,000 | 0 | 0 |
| BD | 0402 | 0.55 ± 0.05 | 10,000 | 50,000 | 0 | 0 |
| CF | 0603 | 0.80 ± 0.07 | 4,000 | 15,000 | 0 | 0 |
| СН | 0603 | 0.85 ± 0.07 | 4,000 | 10,000 | 0 | 0 |
| DN | 0805 | 0.78 ± 0.10 | 4,000 | 15,000 | 0 | 0 |
| DP | 0805 | 0.90 ± 0.10 | 4,000 | 15,000 | 0 | 0 |
| DE | 0805 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| DF | 0805 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EB | 1206 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| EC | 1206 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| ED | 1206 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| | 1206 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| | 1200 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| | 1200 | 1.00 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| | 1210 | 0.78 ± 0.10 | | | 4,000 | |
| | 1210 | 0.90 ± 0.10 1 00 ± 0 10 | 0 | 0 | 4,000 | 10,000 |
| | 1210 | 1.00 ± 0.10 1 10 + 0 10 | | 0 | 2,500 | |
| FG | 1210 | 1.10 ± 0.10 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| FH | 1210 | 1.25 ± 0.15 | 0 | 0 | 2,000 | 8 000 |
| FM | 1210 | 1 70 + 0 20 | 0 | 0 | 2,000 | 8 000 |
| E.J | 1210 | 1 85 + 0 20 | 0 | 0 0 | 2 000 | 8,000 |
| FK | 1210 | 2.10 + 0.20 | 0 | Ő | 2,000 | 8,000 |
| NC | 1805 | 1.00 ± 0.15 | 0 | 0 | 4.000 | 10.000 |
| LF | 1808 | 1.00 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GD | 1812 | 1.25 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GH | 1812 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GG | 1812 | 1.55 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GK | 1812 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GJ | 1812 | 1.70 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GN | 1812 | 1.70 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GM | 1812 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| HB | 1825 | 1.10 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| HE HE | 1825 | 1.40 ± 0.15 | | | 1,000 | 4,000 |
| HG | 1825 | 1.60 ± 0.20 | 0 | U C | 1,000 | 4,000 |
| JR | 2220 | 1.00 ± 0.15 | | | 1,000 | 4,000 |
| | 2220 | 1.30 ± 0.15 | | | 1,000 | 4,000 |
| JE | 2220 | 1.40 ± 0.15 1.50 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| IG | 2220 | 1.30 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| 11 | 2220 1.70 ± 0.15 | 2 00 + 0 20 | 0 | 0 | 500 | 2,000 |
| KE | 2225 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic | Quantity |

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".


Table 2B - Bulk Packaging Quantities

| Deeke | ning Tune | Loose P | Loose Packaging | | | | |
|----------|------------------------|------------------------|------------------------|--|--|--|--|
| Раска | Jing Type | Bulk Bag | Bulk Bag (default) | | | | |
| Packagi | ng C-Spec ¹ | N | /A ² | | | | |
| Cas | e Size | Packaging Quantities (| pieces/unit packaging) | | | | |
| EIA (in) | Metric (mm) | Minimum | Maximum | | | | |
| 0402 | 1005 | | | | | | |
| 0603 | 1608 | | | | | | |
| 0805 | 2012 | | 50,000 | | | | |
| 1206 | 3216 | | | | | | |
| 1210 | 3225 | 1 | | | | | |
| 1808 | 4520 | | | | | | |
| 1812 | 4532 | | | | | | |
| 1825 | 4564 | | 20,000 | | | | |
| 2220 | 5650 | | | | | | |
| 2225 | 5664 | | | | | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial Grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive Grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size | Metric Size | Density Level A: Maximum (Most) Land Protrusion (mm) | | I | Density Level B: Median (Nominal) Land Protrusion (mm) | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | | | |
|-------------------|----------------|--|------|------|--|------|------|---|------|------|------|------|------|------|------|------|
| Goue | Coue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 |
| 1210 ¹ | 3225 | 1.50 | 1.60 | 2.90 | 5.60 | 3.90 | 1.40 | 1.40 | 2.80 | 4.70 | 3.30 | 1.30 | 1.20 | 2.70 | 4.00 | 3.00 |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 |
| 1825 | 4564 | 2.15 | 1.60 | 6.90 | 6.90 | 7.90 | 2.05 | 1.40 | 6.80 | 6.00 | 7.30 | 1.95 | 1.20 | 6.70 | 5.30 | 7.00 |
| 2220 | 5650 | 2.75 | 1.70 | 5.50 | 8.20 | 6.50 | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | 2.55 | 1.30 | 5.30 | 6.60 | 5.60 |
| 2225 | 5664 | 2.70 | 1.70 | 6.90 | 8.10 | 7.90 | 2.60 | 1.50 | 6.80 | 7.20 | 7.30 | 2.50 | 1.30 | 6.70 | 6.50 | 7.00 |

¹ Only for capacitance values $\ge 22 \ \mu F$

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Termination Finish | | | | |
|--|-----------------------|-----------------------|--|--|--|
| Tomeredure | SnPb | 100% Matte Sn | | | |
| Preheat/Soak | | | | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C | | | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | | | |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds | | | |
| Ramp-Up Rate $(T_L to T_P)$ | 3°C/second maximum | 3°C/second maximum | | | |
| Liquidous Temperature (T_L) | 183°C | 217°C | | | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | | | |
| Peak Temperature (T _P) | 235°C | 260°C | | | |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum | 30 seconds maximum | | | |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | 6°C/second maximum | | | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | | | |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method | | | |
|---|-----------------------------------|--|--|--|--|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds. | | | |
| Board Flex | JIS-C-6429 | Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm for COG. Flexible termination system – 3.0 mm (minimum). | | | |
| | | Magnification 50 X. Conditions: | | | |
| Solderability | I-STD-002 | a) Method B, 4 hours at 155°C, dry heat at 235°C | | | |
| Solderability | J-31D-002 | b) Method B at 215°C category 3 | | | |
| | | c) Method D, category 3 at 260°C | | | |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 Cycles (-55°C to +125°C). Measurement at 24 hours \pm 4 hours after test conclusion. | | | |
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and rated voltage. Add 100 K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. | | | |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours ±4 hours after test conclusion. | | | |
| Thermal Shock | MIL-STD-202 Method 107 | -55°C/+125°C. Note: Number of cycles required – 300, maximum transfer time – 20 seconds, dwell time – 15 minutes. Air – Air. | | | |
| High Temperature Life | MIL-STD-202 Method 108/EIA-198 | 1,000 hours at 125°C (85°C for X5R, Z5U and Y5V) with 2 X rated voltage applied. | | | |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC for 1,000 hours. | | | |
| Vibration MIL-STD-202 5 Method 204 m | | 5 g's for 20 min., 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz | | | |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Condition F. | | | |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. | | | |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature-reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction



Capacitor Marking (Optional)

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- · EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punche | d Paper | |
|----------------------|------|---------|--------------------|--------------------------|----------|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | (W)* | Pitch | (P ₁)* | Pitch (P ₁)* | | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 | |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | |
| Array 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|--|--|----------------------------------|---------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) |) 1.75 ±0 0.0) 1.5 (0.069 ±0 | | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.600 30 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | |
| 16 mm | | (0.059) | | | | (1.181) | | | | |
| Variable Dimensions – Millimeters (Inches) | | | | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | Note 5 | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | | | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|--|--|---|----------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|--|
| Tape Size | D _o | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.104.0 ±0.10(0.069 ±0.004)(0.157 ±0.004) | | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | | |
| Variable Dimensions – Millimeters (Inches) | | | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | | | |
|--|--|---------------------------------------|--|--|--|--|--|--|--|
| Tape Size | А | B Minimum | C | D Minimum | | | | | |
| 8 mm | 178 ±0.20 | | | | | | | | |
| 12 mm | Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | | | |
| 16 mm | (13.000 ±0.008) | | X | | | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | | | |
| 16 mm | 16 mm | | 22.4 (0.882) | | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Overview

KEMET Power Solutions (KPS) Commercial Series stacked capacitors utilize a proprietary lead-frame technology to vertically stack one or two multilayer ceramic chip capacitors into a single compact surface mount package. The attached lead-frame mechanically isolates the capacitor/s from the printed circuit board, therefore offering advanced mechanical and thermal stress performance. Isolation also addresses concerns for audible, microphonic noise that may occur when a bias voltage is applied. A two chip stack offers up to double the capacitance in the same or smaller design footprint when compared to traditional surface mount MLCCs devices. Providing up to 10 mm of board flex capability, KPS Series capacitors are environmentally friendly and in compliance with RoHS legislation. Available in X7R dielectric, these devices are capable of Pb-Free reflow profiles and provide lower ESR, ESL and higher ripple current capability when compared to other dielectric solutions.

Combined with the stability of an X7R dielectric, KEMET's KPS Series devices exhibit a predictable change in capacitance with respect to time and voltage and boast a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to $\pm 15\%$ from -55° C to $\pm 125^{\circ}$ C.

Benefits

- -55°C to +125°C operating temperature range
- Reliable and robust termination system
- EIA 1210, 1812, and 2220 case sizes
- DC voltage ratings of 10 V, 16 V, 25 V, 50 V, 100 V, and 250 V
- Capacitance offerings ranging from 0.1 μF up to 47 μF
- Available capacitance tolerances of ±10% and ±20%
- Higher capacitance in the same footprint
- · Potential board space savings



Ordering Information

| С | 2220 | С | 106 | М | 5 | R | 2 | C | 7186 |
|---------|------------------------|--------------------------|--|---------------------------------------|--|------------|--|-------------------------------|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance ¹ | Rated Voltage (VDC) | Dielectric | Failure Rate/Design | Leadframe Finish ² | Packaging/ Grade (C-Spec) |
| | 1210 1812 2220 | C = Standard | Two significant digits and number of zeros | K = ±10% M = ±20% | 8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 A = 250 | R = X7R | 1 = KPS Single Chip Stack 2 = KPS Double Chip Stack | C = 100% Matte Sn | See "Packaging C-Spec Ordering Options Table" |

¹ Double chip stacks ("2" in the 13th character position of the ordering code) are only available in M (±20%) capacitance tolerance. Single chip stacks ("1" in the 13th character position of the ordering code) are available in K (±10%) or M (±20%) tolerances.

² Additional leadframe finish options may be available. Contact KEMET for details.



Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) ² |
|---|--|
| 7" Reel (Embossed Plastic Tape)/Unmarked | 7186 |
| 13" Reel (Embossed Plastic Tape)/Unmarked | 7289 |

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices. For more information see "Capacitor Marking".

Benefits cont.

- Advanced protection against thermal and mechanical stress
- Provides up to 10 mm of board flex capability
- Reduces audible, microphonic noise
- Extremely low ESR and ESL

- Lead (Pb)-free, RoHS and REACH compliant
- · Capable of Pb-free reflow profiles
- · Non-polar device, minimizing installation concerns
- Tantalum and electrolytic alternative

Applications

Typical applications include smoothing circuits, DC/DC converters, power supplies (input/output filters), noise reduction (piezoelectric/mechanical), circuits with a direct battery or power source connection, critical and safety relevant circuits without (integrated) current limitation and any application that is subject to high levels of board flexure or temperature cycling. Markets include industrial, military, automotive and telecom.

Qualification/Certification

Commercial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance & Reliability.

Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions.



Dimensions – Millimeters (Inches)









Single Chip Stack

| Number of Chips | EIA Size Code | Metric Size Code | L Length | W Width | H Height | LW Lead Width | Mounting Technique |
|--------------------|------------------|---------------------|-------------------------------|-------------------------------|--|-------------------------------|-----------------------|
| | 1210 | 3225 | 3.50 (0.138) ±0.30 (0.012) | 2.60 (0.102) ±0.30 (0.012) | 3.35 (0.132) ±0.10 (0.004) | 0.80 (0.032) ±0.15 (0.006) | |
| Single | 1812 | 4532 | 5.00 (0.197) ±0.50 (0.020) | 3.50 (0.138) ±0.50 (0.020) | 2.65 (0.104) ±0.35 (0.014) | 1.10 (0.043) ±0.30 (0.012) | |
| | 2220 | 5650 | 6.00 (0.236) ±0.50 (0.020) | 5.00 (0.197) ±0.50 (0.020) | 3.50 (0.138) ±0.30 (0.012) | 1.60 (0.063) ±0.30 (0.012) | Solder Reflow |
| | 1210 | 3225 | 3.50 (0.138) ±0.30 (0.012) | 2.60 (0.102) ±0.30 (0.012) | 6.15 (0.242) ±0.15 (0.006) | 0.80 (0.031) ±0.15 (0.006) | Only |
| Double | 1812 | 4532 | 5.00 (0.197) ±0.50 (0.020) | 3.50 (0.138) ±0.50 (0.020) | 5.00 (0.197) -1.00/+0.50 (-0.040/+0.020) | 1.10 (0.043) ±0.30 (0.012) | |
| | 2220 | 5650 | 6.00 (0.236) ±0.50 (0.020) | 5.00 (0.197) ±0.50 (0.020) | 5.00 (0.197) ±0.50 (0.020) | 1.60 (0.063) ±0.30 (0.012) | |

Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|--|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 Vdc Applied (TCC) | ±15% |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| ² Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5±1 seconds and charge/discharge not exceeding 50mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | 5%(10V), 3.5%(16V and 25V) and 2.5%(50V to 250V) |
| ^₄ Insulation Resistance (IR) Minimum Limit at 25°C | See Insulation Resistance Limit Table (Rated voltage applied for 120±5 seconds at 25°C) |

¹ Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 48 or 1,000 hours. Please refer to a part number specific datasheet for referee time details.

² DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

³ Capacitance and dissipation factor (DF) measured under the following conditions:

1 kHz ±50 Hz and 1.0 ±0.2 Vrms if capacitance \leq 10 μ F

120 Hz ±10 Hz and 0.5 ±0.1 Vrms if capacitance > 10 μF

⁴ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."



Post Environmental Limits

| | High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | | |
|------------|---|----------------------|-----------------------------------|----------------------|--------------------------|--|--|--|--|--|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | | | | | |
| | > 25 | | 3.0 | | | | | | | |
| X7R | 16/25 | All | 5.0 | ±20% | 10% of Initial Limit | | | | | |
| | < 16 | | 7.5 | | Limit | | | | | |

Insulation Resistance Limit Table

| EIA Case Size | 1,000 Megohm Microfarads or 100 GΩ | 500 Megohm Microfarads or 10 GΩ |
|---------------|---------------------------------------|------------------------------------|
| 1210 | < 0.39 µF | ≥ 0.39 µF |
| 1812 | < 2.2 µF | ≥ 2.2 µF |
| 2220 | < 10 µF | ≥ 10 µF |

Electrical Characteristics

Z and ESR C1210C475M5R1C



Z and ESR C2220C225MAR2C





Z and ESR C2220C476M3R2C



Impedance - 1812, .10 µF, 50 V X7R



Impedance - 1210, .22 µF, 50 V X7R



ESR - 1812, .10 µF, 50 V X7R



ESR - 1210, .22 µF, 50 V X7R





Microphonics - 1210, 4.7 µF, 50 V, X7R



Microphonics – 2220, 47 μF , 25 V, X7R



Competitive Comparision

Ripple Current (A $_{\rm rms}$) 2220, 22 $\mu F\!\!\!\!$, 50 V



Microphonics - 2220, 22 µF, 50 V, X7R



Microphonics – 1210, 22 μ F, 25 V, X7R





Board Flex vs. Termination Type



Board Flexure to 10 mm



Board Flex vs. Termination Type



Board Flexure to 10 mm





Table 1 – Capacitance Range/Selection Waterfall (1210 – 2220 Case Sizes)

| | | Case Size/Series | | | | C1 | 210C | | | | (| C181 | 2 C | | | C | 2220 | C | |
|-------------|------|-------------------------|-------------------|----|----|-----|--------|-------|----------------------|--------------------|-----------------|------------------|-------------------|--------------------|----------|----|------|-----|-----|
| | Cap | Voltag | e Code | 8 | 4 | 3 | 5 | 1 | A | 4 | 3 | 5 | 1 | A | 4 | 3 | 5 | 1 | Α |
| Capacitance | Code | Rated Vol | age (VDC) | 10 | 16 | 25 | 50 | 100 | 250 | 16 | 25 | 50 | 100 | 250 | 16 | 25 | 50 | 100 | 250 |
| | | Capacitanc | e Tolerance | | | | | Pr | oduct Av See Tabl | vailabi e 2 for | lity an Chip | d Chip Thickn | Thickn ess Din | ess Coo nension | les s | | | | |
| | | | Single Chip Stack | | | | | | | | | | | | | | | | |
| 0.10 µF | 104 | K | М | FV | FV | FV | FV | FV | FV | GP | GP | GP | GP | GP | JP | JP | JP | JP | JP |
| 0.22 µF | 224 | К | M | FV | FV | FV | FV | FV | | GP | GP | GP | GP | GP | JP | JP | JP | JP | JP |
| 0.47 µF | 474 | К | M | FV | FV | FV | FV | FV | | GP | GP | GP | GP | GP | JP | JP | JP | JP | JP |
| 1.0 µF | 105 | К | M | FV | FV | FV | FV | FV | | GP | GP | GP | GP | | JP | JP | JP | JP | JP |
| 2.2 µF | 225 | К | М | FV | FV | FV | FV | FV | | GP | GP | GP | | | JP | JP | JP | JP | |
| 3.3 µF | 335 | К | M | FV | FV | FV | FV | | | GP | GP | GP | | | JP | JP | JP | JP | |
| 4.7 μF | 475 | К | M | FV | FV | FV | FV | | | GP | GP | GP | | | JP | JP | JP | | |
| 10 µF | 106 | К | M | FV | FV | FV | | | | GP | GP | | | | JP | JP | JP | | |
| 15 µF | 156 | к | M | FV | | | | | | | | | | | JP | JP | | | |
| 22 µF | 226 | К | M | FV | | | | | | | | | | | JP | JP | | | |
| | | | | | | Dou | ible C | hip S | tack | | | | | | | | | | |
| 0.10 µF | 104 | | M | FW | FW | FW | FW | FW | FW | GR | GR | GR | GR | GR | JR | JR | JR | JR | JR |
| 0.22 µF | 224 | | M | FW | FW | FW | FW | FW | FW | GR | GR | GR | GR | GR | JR | JR | JR | JR | JR |
| 0.47 µF | 474 | | M | FW | FW | FW | FW | FW | | GR | GR | GR | GR | GR | JR | JR | JR | JR | JR |
| 1.0 μF | 105 | | M | FW | FW | FW | FW | FW | | GR | GR | GR | GR | GR | JR | JR | JR | JR | JR |
| 2.2 µF | 225 | | М | FW | FW | FW | FW | FW | | GR | GR | GR | GR | | JR | JR | JR | JR | JR |
| 3.3 µF | 335 | | M | FW | FW | FW | FW | FW | | GR | GR | GR | GR | | JR | JR | JR | JR | |
| 4.7 µF | 475 | | M | FW | FW | FW | FW | FW | | GR | GR | GR | | | JR | JR | JR | JR | |
| 10 µF | 106 | | M | FW | FW | FW | FW | | | GR | GR | GR | | | JR | JR | JR | | |
| 22 µF | 226 | | M | FW | FW | FW | | | | GR | GR | | | | JR | JR | JR | | |
| 33 µF | 336 | | М | FW | | | | | | | | | | | JR | JR | | | |
| 47 μF | 476 | | м | FW | | | | | | | | | | | JR | JR | | | |
| | | Rated Vol | age (VDC) | 10 | 16 | 25 | 50 | 100 | 250 | 16 | 25 | 50 | 100 | 250 | 16 | 25 | 50 | 100 | 250 |
| Capacitance | Сар | Voltag | e Code | 8 | 4 | 3 | 5 | 1 | A | 4 | 3 | 5 | 1 | A | 4 | 3 | 5 | 1 | A |
| | Code | Case Siz | Case Size/Series | | ° | C1 | 210C | | | | (| C181: | 2 C | | | C | 2220 | C | |

These products are protected under US Patent 8,331,078 other patents pending, and any foreign counterparts.



| Thickness | Case | Thickness ± | Paper C |)uantity | Plastic (| Quantity |
|-----------|------|-------------|---------|----------|-----------|----------|
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| FV | 1210 | 3.35 ± 0.10 | 0 | 0 | 600 | 2,000 |
| FW | 1210 | 6.15 ± 0.15 | 0 | 0 | 300 | 1,000 |
| GP | 1812 | 2.65 ± 0.35 | 0 | 0 | 500 | 2,000 |
| GR | 1812 | 5.00 ± 0.50 | 0 | 0 | 400 | 1,700 |
| JP | 2220 | 3.50 ± 0.30 | 0 | 0 | 300 | 1,300 |
| JR | 2220 | 5.00 ± 0.50 | 0 | 0 | 200 | 800 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size | Range (mm) | Paper (| Quantity | Plastic | Quantity |

Table 2 - Chip Thickness/Tape & Reel Packaging Quantities

Package quantity based on finished chip thickness specifications.

Table 3 – KPS Land Pattern Design Recommendations (mm)

| EIA SIZE | METRIC SIZE | ľ | Median P | (Nomin rotrusic | al) Lan on | d |
|----------|----------------|------|-------------|--------------------|---------------|------|
| UUDL | CODE | C | Y | X | V1 | V2 |
| 1210 | 3225 | 1.50 | 1.14 | 1.75 | 5.05 | 3.40 |
| 1812 | 4532 | 2.20 | 1.35 | 2.87 | 6.70 | 4.50 |
| 2220 | 5650 | 2.69 | 2.08 | 4.78 | 7.70 | 6.00 |

Image at right based on an EIA 1210 case size.



KEMET's KPS Series land pattern design recommendations have been evaluated through extensive internal testing and validation. KPS lead frames are used to mechanically isolate the MLCC from the PCB and provide stress relief for increased mechanical robustness. The land pattern dimensions for each EIA size code are designed to be encompassed within the end terminations thus regulating solder wicking and maintaining lead frame flexibility. This design is optimized to enable durable solder joint fillets which improve the mechanical integrity and reliability upon placement.



Soldering Process

KEMET's KPS Series devices are compatible with IR reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for IR reflow reflect the profile conditions of the IPC/J-STD-020D standard for moisture sensitivity testing.

To prevent degradation of temperature cycling capability, care must be taken to prevent solder from flowing into the inner side of the lead frames (inner side of "J" lead in contact with the circuit board).

After soldering, the capacitors should be air cooled to room temperature before further processing. Forced air cooling is not recommended.

Hand soldering should be performed with care due to the difficulty in process control. If performed, care should be taken to avoid contact of the soldering iron to the capacitor body. The iron should be used to heat the solder pad, applying solder between the pad and the lead, until reflow occurs. Once reflow occurs, the iron should be removed immediately. (Preheating is required when hand soldering to avoid thermal shock.)

| Profile Feature | SnPb Assembly | Pb-Free Assembly | | |
|--|---------------------|---------------------|--|--|
| Preheat/Soak | | | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C | | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | | |
| Time (t _s) from T_{min} to T_{max}) | 60 – 120 seconds | 60 – 120 seconds | | |
| Ramp-up Rate $(T_L to T_P)$ | 3°C/seconds maximum | 3°C/seconds maximum | | |
| Liquidous Temperature (T _L) | 183°C | 217°C | | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | | |
| Peak Temperature (T _P) | 235°C | 250°C | | |
| Time within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 10 seconds maximum | | |
| Ramp-down Rate $(T_p to T_L)$ | 6°C/seconds maximum | 6°C/seconds maximum | | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | | |

Note: All temperatures refer to the center of the package, measured on the package body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method | | | |
|---|---------------------------|--|--|--|--|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds. | | | |
| Board Flex | JIS-C-6429 | Appendix 2, Note: 5.0 mm minimum | | | |
| | | Magnification 50 X. Conditions: | | | |
| Ostdanskillar | | a) Method B, 4 hours at 155°C, dry heat at 235°C | | | |
| Solderability | J-SID-002 | b) Method B at 215°C category 3 | | | |
| | | c) Method D, category 3 at 250°C | | | |
| Temperature Cycling JESD22 Method JA-104 | | 1,000 cycles (-55°C to +125°C). Measurement at 24 hours +/- 4 hours after test conclusion. | | | |
| Biased Humidity MIL-STD-202 Method 103 | | Load Humidity: 1,000 hours 85°C/85% RH and rated voltage. Add 100 K ohm resistor. Measurement at 24 hours +/- 4 hours after test conclusion. Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours +/- 4 hours after test conclusion. | | | |
| Moisture Resistance MIL-STD-202 Method 106 | | t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours +/- 4 hours after test conclusion. | | | |
| Thermal Shock | MIL-STD-202 Method 107 | -55°C/+125°C. Note: Number of cycles required – 300. Maximum transfer time – 20 seconds. Dwell time – 15 minutes. Air-Air. | | | |
| High Temperature Life | MIL-STD-202 Method 108 | 1,000 hours at 125°C with 1.5X rated voltage applied. | | | |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC for 1,000 hours. | | | |
| Vibration MIL-STD-202 Method 204 | | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB .031" thick, 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz. | | | |
| Mechanical Shock MIL–STD–202 Method 213 | | Figure 1 of Method 213, Condition F. | | | |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. | | | |

Storage & Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction (Typical)



Product Marking

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration – Embossed Plastic (mm)

| EIA Case Size | Tape Size (W)* | Pitch (P ₁)* | | |
|-------------------|----------------|--------------------------|--|--|
| 01005 - 0402 | 8 | 2 | | |
| 0603 - 1210 | 8 | 4 | | |
| 1805 - 1808 | 12 | 4 | | |
| ≥ 1812 | 12 | 8 | | |
| KPS 1210 | 12 | 8 | | |
| KPS 1812 and 2220 | 16 | 12 | | |
| Array 0612 | 8 | 4 | | |

*Refer to Figure 1 for W and P, carrier tape reference locations. *Refer to Table 5 for tolerance specifications.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|---------------------------------|---------------------------|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximim |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | |
| 12 mm | 1.5 +0.10/0.0-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 16 mm | | (0.059) | | | | (1.181) | | | |
| | Variable Dimensions — Millimeters (Inches) | | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ , B ₀ | , & K ₀ |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | |
| 12 mm | Single (4 mm) and Double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | Not | e 5 |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.

2. The tape with or without components shall pass around R without damage (see Figure 5).

3. If S₁ < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Standard 481 paragraph 4.3 section b).

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{α} , B_{α} and K_{α} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 2).

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 3).

(e) for KPS Series product, A_n and B_n are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 2 – Maximum Component Rotation



Figure 3 – Maximum Lateral Movement



Figure 4 – Bending Radius





Figure 5 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 7 – Reel Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | |
|--|--|---------------------------------------|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | |
| 8 mm | 178 ±0.20 | | | | | |
| 12 mm | Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | |
| 16 mm | (13.000 ±0.008) | | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | |



Figure 6 – Tape Leader & Trailer Dimensions



Figure 7 – Maximum Camber





Overview

KEMET Power Solutions (KPS) Automotive Series stacked capacitors utilize a proprietary lead-frame technology to vertically stack one or two multilayer ceramic chip capacitors into a single compact surface mount package. The attached lead-frame mechanically isolates the capacitor/s from the printed circuit board, therefore offering advanced mechanical and thermal stress performance. Isolation also addresses concerns for audible, microphonic noise that may occur when a bias voltage is applied. A two chip stack offers up to double the capacitance in the same or smaller design footprint when compared to traditional surface mount MLCC devices. Providing up to 10 mm of board flex capability, KPS Series capacitors are environmentally friendly and in compliance with RoHS legislation. Available in X7R dielectric, these devices are capable of Pb-Free reflow profiles and provide lower ESR, ESL and higher ripple current capability when compared to other dielectric solutions.

Combined with the stability of an X7R dielectric, KEMET's KPS Series devices exhibit a predictable change in capacitance with respect to time and voltage and boast a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to $\pm 15\%$ from -55° C to $\pm 125^{\circ}$ C.

KPS Series automotive grade capacitors meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.

Benefits

- · AEC-Q200 automotive qualified
- -55°C to +125°C operating temperature range
- · Reliable and robust termination system
- EIA 1210, 1812, and 2220 Case sizes
- DC voltage ratings of 10 V, 16 V, 25 V, 50 V, 100 V, and 250 V



Ordering Information

| С | 2220 | C | 106 | М | 5 | R | 2 | C | AUTO |
|---------|------------------------|--------------------------|--|---------------------------------------|--|------------|--|-------------------------------|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance ¹ | Rated Voltage (VDC) | Dielectric | Failure Rate/Design | Leadframe Finish ² | Packaging/Grade (C-Spec) |
| | 1210 1812 2220 | C = Standard | Two significant digits and number of zeros | K = ±10% M = ±20% | 8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 A = 250 | R = X7R | 1 = KPS Single Chip Stack 2 = KPS Double Chip Stack | C = 100% Matte Sn | See "Packaging C-Spec Ordering Options Table" |

¹ Double chip stacks ("2" in the 13th character position of the ordering code) are only available in M (\pm 20%) capacitance tolerance. Single chip stacks ("1" in the 13th character position of the ordering code) are available in K (\pm 10%) or M (\pm 20%) tolerances.

² Additional leadframe finish options may be available. Contact KEMET for details.



Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) ² |
|---|--|
| 7" Reel (Embossed Plastic Tape)/Unmarked | AUTO |
| 13" Reel (Embossed Plastic Tape)/Unmarked | AUTO 7289 |

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices. For more information see "Capacitor Marking". ² For additional information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information".

Benefits cont.

- Capacitance offerings ranging from 0.1μ F up to 47μ F
- Available capacitance tolerances of ±10% and ±20%
- · Higher capacitance in the same footprint
- · Potential board space savings
- Advanced protection against thermal and mechanical stress
- · Provides up to 10 mm of board flex capability

- Reduces audible, microphonic noise
- Extremely low ESR and ESL
- · Lead (Pb)-free, RoHS and REACH compliant
- Capable of Pb-free reflow profiles
- Non-polar device, minimizing installation concerns
- Tantalum and electrolytic alternative

Applications

Typical applications include smoothing circuits, DC/DC converters, power supplies (input/output filters), noise reduction (piezoelectric/mechanical), circuits with a direct battery or power source connection, critical and safety relevant circuits without (integrated) current limitation and any application that is subject to high levels of board flexure or temperature cycling.



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | tion Due To: | Days Prior To Implementation | | |
|-----------------------------|----------------------------------|---------------|---------------------------------|--|--|
| C-Spec | Process/Product change | Obsolescence* | Implementation | | |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum | | |
| AUTO | Yes (without approval) | Yes | 90 days minimum | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | | PPAP (Product Part Approval Process) Level | | | | |
|-----------------------------|---|--|---|---|---|--|
| C-Spec | 1 | 2 | 3 | 4 | 5 | |
| KEMET assigned ¹ | • | • | • | • | • | |
| AUTO | | | 0 | | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only

W



Dimensions – Millimeters (Inches)







Single Chip Stack

| Number of Chips | EIA Size Code | Metric Size Code | L Length | W Width | H Height | LW Lead Width | Mounting Technique |
|--------------------|------------------|---------------------|---------------|---------------|--------------------------------|---------------|-----------------------|
| | 1210 | 3225 | 3.50 (0.138) | 2.60 (0.102) | 3.35 (0.132) | 0.80 (0.032) | |
| | 1210 | 3225 | ±0.30 (0.012) | ±0.30 (0.012) | ±0.10 (0.004) | ±0.15 (0.006) | |
| Cingle | 1010 | 4522 | 5.00 (0.197) | 3.50 (0.138) | 2.65 (0.104) | 1.10 (0.043) | |
| Single | Single 1812 | 4052 | ±0.50 (0.020) | ±0.50 (0.020) | ±0.35 (0.014) | ±0.30 (0.012) | |
| | 2220 | 5650 | 6.00 (0.236) | 5.00 (0.197) | 3.50 (0.138) | 1.60 (0.063) | |
| | | | ±0.50 (0.020) | ±0.50 (0.020) | ±0.30 (0.012) | ±0.30 (0.012) | |
| | 1010 | 2225 | 3.50 (0.138) | 2.60 (0.102) | 6.15 (0.242) | 0.80 (0.031) | Solder Reflow Only |
| | 1210 | 3225 | ±0.30 (0.012) | ±0.30 (0.012) | ±0.15 (0.006) | ±0.15 (0.006) | |
| | 1010 | 4500 | 5.00 (0.197) | 3.50 (0.138) | 5.00 (0.197) | 1.10 (0.043) | |
| 2220 | 1812 | 4532 | ±0.50 (0.020) | ±0.50 (0.020) | -1.00/+0.50 (-0.040/+0.020) | ±0.30 (0.012) | |
| | 2220 | 5650 | 6.00 (0.236) | 5.00 (0.197) | 5.00 (0.197) | 1.60 (0.063) | |
| | 2220 | 5050 | ±0.50 (0.020) | ±0.50 (0.020) | ±0.50 (0.020) | ±0.30 (0.012) | |

Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|--|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±15% |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5±1 seconds and charge/discharge not exceeding 50 mA) |
| Dissipation Factor (DF) Maximum Limit at 25°C | 5% (6.3 and 10 V), 3.5% (16 and 25 V) and 2.5% (50 to 250 V) |
| Insulation Resistance (IR) Limit at 25°C | See Insulation Resistance Limit Table (Rated voltage applied for 120±5 seconds at 25°C) |

Regarding aging rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours. To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Capacitance and dissipation factor (DF) measured under the following conditions:

1 kHz ±50 Hz and 1.0 ±0.2 Vrms if capacitance \leq 10 μF

120 Hz ±10 Hz and 0.5 ±0.1 Vrms if capacitance > 10 μF

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."



Post Environmental Limits

| High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | |
|---|---------------------|----------------------|-----------------------------------|----------------------|--------------------------|--|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | |
| | > 25 | | 3.0 | | | |
| X7R | 16/25 | All | 5.0 | ±20% | 10% of Initial Limit | |
| | < 16 | | 7.5 | | | |

Insulation Resistance Limit Table

| EIA Case Size | 1,000 Megohm Microfarads or 100 GΩ | 500 Megohm Microfarads or 10 GΩ |
|---------------|---------------------------------------|------------------------------------|
| 1210 | < 0.39 µF | ≥ 0.39 µF |
| 1812 | < 2.2 µF | ≥ 2.2 µF |
| 2220 | < 10 µF | ≥ 10 µF |



Electrical Characteristics

Z and ESR C1210C475M5R1C



ESR - 1812, .10 µF, 50 V X7R



ESR – 1210, .22 µF, 50 V X7R



Z and ESR C2220C476M3R2C



Impedance - 1812, .10 µF, 50 V X7R



Impedance - 1210, .22 µF, 50 V X7R





Microphonics - 1210, 4.7 µF, 50 V, X7R



Microphonics – 2220, 47 μF , 25 V, X7R



Competitive Comparision

Ripple Current (A $_{\rm rms}$) 2220, 22 $\mu F\!\!\!\!$, 50 V



Microphonics - 2220, 22 µF, 50 V, X7R



Microphonics – 1210, 22 μ F, 25 V, X7R





Board Flex vs. Termination Type



Board Flexure to 10 mm



Board Flex vs. Termination Type



Board Flexure to 10 mm




Table 1 – Capacitance Range/Selection Waterfall (1210 – 2220 Case Sizes)

| | | Case Siz | e/Series | | | C12 | 10C | | | | C | 1812 | С | | | С | 2220 | C | |
|-------------------|------|------------|-------------|----|----|-------|-------|-------|--------|---------|----------|--------|---------|--------|-----|----|------|-----|-----|
| 0 | Сар | Voltag | e Code | 8 | 4 | 3 | 5 | 1 | A | 4 | 3 | 5 | 1 | A | 4 | 3 | 5 | 1 | A |
| Capacitance | Code | Rated Vol | age (VDC) | 10 | 16 | 25 | 20 | 100 | 250 | 16 | 25 | 50 | 100 | 250 | 16 | 25 | 20 | 100 | 250 |
| | | Conscience | a Talaranaa | | 1 | 1 | | Pro | duct A | vailabi | lity and | d Chip | Thickn | ess Co | des | | 1 | | |
| | | Capacitanc | | | | | | S | ee Tab | e 2 for | Chip T | hickne | ess Din | nensio | ns | | | | |
| Single Chip Stack | | | | | | | | | | | | | | | | | | | |
| 0.10 µF | 104 | K | М | FV | FV | FV | FV | FV | FV | GP | GP | GP | UD | UD | JP | JP | JP | JP | JP |
| 0.22 µF | 224 | К | М | FV | FV | FV | FV | FV | | GP | GP | GP | UD | UD | JP | JP | JP | JP | JP |
| 0.47 µF | 474 | К | М | FV | FV | FV | FV | FV | | GP | GP | GP | UD | UD | JP | JP | JP | | |
| 1.0 µF | 105 | К | М | FV | FV | FV | FV | FV | | GP | GP | GP | UD | | JP | JP | JP | | |
| 2.2 µF | 225 | К | М | FV | FV | FV | FV | | | GP | GP | GP | | | JP | JP | JP | UD | |
| 3.3 µF | 335 | К | М | FV | FV | FV | FV | | | GP | GP | GP | | | JP | JP | JP | UD | |
| 4.7 µF | 475 | К | М | FV | FV | FV | FV | | | GP | GP | GP | | | JP | JP | JP | | |
| 10 µF | 106 | К | М | FV | FV | FV | | | | GP | GP | | | | JP | JP | JP | | |
| 15 µF | 156 | К | М | | | | | | | | | | | | JP | JP | | | |
| 22 µF | 226 | К | М | | | | | | | | | | | | JP | JP | | | |
| | | | | | D | ouble | e Chi | p Sta | ck | | | | | | | | | | |
| 0.10 µF | 104 | | М | FW | FW | FW | FW | FW | FW | GR | GR | GR | UD | UD | JR | JR | JR | JR | JR |
| 0.22 µF | 224 | | М | FW | FW | FW | FW | FW | FW | GR | GR | GR | UD | UD | JR | JR | JR | JR | JR |
| 0.47 µF | 474 | | М | FW | FW | FW | FW | FW | | GR | GR | GR | UD | UD | JR | JR | JR | JR | JR |
| 1.0 µF | 105 | | М | FW | FW | FW | FW | FW | | GR | GR | GR | UD | UD | JR | JR | JR | | |
| 2.2 µF | 225 | | М | FW | FW | FW | FW | FW | | GR | GR | GR | UD | | JR | JR | JR | | |
| 3.3 µF | 335 | | М | FW | FW | FW | FW | | | GR | GR | GR | UD | | JR | JR | JR | UD | |
| 4.7 µF | 475 | | М | FW | FW | FW | FW | | | GR | GR | GR | | | JR | JR | JR | | |
| 10 µF | 106 | | М | FW | FW | FW | FW | | | GR | GR | GR | | | JR | JR | JR | | |
| 22 µF | 226 | | М | FW | FW | FW | | | | GR | GR | | | | JR | JR | JR | | |
| 33 µF | 336 | | М | | | | | | | | | | | | JR | JR | | | |
| 47 µF | 476 | | М | | | | | | | | | | | | JR | JR | | | |
| | 0 | Rated Vol | age (VDC) | 10 | 16 | 25 | 20 | 100 | 250 | 16 | 25 | 50 | 100 | 250 | 16 | 25 | 50 | 100 | 250 |
| Capacitance | Cap | Voltag | e Code | 8 | 4 | 3 | 5 | 1 | A | 4 | 3 | 5 | 1 | A | 4 | 3 | 5 | 1 | A |
| Capacitance Code | | Case Siz | e/Series | | | C12 | 10C | | | | C | 1812 | С | | | С | 2220 | C | |

UD = Under development

These products are protected under US Patent 8,331,078 other patents pending, and any foreign counterparts.



| Thickness | Case | Thickness ± | Paper C | Quantity | Plastic (| Quantity | |
|-----------|------|-------------|---------|----------|------------------|----------|--|
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| FV | 1210 | 3.35 ± 0.10 | 0 | 0 | 600 | 2,000 | |
| FW | 1210 | 6.15 ± 0.15 | 0 | 0 | 300 | 1,000 | |
| GP | 1812 | 2.65 ± 0.35 | 0 | 0 | 500 | 2,000 | |
| GR | 1812 | 5.00 ± 0.50 | 0 | 0 | 400 | 1,700 | |
| JP | 2220 | 3.50 ± 0.30 | 0 | 0 | 300 | 1,300 | |
| JR | 2220 | 5.00 ± 0.50 | 0 | 0 | 200 | 800 | |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| Code | Size | Range (mm) | Paper (| Quantity | Plastic Quantity | | |

Table 2 - Chip Thickness/Tape & Reel Packaging Quantities

Package quantity based on finished chip thickness specifications.

Table 3 – KPS Land Pattern Design Recommendations (mm)

| EIA SIZE CODE | METRIC SIZE | ľ | Median P | (Nomin rotrusio | al) Lan on | d |
|------------------|----------------|------|-------------|--------------------|---------------|------|
| | CODE | C | Y | X | V1 | V2 |
| 1210 | 3225 | 1.50 | 1.14 | 1.75 | 5.05 | 3.40 |
| 1812 | 4532 | 2.20 | 1.35 | 2.87 | 6.70 | 4.50 |
| 2220 | 5650 | 2.69 | 2.08 | 4.78 | 7.70 | 6.00 |



Image at right based on an EIA 1210 case size.

KEMET's KPS Series land pattern design recommendations have been evaluated through extensive internal testing and validation. KPS lead frames are used to mechanically isolate the MLCC from the PCB and provide stress relief for increased mechanical robustness. The land pattern dimensions for each EIA size code are designed to be encompassed within the end terminations thus regulating solder wicking and maintaining lead frame flexibility. This design is optimized to enable durable solder joint fillets which improve the mechanical integrity and reliability upon placement.



Soldering Process

KEMET's KPS Series devices are compatible with IR reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for IR reflow reflect the profile conditions of the IPC/J-STD-020D standard for moisture sensitivity testing.

To prevent degradation of temperature cycling capability, care must be taken to prevent solder from flowing into the inner side of the lead frames (inner side of "J" lead in contact with the circuit board).

After soldering, the capacitors should be air cooled to room temperature before further processing. Forced air cooling is not recommended.

Hand soldering should be performed with care due to the difficulty in process control. If performed, care should be taken to avoid contact of the soldering iron to the capacitor body. The iron should be used to heat the solder pad, applying solder between the pad and the lead, until reflow occurs. Once reflow occurs, the iron should be removed immediately. (Preheating is required when hand soldering to avoid thermal shock.)

| Profile Feature | SnPb Assembly | Pb-Free Assembly | |
|--|---------------------|---------------------|--|
| Preheat/Soak | | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | |
| Time (t_s) from T_{smin} to T_{smax}) | 60 – 120 seconds | 60 – 120 seconds | |
| Ramp-up Rate (T_L to T_P) | 3°C/seconds maximum | 3°C/seconds maximum | |
| Liquidous Temperature (T _L) | 183°C | 217°C | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | |
| Peak Temperature (T _P) | 235°C | 250°C | |
| Time within 5°C of Maximum Peak Temperature (t _n) | 20 seconds maximum | 10 seconds maximum | |
| Ramp-down Rate $(T_{p} to T_{L})$ | 6°C/seconds maximum | 6°C/seconds maximum | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | |

Note: All temperatures refer to the center of the package, measured on the package body surface that is facing up during assembly reflow.



Storage & Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction (Typical)



Product Marking

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 4 – Carrier Tape Configuration – Embossed Plastic (mm)

| EIA Case Size | Tape Size (W)* | Pitch (P ₁)* |
|-------------------|----------------|--------------------------|
| 01005 - 0402 | 8 | 2 |
| 0603 - 1210 | 8 | 4 |
| 1805 - 1808 | 12 | 4 |
| ≥ 1812 | 12 | 8 |
| KPS 1210 | 12 | 8 |
| KPS 1812 & 2220 | 16 | 12 |
| Array 0508 & 0612 | 8 | 4 |

*Refer to Figure 1 for W and P_1 carrier tape reference locations. *Refer to Table 5 for tolerance specifications.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 5 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions — Millimeters (Inches) | | | | | | | | | |
|-----------|--|----------------------------------|----------------------------|---------------------------|----------------------------|---------------------------|----------------------------------|---------------------------------|---------------------------|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximim | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | |
| 12 mm | 1.5+0.10/0.0-0.0 (0.059+0.004/-0.0) | 1.5 | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.05 (0.079±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | |
| 16 mm | | (0.059) | | | | (1.181) | | | | |
| | Variable Dimensions — Millimeters (Inches) | | | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ , B ₀ | , & K ₀ | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5±0.05 (0.138±0.002) | 4.0±0.10 (0.157±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | |
| 12 mm | Single (4 mm) & Double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5±0.05 (0.217±0.002) | 8.0±0.10 (0.315±0.004) | 4.6 (0.181) | 12.3 (0.484) | Not | e 5 | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5±0.05 (0.138±0.002) | 12.0±0.10 (0.157±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.

2. The tape with or without components shall pass around R without damage (see Figure 5).

3. If S₁ < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Standard 481 paragraph 4.3 section b).

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 2).

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 3).

(e) for KPS Series product, A_a and B_a are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 Kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 2 – Maximum Component Rotation



Figure 3 – Maximum Lateral Movement



Figure 4 – Bending Radius





Figure 5 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 6 – Reel Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | |
|--|---------------------|-------------------------------------|--------------------------------------|---|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | | |
| 8 mm | 178±0.20 | | | | | | | |
| 12 mm | (7.008±0.008) Or | 1.5 (0.059) | 13.0+0.5/-0.2 (0.521+0.02/-0.008) | 20.2 (0.795) | | | | |
| 16 mm | (13.000±0.008) | | | | | | | |
| Variable Dimensions — Millimeters (Inches) | | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | |
| 8 mm | | 8.4+1.5/-0.0 (0.331+0.059/-0.0) | 14.4 (0.567) | | | | | |
| 12 mm | 50 (1.969) | 12.4+2.0/-0.0 (0.488+0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | | |
| 16 mm | | 16.4+2.0/-0.0 (0.646+0.078/-0.0) | 22.4 (0.882) | | | | | |



Figure 6 – Tape Leader & Trailer Dimensions



Figure 7 – Maximum Camber





Overview

KEMET's Automotive Grade Series surface mount capacitors in COG dielectric are suited for a variety of applications requiring proven, reliable performance in harsh environments. Whether under-hood or in-cabin, these devices emphasize the vital and robust nature of capacitors required for mission and safety critical automotive circuits. Stricter testing protocol and inspection criteria have been established for automotive grade products in recognition of potentially harsh environmental conditions. KEMET automotive grade series capacitors meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements. COG dielectric features a 125°C maximum operating temperature and is considered "stable." The Electronics Industries Alliance (EIA) characterizes COG dielectric as a Class I material. Components of this classification are temperature compensating and are suited for resonant circuit applications or those where Q and stability of capacitance characteristics are required. COG exhibits no change in capacitance with respect to time and voltage and boasts a negligible change in capacitance with reference to ambient temperature. Capacitance change is limited to ±30 ppm/°C from -55°C to +125°C.

Benefits

- · AEC-Q200 automotive qualified
- -55°C to +125°C operating temperature range
- Lead (Pb)-Free, RoHS and REACH compliant
- EIA 0402, 0603, 0805, 1206, 1210, 1812, and 2220 case sizes
- DC voltage ratings of 10 V, 16 V, 25 V, 50 V, 100 V, 200 V, and 250 V
- Capacitance offerings ranging from 0.5 pF up to 0.47 μF
- Available capacitance tolerances of ±0.10 pF, ±0.25 pF, ±0.5 pF, ±1%, ±2%, ±5%, ±10%, and ±20%

Ordering Information

| С | 1206 | C | 104 | J | 3 | G | Α | С | AUTO |
|---------|--|--------------------------|---|---|---|------------|-------------------------|---------------------------------|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance ¹ | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ² | Packaging/Grade (C-Spec) |
| | 0402 0603 0805 1206 1210 1812 2220 | C = Standard | Two significant digits and number of zeros Use 9 for 1.0 - 9.9 pF Use 8 for 0.599 pF ex. 2.2 pF = 229 ex. 0.5 pF = 508 | $B = \pm 0.10 \text{ pF}$ $C = \pm 0.25 \text{ pF}$ $D = \pm 0.5 \text{ pF}$ $F = \pm 1\%$ $G = \pm 2\%$ $J = \pm 5\%$ $K = \pm 10\%$ $M = \pm 20\%$ | 8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 2 = 200 A = 250 | G = COG | A = N/A | C = 100% Matte Sn | See "Packaging C-Spec Ordering Options Table" |

¹Additional capacitance tolerance offerings may be available. Contact KEMET for details.

² Additional termination finish options may be available. Contact KEMET for details.

Built Into Tomorrow

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Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) ³ |
|---|---|
| 7" Reel | AUTO |
| 13" Reel/Unmarked | AUT07411 (EIA 0603 and smaller case sizes) AUT07210 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2 mm pitch ² | 3190 |
| 13" Reel/Unmarked/2 mm pitch ² | 3191 |

¹ Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information".

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

³ All Automotive packaging C-Specs listed exclude the option to laser mark components. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking".

³ For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information".

Benefits cont.

- · No piezoelectric noise
- Extremely low ESR and ESL
- · High thermal stability
- High ripple current capability
- Preferred capacitance solution at line frequencies and into
 Non-polar device, minimizing installation concerns the MHz range
- No capacitance change with respect to applied rated DC voltage
- Negligible capacitance change with respect to temperature from -55°C to +125°C
- No capacitance decay with time
- 100% pure matte tin-plated termination finish allowing for excellent solderability

Applications

Typical applications include critical timing, tuning, circuits requiring low loss, circuits with pulse, high current, decoupling, bypass, filtering, transient voltage suppression, blocking and energy storage.



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | tion Due To: | Days Prior To | | |
|-----------------------------|----------------------------------|--------------------------------------|------------------|--|--|
| C-Spec | Process/Product change | Process/Product change Obsolescence* | | | |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum | | |
| AUTO | Yes (without approval) | Yes | 90 days minimum | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | | PPAP (Product Part Approval Process) Level | | | | | | | | |
|-----------------------------|---|--|---|---|---|--|--|--|--|--|
| C-Spec | 1 | 2 | 3 | 4 | 5 | | | | | |
| KEMET assigned ¹ | • | • | • | • | • | | | | | |
| AUTO | | | 0 | | | | | | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|----------------------------|---------------------------------|
| 0402 | 1005 | 1.00 (0.040) ±0.05 (0.002) | 0.50 (0.020) ±0.05 (0.002) | | 0.30 (0.012) ±0.10 (0.004) | 0.30 (0.012) | Solder Reflow Only |
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | |
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave or Solder Reflow |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | See Table 2 for Thickness | 0.50 (0.02) ±0.25 (0.010) | | |
| 1210 | 3225 | 3.20 (0.126) ±0.20 (.008) | 2.50 (0.098) ±0.20 (0.008) | - | 0.50 (0.02) ±0.25 (0.010) | N1/A | |
| 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | | 0.60 (0.024) ±0.35 (0.014) | IN/A | Solder Reflow Only |
| 2220 | 5650 | 5.70 (0.224) ±0.40 (0.016) | 5.00 (0.197) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | |



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±30 ppm/°C |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 0% |
| ¹ Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5±1 seconds and charge/discharge not exceeding 50 mA) |
| ² Dissipation Factor (DF) Maximum Limit at 25°C | 0.1% |
| ³ Insulation Resistance (IR) Limit at 25°C | 1,000 megohm microfarads or 100 GΩ (Rated voltage applied for 120±5 seconds at 25°C) |

¹ DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

² Capacitance and dissipation factor (DF) measured under the following conditions:

1 MHz ±100 kHz and 1.0 Vrms ±0.2 V if capacitance \leq 1,000 pF

1 kHz ±50 Hz and 1.0 Vrms ±0.2 V if capacitance > 1,000 pF

³ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Capacitance and Dissipation Factor (DF) measured under the following conditions:

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

Post Environmental Limits

| | High Temperatu | ıre Life, Biased | Humidity, Mois | ture Resistance | 9 | | | | | | | |
|--|----------------|------------------|----------------|------------------|-------------------------|--|--|--|--|--|--|--|
| Dielectric Rated DC Voltage Capacitance Value Dissipation Factor (Maximum %) Capacitance Shift Insulation Resistance | | | | | | | | | | | | |
| COG | All | All | 0.5 | 0.3% or ±0.25 pF | 10% of Initial Limit | | | | | | | |



Table 1A – Capacitance Range/Selection Waterfall (0402 – 0805 Case Sizes)

| | | C | as | e | Si | ze | e/S | Se | rie | s | | | C | 040 | 2 C | | | | | C | 0603 | BC | | | | | C | 0805 | 5C | | |
|----------------|-------------|----|----|-----|------|-------|-----|-----|-----------------------|----|----|----|----|------|------------|-----|------|-------|--------------|----------|----------|-------------|-------|--------|-----------|----|----|------|-----|-----|-----|
| Osmasitanaa | Сар | Г | | Vo | olta | ge | Co | de | | | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A |
| Capacitance | Code | | Ra | ted | Vo | lta | ge | (VI | DC) | | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 10 | 16 | 25 | 50 | 100 | 200 | 250 |
| | | Ca | pa | cit | an | ce | То | ler | an | ce | | | | | | | Prod | uct A | vailab | oility a | and C | hip T | hickn | iess C | odes | ; | | | | | |
| 0.50 & 0.75 pF | 508 & 758 | В | C | D | | | | | | _ | BB | BB | BB | BB | | | 566 | CF | e 2 10 CF | CF | CF | CKNES CF | CF | CF | ONS DN | DN | DN | DN | DN | DN | DN |
| 1.0 - 9.1 pF* | 109 - 919* | В | C | D | | | | | | | BB | BB | BB | BB | | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN |
| 10 – 91 pF* | 100 - 910* | | | | F | : (| G | J | K | М | BB | BB | BB | BB | | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN |
| 100 pF | 101 | | | | F | | G | J | K | М | BB | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN |
| 110 - 180 pF* | 111 - 181* | | | | F | | G | J | K | М | BB | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN |
| 200 – 270 pF* | 201 - 271* | | | | F | | G | J | K | М | BB | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN |
| 300 pF | 301 | | | | | | G | J | K | M | BB | BB | BB | BB | BB | BD | BD | | CF | CF | CF | CF | | CF | | | DN | | DN | DN | DN |
| 330 pF | 331 | | | | | | 6 | J | ĸ | | BB | BB | BB | BB | BB | RD | BD | | | | | | | | | | | | | | |
| 300 pF | 301 | | | | | | c | J | r v | M | | | | | | | | | | | | | | | | | | | | | |
| 390 pF | 391 //31 | | | | E F | | G | J | ĸ | M | BB | BB | BB | BB | BB | | | | CE | CF | | CF | | CF | | | | | DN | | |
| 470 pF | 471 | | | | | : | G | 1 | ĸ | м | BB | BB | BR | BB | BB | | | CE | CE | CE | CE | CE | CE | CF | | | | | | | |
| 510 - 820 nF* | 511 - 821* | | | | Ē | : | G | J | ĸ | м | BB | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | | DN | DN | DN | DN | DN |
| 910 pF | 911 | | | | Ē | : , | G | J | ĸ | м | BB | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DP | DP | DP |
| 1,000 pF | 102 | | | | F | : | G | J | K | М | BB | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DP | DP | DP |
| 1,100 pF | 112 | | | Г | F | : | G | J | Κ | М | BB | BB | BB | BB | | | | CF | CF | CF | CF | CF | СН | СН | DN | DN | DN | DN | DN | DN | DN |
| 1,200 pF | 122 | | | | F | : (| G | J | ĸ | м | BB | BB | BB | BB | | | | CF | CF | CF | CF | CF | СН | СН | DN | DN | DN | DN | DN | DN | DN |
| 1,300 pF | 132 | | | | F | : (| G | J | K | М | BB | BB | BB | BB | | | | CF | CF | CF | CF | CF | СН | СН | DP | DP | DP | DP | DP | DN | DN |
| 1,500 pF | 152 | | | | F | : 1 | G | J | K | М | BB | BB | BB | BB | | | | CF | CF | CF | CF | CF | СН | СН | DP | DP | DP | DP | DP | DN | DN |
| 1,600 pF | 162 | | | | F | : (| G | J | Κ | М | BB | BB | BB | | | | | CF | CF | CF | CF | CF | СН | СН | DP | DP | DP | DP | DP | DN | DN |
| 1,800 pF | 182 | | | | F | : (| G | J | K | М | BB | BB | BB | | | | | CF | CF | CF | CF | CF | СН | СН | DP | DP | DP | DP | DP | DN | DN |
| 2,000 pF | 202 | | | | F | | G | J | K | М | BB | BB | BB | | | | | CF | CF | CF | CF | CF | СН | СН | DN | DN | DN | DN | DN | DN | DN |
| 2,200 pF | 222 | | | | F | | G | J | K | М | BB | BB | BB | | | | | CF | CF | CF | CF | CF | СН | СН | DN | DN | DN | DN | DN | DN | DN |
| 2,400 pF | 242 | | | | | | G | J | K | M | | | | | | | | | CF | CF | CF | CF | | | | DN | DN | DN | DN | DN | DN |
| 2,/UU pF | 272 | | | | E F | - | G | J | K | M | | | | | | | | | | UF OF | UF OF | UF OF | | | | DN | DN | DN | DN | DN | DN |
| 3,000 pF | 302 | | | | | | c | J | r v | M | | | | | | | | | | | | | | | | | | | | | |
| 3,500 pF | 362 | | | | | - | 6 | 1 | ĸ | M | | | | | | | | CF | CF | CF | CF | CF | | | | | | | | | |
| 3,000 pr | 392 | | | | | :] | G | | ĸ | м | | | | | | | | CF | CF | CF | CF | CF | | | DF | DF | DF | DF | | | |
| 4.300 pF | 432 | | | | E F | : | G | J | ĸ | м | | | | | | | | CF | CF | CF | CF | CF | | | DE | DE | DE | DE | DN | DP | DP |
| 4.700 pF | 472 | | | | E | : | G | J | K | М | | | | | | | | CF | CF | CF | CF | CF | | | DE | DE | DE | DE | DN | DP | DP |
| 5,100 pF | 512 | | | | F | : | G | J | K | м | | | | | | | | CF | CF | CF | CF | | | | DE | DE | DE | DE | DN | DP | DP |
| 5,600 pF | 562 | | | | F | : | G | J | K | М | | | | | | | | CF | CF | CF | CF | | | | DN | DN | DN | DN | DN | DP | DP |
| 6,200 pF | 622 | | | | F | : | G | J | K | М | | | | | | | | CF | CF | CF | CF | | | | DN | DN | DN | DN | DN | DG | DG |
| 6,800 pF | 682 | | | | F | - | G | J | K | М | | | | | | | | CF | CF | CF | CF | | | | DN | DN | DN | DN | DN | DG | DG |
| 7,500 pF | 752 | | | | F | : (| G | J | K | М | | | | | | | | CF | CF | CF | | | | | DN | DN | DN | DN | DN | DG | DG |
| 8,200 pF | 822 | | | | F | - | G | J | K | М | | | | | | | | CF | CF | CF | | | | | DN | DN | DN | DN | DN | DG | DG |
| 9,100 pF | 912 | | | | F | - | G | J | K | М | | | | | | | | CF | CF | CF | | | | | DN | DN | DN | DN | DN | | |
| 10,000 pF | 103 | | | | F | 1 | G | J | K | М | | | | | | | | CF | CF | CF | | | | | DN | DN | DN | DN | DP | | |
| 12,000 pF | 123 | | | | F | • | G | J | K | M | | | | | | | | CF | CF | CF | | | | | DN | DN | DN | DN | DE | | |
| 15,000 pF | 153 | | | | | | G | J | K | M | | | | | | | | CF | CF | CF | | | | | | DN | DN | DP | DG | | |
| 22 000 pF | 103 | | | | F | | C | J | N K | M | | | | | | | | | | | | | | | | | | DP | | | |
| 22,000 pF | 223 | | | | | | G | J | K | M | | | | | | | | | | | | | | | | | | Dr | | | |
| 33 000 pF | 333 | | | | F | : | G | J | K | м | | | | | | | | | | | | | | | DG | DG | DG | | | | |
| 39.000 pF | 393 | | | | F | : | G | J | K | м | | | | | | | | | | | | | | | DG | DG | DG | | | | |
| 47,000 pF | 473 | | | | F | : | G | J | K | М | | | | | | | | | | | | | | ļ | DG | DG | DG | | | | |
| | | Ĺ | Ra | ted | Vo | lta | ge | (VI |)C) | | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 10 | 16 | 25 | 50 | 100 | 200 | 250 |
| Capacitance | Cap Code | Ĺ | | Vo | olta | ge | Co | de | 8 4 3 5 1 2 A 8 4 3 5 | | | | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | | | | | | | | | |
| | | | Ca | ase | e Si | ze | /Se | eri | es | | | | C | 0402 | C | | | | | C | 0603 | C | | | | | C | 0805 | C | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).

These products are protected under US Patents 7,172,985 & 7,670,981, other patents pending, and any foreign counterparts.

Table 1B - Capacitance Range/Selection Waterfall (1206 - 2220 Case Sizes)

| | | 0 | Cas | se | Si | ze | /S | eri | es | B C1206C C1210C 8 4 3 5 1 2 A 8 4 3 5 1 2 | | | | | | | C18 | 12C | ; | C2 | 2220 |)C | | | | | | | | | |
|----------------------|------------|-----|-----|------|----------|----------|-------------|----------------|------|---|----------------|----------|----------|------|--------|-----|--------|----------|--------|--------|-------|--------|--------|--------|------|--------|------|------|----|----------|----------|
| Can | Can Codo | | | V | olta | ge (| Cod | е | | 8 | | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 5 | 1 | 2 |
| Cah | cap coue | | Ra | ateo | d Vo | ltaç | je (| VDC) | | = | 2 | 16 | 25 | 50 | 100 | 200 | 250 | 2 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | 50 | 10 | 200 |
| | | C | ap | aci | itan | ce ' | Tol | erar | се | | | | | | | I | Produ | ict Av | vailal | oility | and C | hip T | hick | ness | Code | S | | | | | |
| 1.0 - 9.1 pF* | 109 - 919* | В | C | D |) | | | | | E | 3 1 | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | lons | | | | | | |
| 10 - 91 pF* | 100 - 910* | I I | | | F | : 0 | 3. | JK | M | E E | 3 1 | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | 1 | | | | | | |
| 100 - 430 pF* | 101 - 431* | | | | F | : (· | 3 . | JK | M | E | 3 1 | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 470 - 910 pF* | 471 - 911* | | | | F | | 3 . | JK | M | E | 3 1 | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | | | |
| 1,000 pF | 102 | | | | E E | : c | | JK | | E | 5 I 2 I | EB | EB | EB | EB | EE | EE | F B | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | | | |
| 1,100 pF | 112 | | | | F | : r | | JK | M | | 2 I 2 I | ED ER | FR | FR | FR | FR | FR | FR | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | | | |
| 1,200 pF | 132 | | | | F | : (| | JK | M | E | 3 1 | EB | EB | EB | EC | EC | EC | FB | FB | FB | FB | FB | FC | FC | GB | GB | GB | GB | | | |
| 1,500 pF | 152 | | | | F | : c | 3 | JK | M | E | 3 1 | EB | EB | EB | ED | EC | EC | FB | FB | FB | FB | FB | FE | FE | GB | GB | GB | GB | | | |
| 1,600 pF | 162 | | | | F | : C | 3 . | JK | M | E | 3 1 | ЕВ | EB | EB | ED | ED | ED | FB | FB | FB | FB | FB | FE | FE | GB | GB | GB | GB | | | |
| 1,800 pF | 182 | | | | F | G | 3, | JK | M | E | 3 E | EB | EB | EB | ED | ED | ED | FB | FB | FB | FB | FB | FE | FE | GB | GB | GB | GB | | | |
| 2,000 pF | 202 | | | | F | G |) . | JK | M | E | 3 E | B | EB | EB | ED | ED | ED | FB | FB | FB | FB | FC | FE | FE | GB | GB | GB | GB | | | |
| 2,200 pF | 222 | | | | F | G | j, | JK | M | E | 3 E | B | EB | EB | EE | EE | ED | FB | FB | FB | FB | FC | FG | FG | GB | GB | GB | GB | | | |
| 2,400 pF | 242 | | | | F | : 0 | , i | JK | | | | EB | EB | EB | EC | EC | EC | FB | FB | FB | FB | | | | GR | GR | CP | GR | | | |
| 3 000 pF | 302 | | | T | F | : (|), | JK | M | E | 2 I 2 F | -D -C | FC | FC | FC | FB | FB | FB | FB | FB | FB | FC | FF | FF | 00 | GD | GD | 60 | | | |
| 3,300 pF | 332 | | | | F | : 0 | 3 | JK | M | E | | EC | EC | EC | EE | EB | EB | FB | FB | FB | FB | FF | FF | FF | GB | GB | GB | GB | | | |
| 3,600 pF | 362 | | | | F | : c | 3 . | JK | M | E | c I | EC | EC | EC | EE | EB | EB | FB | FB | FB | FB | FF | FF | FF | | | | | | | |
| 3,900 pF | 392 | | | | F | : 0 | 3 . | JK | M | E | 2 I | EC | EC | EC | EF | EB | EB | FB | FB | FB | FB | FF | FF | FF | GB | GB | GB | GB | | | |
| 4,300 pF | 432 | | | 1 | F | : C | 3, | JK | N | E | C I | EC | EC | EC | EC | EB | EB | FB | FB | FB | FB | FF | FF | FF | | | | | | | |
| 4,700 pF | 472 | | | | F | 0 | 3 . | JK | M | E | | | EC | EC | EC | EB | EB | FF | FF | FF | FF | FG | FG | FG | GB | GB | GD | GD | | | |
| 5,100 pF | 512 | | | | F | | j, | JK | | | | =D | ED | ED | ED | EB | EB | I FB | FB | FB | FB | FG | FG | FG | | CD | 011 | 011 | | | |
| 5,000 pF 6 200 pF | 622 | | | | F | : c | | JK | | | ין כ א א | =D =R | ED FR | ED | FR | FR | FR | FB | FB | FB | FB | FG | FB | FB | GB | GB | GH | GH | | | |
| 6.800 pF | 682 | | | | F | : 0 | | JK | M | E | 3 1 | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FG | FB | FB | GB | GB | GJ | GJ | JE | JE | JB |
| 7,500 pF | 752 | | | T | F | : (| 3 | JK | M | E | 3 I | EB | EB | EB | EB | EB | EB | FC | FC | FC | FC | FC | FB | FB | 0.5 | | | | | | |
| 8,200 pF | 822 | | | | F | : 0 | 3 . | JК | M | E | C I | EC | EC | EC | EB | EC | EC | FC | FC | FC | FC | FC | FB | FB | GB | GH | GB | GB | JE | JE | JB |
| 9,100 pF | 912 | | | | F | : 0 | 3 , | JK | M | E | C E | EC | EC | EC | EB | EC | EC | FE | FE | FE | FE | FE | FB | FB | | | | | | | |
| 10,000 pF | 103 | | | | F | G |) , | JK | M | E |) [| ED | ED | ED | EB | EC | EC | FF | FF | FF | FF | FF | FB | FB | GB | GH | GB | GB | JE | JE | JB |
| 12,000 pF | 123 | | | 4 | F | G |) , | JK | M | E | 3 E | EB | EB | EB | EB | ED | ED | FG | FG | FG | FG | FB | FB | FB | GB | GG | GB | GB | JE | JE | JB |
| 15,000 pF | 153 | | | | F | : 0 | j , | JK JK | | | 5 E 5 E | EB | EB | EB | EB | | | FG | FG | FG | FG | FB | FC | FC | GB | GB | GB | GB | JE | JE | JB |
| 22 000 pF | 223 | | | | F | : 6 | | I K I V | M | | 2 1 | ED ER | ED | FR | ED | EH | FH | | FR | FR | FR | FR | FF | FF | GB | GB | GB | GB | JE | JE IR | JD IR |
| 27.000 pF | 273 | | | | F | : (| | JK | N | E | 3 1 | EB | EB | EB | EE | | | FB | FB | FB | FB | FB | FG | FG | GB | GB | GB | GB | JE | JB | JB |
| 33,000 pF | 333 | | | | F | : 0 | 3, | JK | M | E | 3 1 | EB | EB | EB | EE | | | FB | FB | FB | FB | FB | FH | FH | GB | GB | GB | GB | JB | JB | JB |
| 39,000 pF | 393 | | | | F | : (| 3, | JK | M | E | C I | EC | EC | EE | EH | | | FB | FB | FB | FB | FE | FH | FH | GB | GB | GB | GB | JB | JB | JB |
| 47,000 pF | 473 | | | | F | : C | 3 , | JK | M | E | C I | EC | EC | EE | EH | | | FB | FB | FB | FB | FE | FJ | FJ | GB | GB | GD | GD | JB | JB | JB |
| 56,000 pF | 563 | | | | F | 0 | 3 , | JK | M | E | | ED | ED | EF | | | | FB | FB | FB | FB | FF | | | GB | GB | GD | GD | JB | JB | JB |
| 68,000 pF | 683 | | | | F | - 0 | ; ; | JK | | | | EF | EF | EH | | | | FB | FB | FB | FC | FG | | | GB | GB | GK | GK | JB | JB | JB |
| 82,000 pF | 823 | | | t. | F | : c |) , 2 | JK | . IV | | 1 L 4 F | н | EH | EH | | | | FC | FC | FC | FF | FH | | | GB | GB | GM | GM | JB | JB | JB |
| 0.10 µF | 104 | | | | F | : (| | JK | M | | ' ' | -'' | L11 | | | | | FG | FG | FG | FH | FIVI | | | GB | GH | Givi | Givi | JB | JB | JD |
| 0.15 µF | 154 | | | | Ē | : (| | JK | M | | | | | | | | | FH | FH | FH | FM | | | | GD | GN | | | JB | JB | JG |
| 0.18 µF | 184 | | | | F | : C | 3 | JK | M | | | | | | | | | FJ | FJ | FJ | | | | | GH | | | | JB | JD | JG |
| 0.22 µF | 224 | | | | F | 0 | 3, | JK | M | | | | | | | | | FK | FK | FK | | | | | GK | | | | JB | JD | JL |
| 0.27 µF | 274 | | | | F | 6 |) . | JK | M | | | | | | | | | | | | | | | | | | | | JB | JF | |
| 0.33 µF | 334 | | | | F | 0 | <u>}</u> , | JK | M | | | | | | | | | | | | | | | | | | | | JD | JG | |
| 0.39 µF | 394 | | | | F | : 6 | , , | ע K ע ו | | | | | | | | | | | | | | | | | | | | | | | |
| υ.47 με | 4/4 | | R | ater | d Vo | Itar | 1e (' | UDC) | | | 2 | 9 | 25 | 10 | 8 | 8 | 50 | <u> </u> | 9 | 25 | | 8 | 8 | 50 | 10 | 8 | 8 | 50 | 10 | 8 | 8 |
| Cap | Cap Code | | | v | olta | ige (| Cod | e | | | | 4 | 3 | 5 | - 1 | 2 | ∾ A | 8 | 4 | 3 | 5 | - 1 | ~ 2 | ∾ A | 5 | - 1 | 2 | A N | 5 | - 1 | ∾ 2 |
| | | | C | Cas | e Si | ize/ | Se | ries | | \uparrow | | | C | 1206 | C . | | | - | 1 | | C1210 | C . | | | - | C18 | 12C | | C | 2220 | C |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).

These products are protected under US Patents 7,172,985 & 7,670,981, other patents pending, and any foreign counterparts.



Table 2 - Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic (| Quantity |
|-----------|-------|------------------------------------|---------|----------------------|------------------|----------|
| Code | Size1 | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| BB | 0402 | 0.50 ± 0.05 | 10,000 | 50,000 | 0 | 0 |
| BD | 0402 | 0.55 ± 0.05 | 10,000 | 50,000 | 0 | 0 |
| CF | 0603 | 0.80 ± 0.07 | 4,000 | 15,000 | 0 | 0 |
| СН | 0603 | 0.85 ± 0.07 | 4,000 | 10,000 | 0 | 0 |
| DN | 0805 | 0.78 ± 0.10 | 4,000 | 15,000 | 0 | 0 |
| DP | 0805 | 0.90 ± 0.10 | 4,000 | 15,000 | 0 | 0 |
| DE | 0805 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| DF | 0805 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EB | 1206 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| EC | 1206 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| ED | 1206 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| | 1200 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| | 1200 | 1.20 ± 0.15 | 0 | 0 | 2,500 | |
| | 1200 | 1.00 ± 0.20 0.70 ± 0.10 | 0 | 0 | 2,000 | 8,000 |
| | 1210 | 0.76 ± 0.10 0.00 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| | 1210 | 0.90 ± 0.10 1 00 ± 0 10 | 0 | 0 | 4,000 | 10,000 |
| | 1210 | 1.00 ± 0.10 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FG | 1210 | 1.10 ± 0.10 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| FH | 1210 | 1.25 ± 0.15 | 0 | 0 | 2,000 | 8 000 |
| FM | 1210 | 1 70 + 0 20 | 0 | 0 O | 2,000 | 8 000 |
| EI | 1210 | 1 85 + 0 20 | Ő | Ő | 2,000 | 8,000 |
| FK | 1210 | 2.10 + 0.20 | Ő | Ő | 2,000 | 8,000 |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1.000 | 4.000 |
| GD | 1812 | 1.25 + 0.15 | 0 | 0 | 1.000 | 4.000 |
| GH | 1812 | 1.40 ± 0.15 | 0 | Ő | 1.000 | 4.000 |
| GG | 1812 | 1.55 ± 0.10 | 0 | 0 | 1.000 | 4.000 |
| GK | 1812 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GJ | 1812 | 1.70 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GN | 1812 | 1.70 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GM | 1812 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| JB | 2220 | 1.00 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JD | 2220 | 1.30 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JE | 2220 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JF | 2220 | 1.50 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JG | 2220 | 1.70 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JL | 2220 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size1 | Range (mm) | Paper Q | uantity ¹ | Plastic Quantity | |

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size | Metric Size | | Dens Maxi Land Pi | sity Lev mum (I rotrusio | vel A: Most) on (mm |) | | Dens Media Land Pi | sity Lev an (Nor rotrusio | vel B: ninal) on (mm |) | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | |
|-------------------|----------------|------|-------------------------|--------------------------------|---------------------------|------|------|--------------------------|---------------------------------|----------------------------|------|------|---|------|------|------|--|--|--|
| ooue | ooue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | | | |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 | | | |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 | | | |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 | | | |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 | | | |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 | | | |
| 1210 ¹ | 3225 | 1.50 | 1.60 | 2.90 | 5.60 | 3.90 | 1.40 | 1.40 | 2.80 | 4.70 | 3.30 | 1.30 | 1.20 | 2.70 | 4.00 | 3.00 | | | |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 | | | |
| 2220 | 5650 | 2.75 | 1.70 | 5.50 | 8.20 | 6.50 | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | 2.55 | 1.30 | 5.30 | 6.60 | 5.60 | | | |

¹ Only for capacitance values \geq 22 μ F

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805, and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/ J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Terminat | ion Finish |
|--|-----------------------|-----------------------|
| Fromereature | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate (T_L to T_p) | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T _L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |



Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature-reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction



Capacitor Marking (Optional)

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- · EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punche | d Paper |
|----------------------|------|---------|--------------------|---------|--------------------|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| | (W)* | Pitch | (P ₁)* | Pitch | (P ₁)* |
| 01005 - 0402 | 8 | | | 2 | 2 |
| 0603 | 8 | | | 2/4 | 2/4 |
| 0805 | 8 | 4 | 4 | 4 | 4 |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 |
| 1805 - 1808 | 12 | 4 | 4 | | |
| ≥ 1812 | 12 | 8 | 8 | | |
| KPS 1210 | 12 | 8 | 8 | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | |
| Array 0612 | 8 | 4 | 4 | | |

*Refer to Figures 1 and 2 for W and P₁ carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size. 2 mm pitch reel for 0805 EIA case size under development.

2 mm pitch reel for U805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.

Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | | (| Constant Dim | ensions – Mil | limeters (Inc | hes) | | | |
|-----------|---------------------------------------|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 16 mm | | (0.059) | | | | (1.181) | | | |
| | | , | Variable Dime | ensions – Mil | limeters (Incl | nes) | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | te 5 |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_a and B_a are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | | | | | |
|-----------|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|--|--|--|--|--|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | | | | | | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | | | | | | | |
| | | Variable D | imensions – M | illimeters (Inche | es) | | | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | | | | | | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | | | | | | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | | | | | | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius



Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant | Dimensions — Millimete | rs (Inches) | | | | | | |
|-----------|----------------------|---------------------------------------|--|--|--|--|--|--|--|
| Tape Size | А | A B Minimum C | | | | | | | |
| 8 mm | 178 ±0.20 | | | | | | | | |
| 12 mm | (7.008 ±0.008) Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | | | |
| 16 mm | (13.000 ±0.008) | | | | | | | | |
| | Variable | Dimensions — Millimete | rs (Inches) | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Overview

The KEMET Automotive Grade Surface Mount Capacitors in X7R dielectric are suited for a variety of applications requiring proven, reliable performance in harsh environments. Whether underhood or in-cabin, these devices emphasize the vital and robust nature of capacitors required for mission and safety of critical automotive circuits. Stricter testing protocol and inspection criteria have been established for automotive grade products in recognition of potentially harsh environmental conditions. KEMET automotive grade capacitors meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements. X7R dielectric features a 125°C maximum operating temperature and is considered temperature stable. The Electronics Industries Alliance (EIA) characterizes X7R dielectric as a Class II material. Components of this classification are fixed, ceramic dielectric capacitors, suited for bypass and decoupling applications, or for frequency discriminating circuits, where Q and stability of capacitance characteristics are not critical. X7R exhibits a predictable change in capacitance with respect to time and voltage, and boasts a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to $\pm 15\%$ from -55°C to $\pm 125°C$.

Benefits

- · AEC-Q200 automotive qualified
- -55°C to +125°C operating temperature range
- · Lead (Pb)-free, RoHS and REACH compliant
- Temperature stable dielectric
- EIA 0402, 0603, 0805, 1206, 1210, 1808, 1812, 1825, and 2220 case sizes
- DC voltage ratings of 6.3 V, 10 V, 16 V, 25 V, 50 V, 100 V, 200 V and 250 V
- Capacitance offerings ranging from 10 pF to 22 μF
- Available capacitance tolerances of ±5%, ±10% and ±20%
- · Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish, allowing for excellent solderability

Applications

Typical applications include decoupling, bypass, filtering and transient voltage suppression.





Ordering Information

| С | 0805 | C | 225 | М | 4 | R | Α | C | AUTO |
|---------|--|--------------------------|--|---------------------------------|--|------------|------------------------|---------------------------------|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/Design | Termination Finish ¹ | Packaging/Grade (C-Spec) |
| | 0402 0603 0805 1206 1210 1805 1808 1812 1825 2220 | C = Standard | Two significant digits and number of zeros. | J = ±5% K = ±10% M = ±20% | 9 = 6.3 8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 2 = 200 A = 250 | R = X7R | A = N/A | C = 100% matte Sn | See "Packaging C-Spec Ordering Options Table" |

¹ Additional termination finish options may be available. Contact KEMET for details.

Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) ³ |
|---|---|
| 7" Reel | AUTO |
| 13" Reel/Unmarked | AUTO7411 (EIA 0603 and smaller case sizes) AUTO7210 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2 mm pitch ² | 3190 |
| 13" Reel/Unmarked/2 mm pitch ² | 3191 |

¹ Reeling tape options (paper or plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information."

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information."

³ All automotive packaging C-Specs listed exclude the option to laser mark components. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking."

³ For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information."



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | tion Due To: | Days Prior To |
|-----------------------------|----------------------------------|----------------|------------------|
| C-Spec | Process/Product change | Implementation | |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum |
| AUTO | Yes (without approval) | Yes | 90 days minimum |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | | PPAP (Product Part Approval Process) Level | | | | | | | | | | | | | |
|-----------------------------|---|--|---|---|---|--|--|--|--|--|--|--|--|--|--|
| C-Spec | 1 | 2 | 3 | 4 | 5 | | | | | | | | | | |
| KEMET assigned ¹ | • | • | • | • | • | | | | | | | | | | |
| AUTO | | | 0 | | | | | | | | | | | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|-------------------|---------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|----------------------------|---------------------------------|
| 0402 | 1005 | 1.00 (0.040) ±0.05 (0.002) | 0.50 (0.020) ±0.05 (0.002) | | 0.30 (0.012) ±0.10 (0.004) | 0.30 (0.012) | Solder reflow only |
| 06031 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | |
| 0805 ² | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder wave or Solder reflow |
| 1206 ³ | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | | |
| 1210 ⁴ | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | See Table 2 for Thickness | 0.50 (0.02) ±0.25 (0.010) | | |
| 1805 | 4513 | 4.50 (0.177) ±0.50 (0.020) | 1.27 (0.050) ±0.38 (0.015) | | 0.60 (0.024) ±0.35 (0.014) | N/A | |
| 1808 | 4520 | 4.70 (0.185) ±0.50 (0.020) | 2.00 (0.079) ±0.20 (0.008) | | 0.60 (0.024) ±0.35 (0.014) | IN/A | Solder reflow only |
| 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | | 0.60 (0.024) ±0.35 (0.014) | | |
| 2220 | 5650 | 5.70 (0.224) ±0.40 (0.016) | 5.00 (0.197) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | |

¹ For capacitance values \geq 0.56 µF add 0.05 (0.002) to length tolerance dimension with exception on capacitance value 0.22 µF 50V add 0.10 (0.004) to length tolerance dimension.

² For capacitance values 1.0 μ F or \ge 2.2 μ F add 0.10 (0.004) to length tolerance dimension.

 3 For capacitance value 1.0 μ F all voltages and 10 μ F with 25 V add 0.05 (0.002) to length tolerance dimension.

⁴ For capacitance values \geq 4.7 μ F add 0.02 (0.001) to the width tolerance dimension and 0.10 (0.004) to the length tolerance dimension.

For capacitance value 22 µF, Length is [L] 3.30 (0.130) ± 0.40 (0.016) and Width [W] is 2.60 (0.102) ± 0.30 (0.012).



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±15% |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| ² Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | See Dissipation Factor Limit table |
| ^₄ Insulation Resistance (IR) Minimum Limit at 25°C | See Insulation Resistance Limit table (Rated voltage applied for 120 ±5 seconds at 25°C) |

¹ Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 48 or 1,000 hours. Please refer to a part number specific datasheet for referee time details

²DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

³ Capacitance and dissipation factor (DF) measured under the following conditions:

1 kHz ± 50 Hz and 1.0 ± 0.2 $V_{\rm rms}$ if capacitance \leq 10 μF

120 Hz ± 10 Hz and 0.5 ± 0.1 V_{rms} if capacitance > 10 μ F

⁴ To obtain IR limit, divide $M\Omega - \mu F$ value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

| EIA Case Size | Rated DC Voltage | 1,000 megohm microfarads or 100 GΩ | 500 megohm microfarads or 10 GΩ | 100 megohm microfarads or 10 GΩ | | | | | |
|---------------|------------------|---------------------------------------|------------------------------------|------------------------------------|--|--|--|--|--|
| 0402 | < 100 V | < 0.012 µF | ≥ 0.012 µF< 0.47 µf | ≥ 0.47 µf | | | | | |
| 0402 | 100 V | N/A | ALL | N/A | | | | | |
| 06021 | ≤ 200 V | < 0.047 µF | ≥ 0.047 µf < 0.47 µf | ≥ 0.47 µf | | | | | |
| 0003 | 250 V | N/A | N/A | ALL | | | | | |
| 09052 | ≤ 200 V | < 0.15 µF | ≥ 0.15 µF < 2.2 µf | ≥ 2.2 µf | | | | | |
| 0805- | 250 V | < .027 µF | N/A | ≥ .027 µF | | | | | |
| 1206 | ≤ 200 V | < 0.47 µF | ≥ 0.47 µF < 2.2 µf | ≥ 2.2 µf | | | | | |
| 1200 | 250 V | < 0.12 µF | N/A | ≥ 0.12 µF | | | | | |
| 12103 | ≤ 200 V | < 0.39 µF | ≥ 0.39 µF < 10 µf | ≥ 10 µf | | | | | |
| 1210- | 250 V | < 0.27 µF | N/A | ≥ 0.27 µF | | | | | |
| 1805 | ALL | ALL | N/A | N/A | | | | | |
| 1808 | ALL | ALL | N/A | N/A | | | | | |
| 1812 | ALL | < 2.2 µF | ≥ 2.2 µF | N/A | | | | | |
| 1825 | ALL | ALL | N/A | N/A | | | | | |
| 2220 | ALL | < 10 µF | ≥ 10 µF | N/A | | | | | |
| 2225 | ALL | ALL | N/A | N/A | | | | | |

Insulation Resistance Limit Table

¹ For Capacitance values 5.6 nF, 6.8 nF, 8.2 nF and 10 nF (100 V) IR should be calculated under 500 megohm microfarads or 10 GΩ.

 2 For Capacitance value 1.0 μ F (50 V) IR should be calculated under 100 megohm microfarads or 10 G Ω .

 3 For Capacitance value 4.7 μ F (50 V) IR should be calculated under 100 megohm microfarads or 10 G Ω .



Dissipation Factor (DF) Limits Table

| EIA Case Size | Rated DC Voltage | Capacitance | Dissipation Factor (Maximum %) | | | | | |
|-------------------|---------------------|-------------|--------------------------------------|--|--|--|--|--|
| | < 16 | | 5.0 | | | | | |
| 0402 | 16/25 | All | 3.5 | | | | | |
| | > 25 | | 2.5 | | | | | |
| | < 16 | | 5.0 | | | | | |
| 06021 | 16/25 | < 1.0 µF | 3.5 | | | | | |
| 0003 | > 25 | | 2.5 | | | | | |
| | All | ≥ 1.0 µF | 10.0 | | | | | |
| | ~ 16 | < 4.7 µF | 5.0 | | | | | |
| | < 10 | ≥ 4.7 µF | 10.0 | | | | | |
| | 16 | < 4.7 µF | 3.5 | | | | | |
| 08052 | 10 | ≥ 4.7 µF | 10.0 | | | | | |
| 0005 | 25 | <2.2 µF | 3.5 | | | | | |
| | 25 | ≥ 2.2 µF | 10.0 | | | | | |
| | > 25 | <1.0 µF | 2.5 | | | | | |
| | - 20 | ≥ 1.0 µF | 10.0 | | | | | |
| | < 16 | All | 5.0 | | | | | |
| 1206 ³ | 16/25 | All | 3.5 | | | | | |
| | > 25 | All | 2.5 | | | | | |
| | < 16 | All | 5.0 | | | | | |
| | 16 | All | 3.5 | | | | | |
| | 05 | < 10 µF | 3.5 | | | | | |
| 1210 ⁴ | 25 | ≥ 10 µF | 10.0 | | | | | |
| | > 25 | All | 2.5 | | | | | |
| | 50 | All | 2.5 | | | | | |
| | > 50 | All | 2.5 | | | | | |
| | < 16 | | 5.0 | | | | | |
| 1805 - 2225 | 16/25 | All | 3.5 | | | | | |
| | > 25 | | 2.5 | | | | | |

¹ For Capacitance values 0.22 μF (16 and 25 Volts) DF is 5%.

 2 For Capacitance values 2.2 μF (6.3, 10, and 16 Volts) DF is 10%.

 3 For Capacitance values 4.7 and 10 μF (All Voltages) and 2.2 μF (25 and 50 Volts) DF is 10%.

⁴ For Capacitance values ≥ 10 μ F (≤ 16 V) DF is 10% and for Capacitance value 4.7 μ F (50 V) DF is 5%.



Post Environmental Limits

| High | Temperature | Life, Biased | Humidity, Mo | oisture Resis | tance | | | | | |
|-------------------|---------------------|--------------|--------------------------------------|----------------------|--------------------------|--|--|--|--|--|
| EIA Case Size | Rated DC Voltage | Capacitance | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | | | | | |
| | < 16 | All | 7.5 | | | | | | | |
| 0402 | 16/25 | All | 5.0 | | | | | | | |
| | > 25 | All | 3.0 | | | | | | | |
| | < 16 | | 7.5 | | | | | | | |
| 00.001 | 16/25 | < 1.0 µF | 5.0 | | | | | | | |
| 0603 | > 25 | | 3.0 | | | | | | | |
| | All | ≥ 1.0 µF | 20.0 | | | | | | | |
| | . 10 | < 4.7 µF | 7.5 | | | | | | | |
| 00053 | < 10 | ≥ 4.7 µF | 20.0 | | | | | | | |
| | 16 | < 4.7 µF | 5.0 | | | | | | | |
| | 10 | | | | | | | | | |
| 0805- | 05 | < 2.2 µF | 5.0 | | | | | | | |
| | 20 | ≥ 2.2 µF | 20.0 | | | | | | | |
| | 5 DE | < 1.0 µF | 3.0 | 120% | 10% of Initial | | | | | |
| | > 25 | ≥ 1.0 µF | 20.0 | ±20% | limit | | | | | |
| | < 16 | All | 7.5 | | | | | | | |
| 1206³ | 16/25 | All | 5.0 | | | | | | | |
| | > 25 | All | 3.0 | | | | | | | |
| | < 16 | All | 7.5 | | | | | | | |
| | 16 | All | 5.0 | | | | | | | |
| | 25 | < 10 µF | 5.0 | | | | | | | |
| 1210 ⁴ | 20 | ≥ 10 µF | 20.0 | | | | | | | |
| | > 25 | All | 3.0 | | | | | | | |
| | 50 | All | 3.0 | | | | | | | |
| | > 50 | All | 3.0 | | | | | | | |
| | < 16 | All | 7.5 | | | | | | | |
| 1805 - 2225 | 16/25 | All | 5.0 | | | | | | | |
| | > 25 | All | 3.0 | | | | | | | |

¹ For Capacitance values 0.22 μF (16 and 25 Volts) DF is 7.5%.

 2 For Capacitance values 2.2 μ F (6.3, 10, and 16 Volts) DF is 20%

 3 For Capacitance values 4.7 and 10 μF (All Voltages) and 2.2 μF (25 and 50 Volts) DF is 20%

 4 For Capacitance values \geq 10 μF (\leq 16 V) DF is 20% and for Capacitance value 4.7 μF (50 V) DF is 7.5%



Table 1A – Capacitance Range/Selection Waterfall (0402 – 1206 Case Sizes)

| | | C | as /S | se S Serio | Size es | | (| CO 4 | 02 | С | · | | | (| C06 | 03 | С | | | | | (| 208 | 05 | С | · | | | | (| :12 | 06 | C | | |
|----------------|-------------|-----------------|-----------|---------------|------------|-------------|----------|-------------|-----|------|-------|--------|-------|------|------|-----|------|-----|------|-----|-------|-------|------|-------|----------|-----|------|------|-------|------|------|----|-----|------|------|
| Canacitance | Сар | V | olt | age (| Code | 9 | 8 | 4 | 3 | 5 | 1 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A |
| | Code | R | ate | d Vol (VDC | tage) | 6.3 | 1 | 16 | 25 | 50 | 100 | 6.3 | 1 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 5 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 1 | 16 | 25 | 50 | 100 | 200 | 250 |
| | | Ľ | Jap To | olerar | nce ice | | | | Р | rodu | ict A | vail | abili | ty a | nd C | hip | Thic | kne | ss C | ode | s - : | See ' | Tabl | e 2 f | or C | hip | Thic | kne | ss Di | imeı | isio | ns | | | |
| 10 - 91 pF* | 100 - 910* | | J | K | М | BB | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DN | DN | DN | | EB | EB | EB | EB | EB | EB | EB | |
| 100 - 150 pF** | 101 - 151** | | J | K | M | BB | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | |
| 1000 pF^^ | 101 - 821^^ | | J | ĸ | M | BB | BB | BB | BB | BB | | | | | | | | | CE | | | | | | | | | EB | EB | EB | EB | EB | EB | EB | FR |
| 1,200 pF | 102 | | J | ĸ | M | BB | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB |
| 1,500 pF | 152 | Г | J | K | M | BB | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB |
| 1,800 pF | 182 | | J | к | м | BB | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB |
| 2,200 pF | 222 | | J | к | М | BB | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB |
| 2,700 pF | 272 | | J | K | М | BB | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB |
| 3,300 pF | 332 | | J | K | M | BB | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB |
| 3,900 pF | 392 | | J | K | M | BB | BB | BB | BB | BB | | | CF | CF | CF | | | CF | CF | | | | | | | | | EB | EB | EB | EB | EB | EB | EB | EB |
| 4,700 pF | 472 | | J | ĸ | M | | BB | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | ED | ED | ED | ED | ED | ED | ED |
| 6 800 pF | 682 | | | ĸ | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | CF | | | | | | | | DN | FR | FR | FR | FR | FR | FR | FB | FB |
| 8.200 pF | 822 | | J | ĸ | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB |
| 10,000 pF | 103 | Ŀ | J | К | М | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB |
| 12,000 pF | 123 | | J | К | м | BB | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB |
| 15,000 pF | 153 | | J | К | м | BB | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DP | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB |
| 18,000 pF | 183 | | J | K | M | BB | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DP | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB |
| 22,000 pF | 223 | | J | K | M | BB | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DP | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB |
| 27,000 pF | 2/3 | | J | ĸ | M | DD RR | DD DD | BB | BB | | | | | | | | | | | | | | | | | | | EB | EB | EB | EB | EB | EB | EB | EB |
| 39,000 pF | 393 | | J .1 | K | M | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | | | | | | | | | DE | DG | FR | FR | FR | FR | FR | FC | FB | FB |
| 47.000 pF | 473 | | J | ĸ | M | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DE | DG | DG | EB | EB | EB | EB | EB | EC | ED | ED |
| 56,000 pF | 563 | | J | K | M | BB | BB | BB | | | | CF | CF | CF | CF | CF | CJ | | | DP | DP | DP | DP | DP | DE | DG | DG | EB | EB | EB | EB | EB | EB | ED | ED |
| 68,000 pF | 683 | | J | К | М | BB | BB | BB | | | | CF | CF | CF | CF | CF | CJ | | | DP | DP | DP | DP | DP | DE | DG | DG | EB | EB | EB | EB | EB | EB | ED | ED |
| 82,000 pF | 823 | | J | К | м | BB | BB | BB | | | | CF | CF | CF | CF | CF | CJ | | | DP | DP | DP | DP | DP | DE | | | EB | EB | EB | EB | EB | EB | ED | ED |
| 0.10 µF | 104 | | J | K | М | BB | BB | BB | | | | CF | CF | CF | CF | CF | CJ | | | DN | DN | DN | DN | DN | DE | | | EB | EB | EB | EB | EB | EB | EM | EM |
| 0.12 µF | 124 | | J | K | M | | | | | | | CF | CF | CF | CF | CF | | | | DN | DN | DN | DN | DP | DG | | | EC | EC | EC | EC | EC | EC | EG | EM |
| 0.15 µF | 154 | | J | K | M | | | | | | | CF | CF | CF | CF | CF | | | | | | | DN | DP | DG | | | EC | EC | EC | EC | EC | EC | EG | EG |
| 0.18 µF | 224 | | J | ĸ | M | | | | | | | | | | | CI | | | | | | | | | | | | | EC | EC | EC | EC | EC | EIVI | EIVI |
| 0.22 µ1 | 274 | | J | ĸ | M | | | | | | | CF | CF | CF | | 00 | | | | DP | DP | DP | DP | DP | 00 | | | FB | FB | FB | FB | FC | FM | LU | LU |
| 0.33 µF | 334 | | J | ĸ | M | | | | | | | CF | CF | CF | | | | | | DP | DP. | DP | DP | DP. | | | | EB | EB | EB | EB | EC | EG | | |
| 0.39 µF | 394 | | J | к | м | | | | | | | CF | CF | CF | | | | | | DG | DG | DG | DG | DE | | | | EB | EB | EB | EB | EC | EG | | |
| 0.47 µF | 474 | | J | K | М | | | | | | | CF | CF | CF | CG | | | | | DP | DP | DP | DP | DE | | | | EC | EC | EC | EC | EC | EG | | |
| 0.56 µF | 564 | | J | K | М | | | | | | | | | | | | | | | DP | DP | DP | DG | DH | | | | ED | ED | ED | ED | EC | EM | | |
| 0.68 µF | 684 | | J | K | М | | | | | | | | | | | | | | | DP | DP | DP | DG | DH | | | | EE | EE | EE | EE | ED | EM | | |
| 0.82 µF | 824 | | J | K | M | | | | | | | 0.11 | 0.11 | 0.11 | | | | | | DP | DP | DP | DG | | | | | EF | EF | EF | EF | ED | EH | | |
| 1.0 μF | 105 | | J | ĸ | M | | | | | | | CJ, | CJ, | CJ. | | | | | | | DP | | DG | UH | | | | | EF | EF | EG | EU | EH | | |
| 1.2 µF | 125 | | J .1 | K | M | | | | | | | | | | | | | | | | | DG | | | | | | FF | FF | FF | FG | FH | | | |
| 1.8 µF | 185 | | J | ĸ | M | | | | | | | | | | | | | | | DG | DG | DG | | | | | | ED | ED | ED | EF | EH | | | |
| 2.2 µF | 225 | | J | K | M | | | | | | | | | | | | | | | DG | DG | DG | DG | DH | | | | EH | EH | EH | EH | EH | | | |
| 2.7 µF | 275 | | J | K | М | | | | | | | | | | | | | | | | | | | | | | | EN | EN | EN | EH | | | | |
| 3.3 µF | 335 | | J | K | M | | | | | | | | | | | | | | | | | | | | | | | ED | ED | ED | EH | | | | |
| 3.9 µF | 395 | Þ | J ate | K K | M | _ | | - | | _ | _ | - | | | | - | _ | _ | _ | - | _ | | | | | _ | _ | I EF | EF | EF | EH | | | _ | _ |
| | | Ľ | (| (VDC |) | <u>و</u> .ژ | 9 | 16 | 25 | 50 | ē | و | 2 | 16 | 25 | 50 | Ĩ | 20(| 25(| ق | 2 | 16 | 25 | 20 | 10 10 | 20(| 25(| و | 9 | 16 | 25 | 20 | é | 20(| 25(|
| Capacitance | Cap Code | le Voltage Code | | 9 | 8 | 4 | 3 | 5 | 1 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | | |
| | | | Ca /S | se S Serie | ize s | | | C04 | 020 | ; | | C0603C | | | | | | | C08 | 05C | ; | | | | | | C12 | 06C | | | | | | | |

*Capacitance range includes E24 decade values only (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91.) **Capacitance range includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, and 82.)

 xx^1 Available only in K and M tolerances.



Table 1A - Capacitance Range/Selection Waterfall (0402 - 1206 Case Sizes) cont.

| Capacitance | | C | as /S | e S eri | Size es | | (| C04 | 02 | С | | | | (| C06 | 03 | С | | | | | (| :08 | 05 | С | | | | | (| C12 | 06 | C | | |
|-------------|----------|------------------------|--------------|---------------|-------------|-----|----|-----|-----|------|-------|------|-------|------|------|-----|------|-----|------|-----|-------|-------|-------------|-------|-------|-----|------|-----|------|-----|------|-----|-----|-----|-----|
| | Сар | V | Voltage Code | | 9 | 8 | 4 | 3 | 5 | 1 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | Α | |
| | Code | Rated Voltage (VDC) | | 6.3 | 10 | 16 | 25 | 50 | 100 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | | |
| | | C | apa To | acita lera | ance nce | | | | Ρ | rodu | ict A | vail | abili | ty a | nd C | hip | Thic | kne | ss C | ode | s – S | See ' | Fabl | e 2 f | for C | hip | Thic | kne | ss D | ime | nsio | ns | | | |
| 4.7 μF | 475 | J | 1 | Κ | М | | | | | | | | | | | | | | | DG | DG | DG | DH | | | | | EF | EH | EH | EH | EH | | | |
| 5.6 µF | 565 | J | | Κ | M | | | | | | | | | | | | | | | | | | | | | | | EH | EH | EH | | | | | |
| 6.8 µF | 685 | J | | Κ | M | | | | | | | | | | | | | | | | | | | | | | | EH | EH | EH | | | | | |
| 8.2 µF | 825 | J | 1 | Κ | M | | | | | | | | | | | | | | | | | | | | | | | EH | EH | EH | | | | | |
| 10 µF | 106 | J | | Κ | M | | | | | | | | | | | | | | | DH | DH | | | | | | | EH | EH | EH | EH | | | | |
| | | Ra | nter (| d Vo VDC | ltage ;) | 6.3 | 10 | 16 | 25 | 50 | 100 | 6.3 | 5 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 9 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 9 | 16 | 25 | 50 | 100 | 200 | 250 |
| Capacitance | Cap Code | v | olta | age | Code | 9 | 8 | 4 | 3 | 5 | 1 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | Α |
| | | (| Cas /S | se S Serio | ize es | | | C04 | 020 | ; | | | | | C06 | 03C | ; | | | | | | C08 | 05C | ; | | | | | | C12 | 06C | | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82 and 91) **Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68 and 82) xx¹ Available only in K and M tolerance.

Table 1B – Capacitance Range/Selection Waterfall (1210 – 1808 Case Sizes)

| | | Ca / | ze s | | C1210C | | | | | | | | 1805 | С | C1808C | | | |
|----------------|-------------|----------------------|----------|---------|--------|---------|-----------|---------|--------|--------|---------|---------|---------|----------|----------|-------------|--------|-------|
| Consoitonoo | Con Codo | Vo | ltage Co | ode | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | 5 | 1 | 2 |
| Capacitance | Cap Code | Rated Voltage (VDC) | | | 6.3 | 5 | 16 | 25 | 20 | 100 | 200 | 250 | 50 | 100 | 200 | 50 | 100 | 200 |
| | | Capacit | ance To | lerance | Prod | uct Ava | ailabilit | y and C | hip Th | icknes | s Code: | s – See | Table 2 | 2 for Cl | nip Thio | l ckness | Dimens | sions |
| 10 - 91 pF* | 100 - 910* | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 100 - 180 pF** | 101 - 181** | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 220 pF | 221 | J | K | M | FB | FB | FB | FB | FB | FB | FB | | NC | NC | NC | | | |
| 270 pF | 271 | J | K | M | FB | FB | FB | FB | FB | FB | FB | | NC | NC | NC | | | |
| 330 pF | 331 | J | K | M | FB | FB | FB | FB | FB | FB | FB | | NC | NC | NC | LF | LF | LF |
| 390 pF | 391 | J | K | M | FB | FB | FB | FB | FB | FB | FB | | NC | NC | NC | LF | LF | LF |
| 470 - 820 pF** | 471 - 821** | J | К | M | FB | FB | FB | FB | FB | FB | FB | | NC | NC | NC | LF | LF | LF |
| 1,000 pF | 102 | J | JKN | | FB | FB | FB | FB | FB | FB | FB | | NC | NC | NC | LF | LF | LF |
| 1,200 pF | 122 | J | J K M | | FB | FB | FB | FB | FB | FB | FB | | NC | NC | | LF | LF | LF |
| 1,500 pF | 152 | J | J K M | | FB | FB | FB | FB | FB | FB | FE | | NC | NC | | LF | LF | LF |
| 1,800 pF | 182 | J | K | M | FB | FB | FB | FB | FB | FB | FE | | NC | NC | | LF | LF | LF |
| 2,200 pF | 222 | J | K | M | FB | FB | FB | FB | FB | FB | FB | FB | NC | NC | | LF | LF | LF |
| 2,700 pF | 272 | J | K | M | FB | FB | FB | FB | FB | FB | FB | FB | NA | | | LF | LF | LF |
| 3,300 pF | 332 | J | K | M | FB | FB | FB | FB | FB | FB | FB | FB | NA | | | LF | LF | |
| 3,900 pF | 392 | J | K | M | FB | FB | FB | FB | FB | FB | FB | FB | NA | | | LF | LF | |
| 4,700 pF | 472 | J | K | M | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | |
| 5,600 pF | 562 | J | K | M | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | |
| 6,800 pF | 682 | J | K | M | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | |
| 8,200 pF | 822 | J | K | M | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | |
| 10,000 pF | 103 | J | K | M | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | |
| | | Rated | Voltage | e (VDC) | 6.3 | 6 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 50 | 100 | 200 |
| Capacitance | Cap Code | Voltage Code | | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | 5 | 1 | 2 | |
| | | Case Size /Series | | | | | | C12 | 10C | | C1805C | ; | C1808C | | | | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82 and 91) **Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68 and 82) ² Available capacitance values available in X7P with KONNEKT Technology.

² Available capacitance values available in <u>X7R with KONNEKT Technology</u>.



Table 1B - Capacitance Range/Selection Waterfall (1210 - 1808 Case Sizes) cont.

| | | Case Size /Series | | | | C1210C | | | | | | | | C1805C | | | C1808C | | | |
|-------------|----------|---|---|-----|---|--------|----|-----|------|-----|--------|-----|----|--------|-----|----|--------|-----|--|--|
| Canacitance | Can Code | ap Code Rated Voltage (VDC) Capacitance Tolerance | | | 9 | 8 | 4 | 3 | 5 | 1 | 2 | Α | 5 | 1 | 2 | 5 | 1 | 2 | | |
| Capacitance | Cap Code | | | | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 50 | 100 | 200 | | |
| | | | | | Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dime | | | | | | | | | | | | | | | |
| 12,000 pF | 123 | J | K | М | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | | | |
| 15,000 pF | 153 | J | K | M | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | | | |
| 18,000 pF | 183 | J | K | M | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | | | |
| 22,000 pF | 223 | J | K | M | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | | | |
| 27,000 pF | 273 | J | K | M | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | | | |
| 33,000 pF | 333 | J | K | M | FB | FB | FB | FB | FB | FB | FB | FB | NA | | | LD | LD | | | |
| 39,000 pF | 393 | J | ĸ | M | FB | FB | FB | FB | FB | FB | FB | FB | NA | | | LD | LD | | | |
| 47,000 pF | 473 | J | K | M | FB | FB | FB | FB | FB | FB | FB | FB | NA | | | LD | LD | | | |
| 56,000 pF | 563 | J | ĸ | M | FB | FB | FB | FB | FB | FB | FC | FC | NA | | | LD | LD | | | |
| 68,000 pF | 683 | J | ĸ | M | FB | FB | FB | FB | FB | FB | FC | FC | NA | | | LD | | | | |
| 82,000 pF | 823 | J | K | M | FB | FB | FB | FB | FB | FC | FF | FF | NA | | | LD | | | | |
| 0.10 µF | 104 | J | K | M | FB | FB | FB | FB | FB | FD | FG | FG | NA | | | LD | | | | |
| 0.12 µF | 124 | | K | M | FB | FB | FB | FB | FB | FD | FH | FH | | | | LD | | | | |
| 0.15 μF | 154 | J | K | M | FC | FC | FC | FC | FC | FD | FM | FM | | | | LD | | | | |
| 0.18 µF | 184 | J | K | M | FC | FC | FC | FC | FC | FD | FK | FK | | | | LD | | | | |
| 0.22 μF | 224 | J | K | М | FC | FC | FC | FC | FC | FD | FK | FK | | | | | | | | |
| 0.27 µF | 274 | J | ĸ | м | FC | FC | FC | FC | FC | FD | FP | FP | | | | | | | | |
| 0.33 µF | 334 | J | ĸ | м | FD | FD | FD | FD | FD | FD | FM | FM | | | | | | | | |
| 0.39 µF | 394 | J | ĸ | м | FD | FD | FD | FD | FD | FD | FK | FK | | | | | | | | |
| 0.47 µF | 474 | J | ĸ | м | FD | FD | FD | FD | FD | FD | FS | FS | | | | | | | | |
| 0.56 µF | 564 | J | K | М | FD | FD | FD | FD | FD | FF | | | | | | | | | | |
| 0.68 µF | 684 | J | к | М | FD | FD | FD | FD | FD | FG | | | | | | | | | | |
| 0.82 µF | 824 | J | к | М | FF | FF | FF | FF | FF | FL | | | | | | | | | | |
| 1.0 µF | 105 | J | к | М | FH | FH | FH | FH | FH | FM | | | | | | | | | | |
| 1.2 µF | 125 | J | к | М | FH | FH | FH | FH | FG | FH | | | | | | | | | | |
| 1.5 µF | 155 | J | К | М | FH | FH | FH | FH | FG | FM | | | | | | | | | | |
| 1.8 µF | 185 | J | к | м | FH | FH | FH | FH | FG | FJ | | | | | | | | | | |
| 2.2 µF | 225 | J | к | м | FJ | FJ | FJ | FJ | FG | FK | | | | | | | | | | |
| 2.7 µF | 275 | J | к | м | FE | FE | FE | FG | FH | | | | | | | | | | | |
| 3.3 µF | 335 | J | ĸ | м | FF | FF | FF | FM | FM | | | | | | | | | | | |
| 3.9 µF | 395 | J | К | М | FG | FG | FG | FG | FK | | | | | | | | | | | |
| 4.7 μF | 475 | J | к | м | FC | FC | FC | FG | FS | | | | | | | | | | | |
| 5.6 µF | 565 | J | к | м | FF | FF | FF | FH | | | | | | | | | | | | |
| 6.8 µF | 685 | J | к | м | FG | FG | FG | FM | | | | | | | | | | | | |
| 8.2 µF | 825 | J | K | М | FH | FH | FH | FK | | | | | | | | | | | | |
| 10 µF | 106 | J | K | М | FS | FS | FS | FS | | | | | | | | | | | | |
| 22 µF | 226 | J | ĸ | м | FS | FS | | | | | | | | | | | | | | |
| | | Rated Voltage (VDC) | | | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 50 | 100 | 200 | | |
| Capacitance | Cap Code | Voltage Code | | ode | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | 5 | 1 | 2 | | |
| | | Case Size /Series | | | | | | C12 | 210C | | C18050 | ; | | C1808C | ; | | | | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82 and 91)

**Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68 and 82)

² Available capacitance values available in <u>X7R with KONNEKT Technology</u>.


Table 1C - Capacitance Range/Selection Waterfall (1812 - 2220 Case Sizes)

| | | | Case Size /Series | | C1812C ² | | | | | C18 | 25C | | C2220C | | | | | |
|----------------|-------------|---------|----------------------|----------|---------------------|---------|-----------|---------|--------|--------|--------|---------|--------|----------|-------------------------------|--------|-------|-------|
| Canacitance | Can Code | Vo | ltage Co | ode | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 3 | 5 | 1 | 2 | A |
| Capacitance | Cap Code | Rated | Rated Voltage (VDC) | | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | 25 | 25 50 100 200 250 | | | 250 |
| | | Capacit | ance To | olerance | Prod | uct Ava | ailabilit | y and C | hip Th | icknes | s Code | s – See | Table | 2 for Cl | hip Thi | ckness | Dimen | sions |
| 470 - 820 pF** | 471 - 821** | J | K | М | GB | GB | GB | GB | | | | | | | | | | |
| 1,000 pF | 102 | J | K | M | GB | GB | GB | GB | | | | | | | | | | |
| 1,200 pF | 122 | J | K | M | GB | GB | GB | GB | | | | | | | | | | |
| 1,500 pF | 152 | J | K | M | GB | GB | GB | GB | | | | | | | | | | |
| 1,800 pF | 182 | J | K | M | GB | GB | GB | GB | | | | | | | | | | |
| 2,200 pF | 222 | J | К | M | GB | GB | GB | GB | | | | | | | | | | |
| 2,700 pF | 272 | J | К | M | GB | GB | GB | GB | | | | | | | | | | |
| 3,300 pF | 332 | J | K | M | GB | GB | GB | GB | | | | | | | | | | |
| 3,900 pF | 392 | J | К | M | GB | GB | GB | GB | | | | | | | | | | |
| 4,700 pF | 472 | J | К | М | GB | GB | GB | GD | | | | | | | | | | |
| 5,600 pF | 562 | J | K | M | GB | GB | GB | GH | | | | | | | | | | |
| 6,800 pF | 682 | J | K | M | GB | GB | GB | GB | GB | | | | | JE | JE | JE | | |
| 8,200 pF | 822 | J | K | M | GB | GB | GB | GB | GB | | | | | JE | JE | JE | | |
| 10,000 pF | 103 | J | K | M | GB | GB | GB | GB | GB | | | | | JE | JE | JE | | |
| 12,000 pF | 123 | J | K | M | GB | GB | GB | GB | GB | | | | | JE | JE | JE | | |
| 15,000 pF | 153 | J | K | M | GB | GB | GB | GB | GB | | | | | JE | JE | JE | | |
| 18,000 pF | 183 | J | K | M | GB | GB | GB | GB | GB | | | | | JE | JE | JE | | |
| 22,000 pF | 223 | J | K | M | GB | GB | GB | GB | GB | HB | HB | HB | HB | JE | JE | JE | | |
| 27,000 pF | 273 | J | ĸ | M | GB | GB | GB | GB | GB | HB | HB | HB | HB | JE | JE | JE | | |
| 33,000 pF | 333 | J | K | М | GB | GB | GB | GB | GB | HB | HB | HB | HB | JB | JB | JB | | |
| 39,000 pF | 393 | J | K | M | GB | GB | GB | GB | GB | HB | HB | HB | HB | JB | JB | JB | | |
| 47,000 pF | 473 | J | K | M | GB | GB | GB | GB | GB | HB | HB | HB | HB | JB | JB | JB | | |
| 56,000 pF | 563 | J | K | M | GB | GB | GB | GB | GB | HB | HB | HB | HB | JB | JB | JB | | |
| 68,000 pF | 683 | J | K | M | GB | GB | GB | GB | GB | HB | HB | HB | HB | JB | JB | JB | | |
| 82,000 pF | 823 | J | K | M | GB | GB | GB | GB | GB | HB | HB | HB | HB | JB | JB | JC | JC | JC |
| 0.10 µF | 104 | J | K | M | GB | GB | GB | GB | GB | HB | HB | HB | HB | JB | JB | JC | JC | JC |
| 0.12 µF | 124 | J | K | M | GB | GB | GB | GB | GB | НВ | HB | HB | HB | JB | JB | JC | JC | JC |
| 0.15 µF | 154 | J | K | M | GB | GB | GB | GE | GE | НВ | HB | HB | HB | JB | JB | JC | JC | JC |
| 0.18 µF | 184 | J | K | M | GB | GB | GB | GG | GG | HB | HB | HB | HB | JB | JB | JC | JC | JC |
| 0.22 µF | 224 | J | K | M | GB | GB | GB | GG | GG | НВ | НВ | НВ | НВ | JB | JB | JC | JC | JC |
| | | Rated | Voltage | e (VDC) | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | 25 | 50 | 100 | 200 | 250 |
| Capacitance | Cap Code | Vo | ltage Co | ode | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 3 | 5 | 1 | 2 | A |
| | | C | ase Siz /Series | ze | | | C1812C | 2 | | | C18 | 25C | | | | C22200 |) | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82 and 91)

**Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68 and 82)

² Available capacitance values available in X7R with KONNEKT Technology.



Table 1C – Capacitance Range/Selection Waterfall (1812 – 2220 Case Sizes) cont.

| | | Ca / | ase Si 'Serie | ze s | | C | 1812 | C ² | | | C18 | 25C | • | | C | 2220 | С | |
|-------------|----------|----------------------|---------------------|---------------------|------|---------|-----------|-----------------------|---------|--------|--------|---------|-------|----------|----------|--------|-------|-------|
| Canacitanco | Can Codo | Vo | Itage Co | ode | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 3 | 5 | 1 | 2 | A |
| Capacitance | Cap Code | Rated | Rated Voltage (VDC) | | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | 25 | 50 | 100 | 200 | 250 |
| | | Capacit | tance To | olerance | Prod | uct Ava | ailabilit | y and C | chip Th | icknes | s Code | s – See | Table | 2 for Cl | hip Thio | ckness | Dimen | sions |
| 0.27 μF | 274 | J | K | M | GB | GB | GG | GG | GG | HB | HB | HB | HB | JC | JC | JC | JC | JC |
| 0.33 µF | 334 | J | K | M | GB | GB | GG | GG | GG | НВ | HB | HB | HB | JC | JC | JC | JC | JC |
| 0.39 µF | 394 | J | K | M | GB | GB | GG | GG | GG | HD | HD | HD | HD | JC | JC | JC | JC | JC |
| 0.47 µF | 474 | J | K | M | GB | GB | GG | GJ | GJ | HD | HD | HD | HD | JC | JC | JC | JC | JC |
| 0.56 µF | 564 | J | K | M | GC | GC | GG | | | HD | HD | HD | HD | JC | JD | JD | JD | JD |
| 0.68 µF | 684 | J | K | M | GC | GC | GG | | | HD | HD | HD | HD | JC | JD | JD | JD | JD |
| 0.82 µF | 824 | J | K | M | GE | GE | GG | | | HF | HF | HF | HF | JC | JF | JF | JF | JF |
| 1.0 μF | 105 | J | ĸ | M | GE | GE | GG | | | HF | HF | HF | HF | JC | JF | JF | JF | JF |
| 1.2 μF | 125 | J | ĸ | M | GB | GB | GB | | | | | | | JC | JC | | | |
| 1.5 μF | 155 | J | ĸ | M | GC | GC | GC | | | | | | | JC | JC | | | |
| 1.8 µF | 185 | J | K | М | GE | GE | GE | | | | | | | JD | JD | | | |
| 2.2 µF | 225 | J | к | M | GO | GO | GG | | | | | | | JF | JF | | | |
| 2.7 µF | 275 | J | К | M | GJ | GJ | GJ | | | | | | | | | | | |
| 3.3 µF | 335 | J | К | М | GL | GL | GL | | | | | | | | | | | |
| 3.9 µF | 395 | J | К | М | GK | GK | | | | | | | | | | | | |
| 4.7 µF | 475 | J | К | М | GK | GK | | | | | | | | JF | JF | | | |
| 10 µF | 106 | J | к | М | GK | | | | | | | | | JF | JO | | | |
| 15 µF | 156 | J | к | М | | | | | | | | | | JO | | | | |
| 22 µF | 226 | J | к | М | | | | | | | | | | JO | | | | |
| | | Rated | Voltage | e (VDC) | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | 25 | 50 | 100 | 200 | 250 |
| Capacitance | Cap Code | Vo | ltage Co | ode | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 3 | 5 | 1 | 2 | A |
| | | Case Size /Series | | C1812C ² | | | C1825C | | | C2220C | | | | | | | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82 and 91)

**Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68 and 82)

² Available capacitance values available in <u>X7R with KONNEKT Technology</u>.



| Table 2 – Chip | Thickness/Tap | e & Reel Pa | ckaging Q | Juantities |
|----------------|----------------------|-------------|-----------|-------------------|
|----------------|----------------------|-------------|-----------|-------------------|

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic Quantity | | | |
|-----------|-------------------|-------------|-----------------------------|----------------------|------------------|----------|--|--|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | |
| BB | 0402 | 0.50 ± 0.05 | 10,000 | 50,000 | 0 | 0 | | |
| CF | 0603 | 0.80 ± 0.07 | 4,000 | 15,000 | 0 | 0 | | |
| CG | 0603 | 0.80 ± 0.10 | 4,000 | 15,000 | 0 | 0 | | |
| CJ | 0603 | 0.80 ± 0.15 | 4,000 | 15,000 | 0 | 0 | | |
| DN | 0805 | 0.78 ± 0.10 | 4,000 | 15,000 | 0 | 0 | | |
| DP | 0805 | 0.90 ± 0.10 | 4,000 | 15,000 | 0 | 0 | | |
| DE | 0805 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 | | |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | | |
| DH | 0805 | 1.25 ± 0.20 | 0 | 0 | 2,500 | 10,000 | | |
| EB | 1206 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 | | |
| EC | 1206 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 | | |
| EN | 1206 | 0.95 ± 0.10 | 0 | 0 | 4,000 | 10,000 | | |
| ED | 1206 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 | | |
| EE | 1206 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 | | |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 | | |
| EM | 1206 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | | |
| EG | 1206 | 1.60 ± 0.15 | 0 | 0 | 2,000 | 8,000 | | |
| EH | 1206 | 1.60 ± 0.20 | 0 | 0 | 2,000 | 8,000 | | |
| FB | 1210 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 | | |
| FC | 1210 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 | | |
| FD | 1210 | 0.95 ± 0.10 | 0 | 0 | 4,000 | 10,000 | | |
| FE | 1210 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 | | |
| FF | 1210 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 | | |
| FG | 1210 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | | |
| FL | 1210 | 1.40 ± 0.15 | 0 | 0 | 2,000 | 8,000 | | |
| FH | 1210 | 1.55 ± 0.15 | 0 | 0 | 2,000 | 8,000 | | |
| FP | 1210 | 1.60 ± 0.20 | 0 | 0 | 2,000 | 8,000 | | |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 | | |
| FJ | 1210 | 1.85 ± 0.20 | 0 | 0 | 2,000 | 8,000 | | |
| FK | 1210 | 2.10 ± 0.20 | 0 | 0 | 2,000 | 8,000 | | |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1,000 | 4,000 | | |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | |
| Code | Size ¹ | Range (mm) | Paper Quantity ¹ | | Plastic Quantity | | | |

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape & Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information."



Table 2 - Chip Thickness/Tape & Reel Packaging Quantities cont.

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic (| Quantity | |
|-----------|-------------------|-------------|---------|-----------------------------|-----------|----------|--|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| NA | 1805 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 | |
| NC | 1805 | 1.00 ± 0.15 | 0 | 0 | 4,000 | 10,000 | |
| LD | 1808 | 0.90 ± 0.10 | 0 | 0 | 2,500 | 10,000 | |
| LF | 1808 | 1.00 ± 0.15 | 0 | 0 | 2,500 | 10,000 | |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 | |
| GC | 1812 | 1.10 ± 0.10 | 0 | 0 | 1,000 | 4,000 | |
| GD | 1812 | 1.25 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| GE | 1812 | 1.30 ± 0.10 | 0 | 0 | 1,000 | 4,000 | |
| GH | 1812 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| GG | 1812 | 1.55 ± 0.10 | 0 | 0 | 1,000 | 4,000 | |
| GK | 1812 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 | |
| GJ | 1812 | 1.70 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| GL | 1812 | 1.90 ± 0.20 | 0 | 0 | 500 | 2,000 | |
| GO | 1812 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 | |
| HB | 1825 | 1.10 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| HD | 1825 | 1.30 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| HF | 1825 | 1.50 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| JB | 2220 | 1.00 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| JC | 2220 | 1.10 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| JD | 2220 | 1.30 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| JE | 2220 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| JF | 2220 | 1.50 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| JO | 2220 | 2.40 ± 0.15 | 0 | 0 | 500 | 2,000 | |
| KB | 2225 | 1.00 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| KC | 2225 | 1.10 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| KD | 2225 | 1.30 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| KE | 2225 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| Code | Size ¹ | Range (mm) | Paper Q | Paper Quantity ¹ | | Quantity | |

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape & Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information."



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size | Metric Size | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | |
|-------------------|----------------|--|------|------|------|------|--|------|------|------|------|---|------|------|------|------|
| ooue | ooue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 |
| 1210 ¹ | 3225 | 1.50 | 1.60 | 2.90 | 5.60 | 3.90 | 1.40 | 1.40 | 2.80 | 4.70 | 3.30 | 1.30 | 1.20 | 2.70 | 4.00 | 3.00 |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 |
| 2220 | 5650 | 2.75 | 1.70 | 5.50 | 8.20 | 6.50 | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | 2.55 | 1.30 | 5.30 | 6.60 | 5.60 |

¹ Only for capacitance values $\ge 22 \ \mu F$

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805, and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

The KEMET families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. The KEMET recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Terminati | ion Finish |
|--|-----------------------|-----------------------|
| Trome reduire | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate ($T_L to T_P$) | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T_L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |



Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.

Storage & Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction (Typical)





Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a "K" to identify KEMET, followed by two characters (per EIA–198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the "K" character only.

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.
- X7R dielectric products in capacitance values outlined below.

| EIA Case Size | Metric Size Code | Capacitance |
|---------------|------------------|-------------|
| 0603 | 1608 | ≤ 170 pF |
| 0805 | 2012 | ≤ 150 pF |
| 1206 | 3216 | ≤ 910 pF |
| 1210 | 3225 | ≤ 2,000 pF |
| 1808 | 4520 | ≤ 3,900 pF |
| 1812 | 4532 | ≤ 6,700 pF |
| 1825 | 4564 | ≤ 0.018 µF |
| 2220 | 5650 | ≤ 0.027 µF |
| 2225 | 5664 | ≤ 0.033 µF |

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 μ F. Orientation of marking is vendor optional.





Capacitor Marking (Optional) cont.

| | Capacitance (pF) For Various Alpha/Numeral Identifiers | | | | | | | | | | | |
|-----------|--|-----|----|-----|-------|----------|---------|-----------|------------|-------------|--|--|
| Alaba | | | | | | Numera | l I | | | | | |
| Alpha | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | |
| Character | | | | | Capa | acitance | e (pF) | | | | | |
| A | 0.10 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 | | |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 | | |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 | | |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 | | |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 | | |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 | | |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 | | |
| Н | 0.20 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 | | |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 | | |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 | | |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 | | |
| М | 0.30 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 | | |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 | | |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 | | |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 | | |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 | | |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 | | |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 | | |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 | | |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 | | |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 | | |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 | | |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 | | |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 | | |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 | | |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 | | |
| d | 0.40 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 | | |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 | | |
| f | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 | | |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 | | |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 | | |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 | | |
| у | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 | | |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punched Paper | | | |
|----------------------|------|---------|--------------------|--------------------------|----------|--|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | |
| | (W)* | Pitch | (P ₁)* | Pitch (P ₁)* | | | |
| 01005 - 0402 | 8 | | | 2 | 2 | | |
| 0603 | 8 | | | 2/4 | 2/4 | | |
| 0805 | 8 | 4 | 4 | 4 | 4 | | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | | |
| 1805 - 1808 | 12 | 4 | 4 | | | | |
| ≥ 1812 | 12 | 8 | 8 | | | | |
| KPS 1210 | 12 | 8 | 8 | | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | | |
| Array 0612 | 8 | 4 | 4 | | | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions — Millimeters (Inches) | | | | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|--|--|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum | | | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | | |
| 16 mm | | (0.059) | | | | (1.181) | | | | | | |
| | | , | Variable Dime | ensions – Mil | limeters (Incl | nes) | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ | | | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | te 5 | | | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | | Constant [|)imensions — M | lillimeters (Inch | es) | | | | | | | | | | |
|-----------|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|--|--|--|--|--|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | | | | | | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | | | | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | | | | | | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | | | | | | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | | | | | | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant | Dimensions — Millimete | rs (Inches) | |
|-----------|-----------------|---------------------------------------|--|--|
| Tape Size | А | B Minimum | С | D Minimum |
| 8 mm | 178 ±0.20 | | | |
| 12 mm | 0r | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) |
| 16 mm | (13.000 ±0.008) | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber



High Voltage with Flexible Termination System (HV FT-CAP) X7R Dielectric, 500 - 3,000 VDC (Commercial Grade)



Overview

KEMET's High Voltage with Flexible Termination (HV FT-CAP) surface mount MLCCs in X7R dielectric address the primary failure mode of MLCCs-flex cracks, which are typically the result of excessive tensile and shear stresses produced during board flexure and thermal cycling. Featuring several of the highest CV (capacitance/voltage) values available in the industry, these devices utilize a pliable and conductive silver epoxy between the base metal and nickel barrier layers of the termination system. The addition of this epoxy layer inhibits the transfer of board stress to the rigid ceramic body, therefore mitigating flex cracks which can result in low IR or short circuit failures. Although flexible termination technology does not eliminate the potential for mechanical damage that may propagate during extreme environmental and handling conditions, it does provide superior flex performance over standard termination systems.

Combined with the stability of an X7R dielectric and designed to accommodate all capacitance requirements, these flex-robust devices are RoHS-compliant, offer up to 5 mm of flex-bend capability and exhibits a predictable change in capacitance with respect to time and voltage. Capacitance change with reference to ambient temperature is limited to ±15% from -55°C to +125°C.

In addition to Commercial Grade, Automotive Grade devices are available which meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.

Ordering Information

Applications

- Charging stations
- LCD fluorescent backlight ballasts
- Voltage multiplier circuits
- DC/DC converters
- Power supply
- · LAN/WAN interface
- High voltage decoupling
- Filters
- DC blocking
- ESD Protection



| C | 1210 | X | 154 | K | С | R | Α | C | TU |
|---------|--|-----------------------------|---|---------------------------------|---|------------|-------------------------|--|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ¹ | Packaging/ Grade (C-Spec) |
| | 0603 0805 1206 1210 1808 1812 1825 2220 2225 | X = Flexible Termination | Two significant digits and number of zeros. | J = ±5% K = ±10% M = ±20% | C = 500 B = 630 D = 1,000 F = 1,500 G = 2,000 Z = 2,500 H = 3,000 | R = X7R | A = N/A | C = 100% Matte Sn L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ Additional termination finish options may be available. Contact KEMET for details.





Packaging C-Spec Ordering Options Table

| Packaging Type ₁ | Packaging/Grade Ordering Code (C-Spec) |
|--|---|
| Bulk Bag/Unmarked | Not required (Blank) |
| 7" Reel/Unmarked | TU |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) |
| 7" Reel/Marked | ТМ |
| 13" Reel/Marked | 7040 (EIA 0603) 7215 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2mm pitch ² | 7081 |
| 13" Reel/Unmarked/2mm pitch ² | 7082 |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking".

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

Benefits

- -55°C to +125°C operating temperature range
- Industry-leading CV values
- Superior flex performance (up to 5 mm)
- Exceptional performance at high frequencies
- Lead (Pb)-free, RoHS and REACH compliant
- EIA 0603, 0805, 1206, 1210, 1808, 1812, 1825, 2220, and 2225 case sizes
- DC voltage ratings of 500 V, 630 V, 1 KV, 1.5 KV, 2 KV, 2.5 KV, and 3 KV

- · Capacitance offerings ranging from 10 pF to 560 nF
- Available capacitance tolerances of ±5%, ±10% or ±20%
- Low ESR and ESL
- · Non-polar device, minimizing installation concerns
- Automotive (AEC-Q200) Grade available
- 100% pure matte tin-plated termination finish allowing for excellent solderability
- SnPb plated termination finish option available upon request (5% Pb minimum)

Application Note

X7R dielectric is not recommended for AC line filtering or pulse applications. These capacitors and/or the assembled circuit board containing these capacitors may require a protective surface coating to prevent external surface arcing.



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|----------------------------|---------------------------------|
| 0603 | 1608 | 1.60 (0.063) ±0.17 (0.007) | 0.80 (0.032) ±0.15 (0.006) | | 0.45 (0.018) ±0.15 (0.006) | 0.58 (0.023) | |
| 0805 | 2012 | 2.00 (0.079) ±0.30 (0.012) | 1.25 (0.049) ±0.30 (0.012) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave or Solder Reflow |
| 1206 | 3216 | 3.30 (0.130) ±0.40 (0.016) | 1.60 (0.063) ±0.35 (0.013) | | 0.60 (0.024) ±0.25 (0.010) | | |
| 1210 | 3225 | 3.30 (0.130) ±0.40 (0.016) | 2.60 (0.102) ±0.30 (0.012) | | 0.60 (0.024) ±0.25 (0.010) | | |
| 1808 | 4520 | 4.70 (0.185) ±0.50 (0.020) | 2.00 (0.079) ±0.20 (0.008) | See Table 2 for Thickness | 0.70 (0.028) ±0.35 (0.014) | | |
| 1812 | 4532 | 4.50 (0.178) ±0.40 (0.016) | 3.20 (0.126) ±0.30 (0.012) | | 0.70 (0.028) ±0.35 (0.014) | N/A | Solder Reflow |
| 1825 | 4564 | 4.60 (0.181) ±0.40 (0.016) | 6.40 (0.252) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | Only |
| 2220 | 5650 | 5.90 (0.232) ±0.75 (0.030) | 5.00 (0.197) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | |
| 2225 | 5664 | 5.90 (0.232) ±0.75 (0.030) | 6.40 (0.248) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | |

Qualification/Certification

Commercial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance & Reliability.

Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions (excluding SnPb termination finish option).



Table 1A - Capacitance Range/Selection Waterfall (0603 - 1812 Case Sizes)

| | | Cas S | se Si Serie | ze/ s | CO |)60 | 3X | CO | 805 | 5X | | C1 | 20 | 6X | | | C 1 | 1210 | XC | | | | C 1 | 80 | 8X | | | | | C1 | 812 | 2X | | |
|----------------------|-------------|----------|------------------|-----------|-----|------|------|-----|------|------|----------|----------|----------|----------|----------|----------|------------|----------|----------|----------|------|------|------------|------|-------|-------|------|-----|----------|----------|------|----------|------|------|
| Can | Сар | Vol | tage C | ode | C | В | D | C | В | D | C | В | D | F | G | C | В | D | F | G | C | В | D | F | G | z | н | C | В | D | F | G | z | Н |
| oup | Code | Rat | ed Volt (VDC) | age | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| | | Ca To | pacita pleran | nce ce | | | | | Prod | luct | Ava | ilabi | lity | and | Chip | Thi | ckne | ess C | ode | s - S | ee T | able | 2 fo | r Ch | ip Tł | nickı | ness | Dim | ensi | ons | | | | |
| 10 pF | 100 | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | | LB | LB | | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 12 pF | 120 | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 13 pF | 130 | J | К | М | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 15 pF | 150 | J | K | M | | | | DG | DG | DG | ES ES | ES | ES | ES | ES | FM FM | FM | FM | FM | FM | | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 18 pF | 180 | J | ĸ | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 20 pF | 200 | J | К | М | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 22 pF | 220 | J | K | M | | | | DG | DG | DG | ES FS | ES | ES | ES | ES | FM | FM | FM | FM | FM | | | | | | | | GB | GB | GB | GB | GB | GB | GB |
| 27 pF | 270 | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 30 pF | 300 | J | К | М | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 33 pF | 330 | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | | LB | LB | LB | LB | LB | | GB | GB | GB | GB | GB | GB | GB |
| 30 pF | 300 | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 43 pF | 430 | J | К | М | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 47 pF | 470 | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 56 pF | 560 | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 62 pF | 620 | J | к | М | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 68 pF | 680 | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 75 pF 82 pF | 820 | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 91 pF | 910 | J | K | М | | | | DG | DG | DG | ES | ES | ES | ES | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GD | GD | GD | GD | GD | GD | GD |
| 100 pF | 101 | J | K | М | | | | DG | DG | DG | ES | ES | ES | ES | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LC | LB | GD | GD | GD | GD | GD | GD | GD |
| 110 pF 120 pF | 121 | J | K | M | | | | | DG | | ES FS | ES FS | ES FS | ES FS | FU | FM | FM | FM FM | FM FM | FM | | LB | LB | LB | LB | | LB | GD | GD | GD | GD | GD | GD | GD |
| 130 pF | 131 | J | ĸ | M | | | | DG | DG | DG | ES | ES | ES | ES | EU | FZ | FZ | FZ | FM | FM | LB | LB | LB | LB | LB | LB | LB | GD | GD | GD | GD | GD | GD | GD |
| 150 pF | 151 | J | K | М | | | | DG | DG | DG | ES | ES | ES | EF | EU | FZ | FZ | FZ | FM | FM | LB | LB | LB | LB | LB | LB | LB | GD | GD | GD | GD | GD | GD | GK |
| 180 pF 220 nF | 181 | J | ĸ | M | | | | | DG | DG | ES | ES | ES | EF FF | EU | FZ | FZ | FZ | FM | FM | LB | LB | LB | LB | LB | LB | LB | GD | GD | GD | GD | GD | GD | GK |
| 270 pF | 271 | J | ĸ | M | | | | DG | DG | DG | ES | ES | ES | EF | EF | FZ | FZ | FZ | FK | FK | LC | LC | LC | LC | LC | LC | LC | GB | GB | GB | GB | GB | GH | GB |
| 330 pF | 331 | J | K | М | | | | DG | DG | DG | ES | ES | EF | EF | EF | FZ | FZ | FZ | FK | FK | LC | LC | LC | LC | LC | LC | LC | GB | GB | GB | GB | GB | GH | GB |
| 390 pF 470 nF | 391 | J | K K | M | | | | | DG | | ES ES | ES ES | EF FF | EF FF | EF FF | F7 | FM | FZ FM | FK FS | FS FS | | LB | LB | | LB | LB | | GB | GB | GB | GB | GD | GK | GH |
| 560 pF | 561 | J | K | M | | | | DG | DG | DG | ES | ES | EF | EF | EF | FL | FL | FL | FL | FL | LB | LB | LB | LB | LB | LB | LC | GB | GB | GB | GD | GH | GH | GK |
| 680 pF | 681 | J | K | М | | | | DG | DG | DG | ES | ES | EF | EF | EF | FL | FL | FL | FL | FL | LA | LA | LA | LA | LB | LC | LC | GB | GB | GB | GD | GH | GH | GK |
| 820 pF | 821 102 | J | K | M | CG | 00 | 00 | DG | DG | DG | ES FS | ES FS | ES FS | EF | EF | FL | FL | FL FI | FL | FL FI | LA | | | | LB | | | GB | GB | GB | GD | GH | GH | GK |
| 1,200 pF | 122 | J | ĸ | M | CG | CG | | DG | DG | DG | ES | ES | ES | EU | EU | FL | FL | FL | FL | FM | LB | LB | LB | LB | LC | LA | | GB | GB | GB | GB | GH | GK | GK |
| 1,500 pF | 152 | J | K | М | CG | CG | | DG | DG | DG | ES | ES | ES | EU | EU | FL | FL | FL | FL | FM | LB | LB | LB | LB | LC | LB | | GB | GB | GB | GB | GH | GK | |
| 1,800 pF | 182 | J | K | M | CG | | | DG | DG | DG | ES | ES | ES | EU | EU | | FL | FL | FL | FM | | | LB | | | | | GB | GD GH | GD GH | GB | GH | GK | |
| 2,200 pF | 272 | J | ĸ | M | CG | | | DG | DG | DG | ES | ES | ES | EU | | FL | FL | FL | FL | FM | LA | LA | LA | LB | LC | LU | | GB | GB | GB | GH | GK | GM | |
| 3,300 pF | 332 | J | К | М | CG | | | DG | DG | DG | ES | ES | ES | EU | | FL | FL | FL | FL | FM | LA | LA | LA | LB | LA | | | GB | GB | GB | GH | GK | GM | |
| 3,900 pF | 392 | J | K | M | CG | | | DG | DG | DG | ES | ES | ES | EU | | FL | FL | FL | FL | FK | | | | | | | | GB | GB | GB | GH | GM C⊔ | GO | |
| 4,700 pF 5,600 pF | 562 | J | K | M | | | | DG | DG | DG | ES | ES | ES | EF | | FL | FL | FL | FM | FK | LA | LA | LA | LC | | | | GH | GH | GH | GK | GK | 60 | |
| 6,800 pF | 682 | J | К | М | | | | DG | DG | | EF | EF | EF | EF | | FL | FL | FL | FM | FS | LA | LB | LB | LC | | | | GH | GH | GH | GK | GM | | |
| 8,200 pF | 822 | J | K | M | | | | DG | DG | _ | EF | EU | EU | EF | | FL | FL | FL | FK | | LA | LB | LB | LC | | | | GH | GH | GH | GK | GM | | |
| 12,000 pF | 123 | J | K | M | | | | DG | DG | | EU | EJ | EJ | 20 | | FL | FL | FL | FK | | LA | LC | LC | LB | | | | GB | GK | GK | GK | 00 | | |
| | 0 | Rat | ed Volt (VDC) | age | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| Cap | Cap Code | Vol | tage C | ode | C | В | D | C | B | D | C | В | D | F | G | C | B | D | F | G | C | B | D | F | G | z | H | C | В | D | F | G | Z | Η |
| | | Ca | se Siz Series | ze/ S | C | 0603 | 3X | C | 0805 | x | | C | 1206 | δX | | | C | 1210 | X | | | | C | 1808 | 8X | | | | | C | 1812 | X | | |

KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).



Table 1A - Capacitance Range/Selection Waterfall (0603 - 1812 Case Sizes) cont.

| | | Ca | se Si Serie | ize/ es | С |)60 | 3X | С |)80 | 5X | | C 1 | 120 | 6X | | | C 1 | 21 | 0X | | | | C 1 | 80 | 8X | | | | | C 1 | 81 | 2 X | | |
|-----------|------|-----|-----------------|------------|-----|------|------|-----|------|------|-----|------------|--------|---------------|--------------|-----|------------|------|-----------|-------|--------|------|------------|------|------------|------|------|-----|------|------------|------|------------|------|------|
| Can | Сар | Vo | tage C | ode | c | В | D | С | В | D | С | В | D | F | G | С | В | D | F | G | С | В | D | F | G | z | н | c | В | D | F | G | z | Н |
| Cap | Code | Rat | ed Vol | tage | 500 | 630 | 000 | 500 | 630 | 000 | 500 | 630 | 000 | 1500 | 000 | 500 | 630 | 000 | 500 | 000 | 500 | 630 | 000 | 1500 | 000 | 500 | 000 | 500 | 630 | 000 | 1500 | 000 | 500 | :000 |
| | | Ca | pacita | nce | | | - | | Dre | | | ilah | :1:4., | _ | _ [] _ [] | ть: | - kn - | | | _ ~ ^ | і Т | ahla | <u> </u> | - 04 | сч : ті | | | D: | | | | ~ | ~ | |
| | | Т | oleran | ce | | | | | Pro | auci | | | | anu | Cmp | | скпе | 55 0 | oue | 5-3 | ee i | able | 2 10 | run | | IICK | iess | חוע | ensi | ons | | | | |
| 15,000 pF | 153 | J | K | M | | | | DG | | | EU | EJ | EJ | | | FL | FL | FL | FL | | LA | LC | LC | LC | | | | GB | GK | GK | GH | | | |
| 18,000 pF | 183 | J | K | M | | | | DG | | | EJ | EJ | EJ | | | FL | FL | FL | FM | | LA | LE | LE | | | | | GB | GK | GK | GM | | | |
| 22,000 pF | 223 | J | K | M | | | | DG | | | EJ | EJ | EJ | | | FL | FM | FM | FM | | LA | LE | LE | | | | | GB | GK | GK | GM | | | |
| 27,000 pF | 273 | J | K | M | | | | | | | EJ | EJ | | | | FM | FK | FK | FK | | LA | LA | LA | | | | | GH | GB | GB | GO | | | |
| 33,000 pF | 333 | J | K | M | | | | | | | EJ | EJ | | | | FM | FZ | FU | FS | | LC | LA | LA | | | | | GH | GB | GB | GO | | | |
| 39,000 pF | 393 | J | K | M | | | | | | | EJ | | | | | FK | FZ | FU | FS | | LC | LA | LA | | | | | GH | GB | GB | | | | |
| 47,000 pF | 473 | J | K | M | | | | | | | EJ | | | | | FK | FU | FK | | | LC | LA | LB | | | | | GH | GB | GC | | | | |
| 56,000 pF | 563 | J | K | М | | | | | | | EJ | | | | | FZ | FU | FK | | | LC | LA | LB | | | | | GH | GB | GE | | | | |
| 68,000 pF | 683 | J | K | M | | | | | | | EJ | | | | | FZ | FK | FS | | | LA | LA | LC | | | | | GE | GE | GE | | | | |
| 82,000 pF | 823 | J | K | M | | | | | | | | | | | | FU | FK | | | | LA | LC | | | | | | GB | GE | GK | | | | |
| 0.10 µF | 104 | J | K | M | | | | | | | | | | | | FK | FS | | | | LA | LC | | | | | | GB | GH | GJ | | | | |
| 0.12 µF | 124 | J | K | M | | | | | | | | | | | | FK | | | | | LA | | | | | | | GE | GK | | | | | |
| 0.15 µF | 154 | J | K | М | | | | | | | | | | | | FK | | | | | LB | | | | | | | GE | GN | | | | | |
| 0.18 µF | 184 | J | K | M | | | | | | | | | | | | | | | | | | | | | | | | GF | | | | | | |
| 0.22 µF | 224 | J | K | M | | | | | | | | | | | | | | | | | | | | | | | | GJ | | | | | | |
| 0.27 µF | 274 | J | K | M | | | | | | | | | | | | | | | | | | | | | | | | GL | | | | | | |
| 0.33 µF | 334 | J | K | M | | | | | | | | | | | | | | | | | | | | | | | | GS | | | | | | |
| | | Rat | ed Vol (VDC) | tage) | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| Cap | Cap | Vo | tage C | ode | С | В | D | С | В | D | С | В | D | F | G | С | В | D | F | G | С | В | D | F | G | z | Н | С | В | D | F | G | z | Н |
| | Code | Ca | ise Si Serie | ze/ s | c | 0603 | 3X | c | 0805 | 5X | | C | 120 | 6X | | | С | 1210 | X | | | | C | 1808 | BX | | | | | C | 1812 | : X | | |

KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).



Table 1B - Capacitance Range/Selection Waterfall (1825 - 2225 Case Sizes)

| | | Ca | se Si Serie | ze/ s | | | C | 1825 | 5X | | | | | C | 2220 | X | | | | | C | 2225 | 5X | | | |
|-------------|----------|---------|----------------------|-----------|-----|-----|-------|-------|--------|--------|-------|--------|-------|-------|-------|-------|-------|-------|--|---------------|------|-------|-------|------|------|--|
| Canacitance | Сар | V0 | ltage C | ode | С | В | D | F | G | z | н | C | В | D | F | G | z | н | С | В | D | F | G | z | н | |
| Capacitance | Code | Rated | Voltage | e (VDC) | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | |
| | | Ca 1 | apacita: Toleranc | ice ce | | I | Produ | ct Av | ailabi | lity a | nd Ch | ip Thi | ickne | ss Co | des – | See 1 | Table | 2 for | Chip ⁻ | Thick | ness | Dimer | nsion | \$ | | |
| 470 pF | 471 | J | K | М | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | | | | | | | | |
| 560 pF | 561 | J | K | М | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | | | | | | | | |
| 680 pF | 681 | J | K | М | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 820 pF | 821 | J | K | М | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 1,000 pF | 102 | J | K | М | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 1,200 pF | 122 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 1,500 pF | 152 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 1,800 pF | 182 | J | K | М | HE | HE | HE | HE | HE | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 2,200 pF | 222 | J | K | M | HE | HE | HE | HE | HE | HG | HG | JE | JE | JE | JE | JE | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 2,700 pF | 272 | J | K | М | HE | HE | HE | HE | HE | HG | HG | JE | JE | JE | JE | JE | JK | JK | KE | KE | KE | KE | KE | KF | KE | |
| 3,300 pF | 332 | J | K | M | HE | HE | HE | HE | HE | HG | HG | JE | JE | JE | JE | JE | JK | JE | KE | KE | KE | KE | KE | KF | KE | |
| 3,900 pF | 392 | J | K | M | HE | HE | HE | HE | HE | HG | | JE | JE | JE | JE | JE | JK | JE | KE | KE | KE | KE | KE | KF | KE | |
| 4,700 pF | 472 | J | K | M | HE | HE | HE | HE | HE | HG | | JE | JE | JE | JE | JK | JE | JE | KE | KE | KE | KE | KE | KF | KE | |
| 5,600 pF | 562 | J | K | M | HE | HE | HE | HE | HE | HG | | JE | JE | JE | JE | JK | JE | JE | KE | KE | KE | KE | KE | KF | KE | |
| 6,800 pF | 682 | J | K | M | HE | HE | HE | HE | HE | HJ | | JE | JE | JE | JE | JK | JE | JE | KE | KE | KE | KE | KF | KE | KE | |
| 8,200 pF | 822 | J | K | М | HE | HE | HE | HE | HE | HJ | | JE | JE | JE | JE | JK | JK | JK | KE | KE | KE | KE | KF | KF | KF | |
| 10,000 pF | 103 | J | K | М | HE | HE | HE | HE | HJ | HK | | JE | JE | JE | JE | JL | JL | JL | KE | KE | KE | KE | KF | KH | KH | |
| 12,000 pF | 123 | J | K | М | HE | HE | HE | HG | HJ | | | JE | JK | JK | JK | JL | JL | JL | KE | KE | KE | KE | KF | KH | KH | |
| 15,000 pF | 153 | J | K | М | HE | HE | HE | HG | НК | | | JE | JK | JK | JK | JN | JN | JN | KE | KE | KE | KE | KF | KJ | KJ | |
| 18,000 pF | 183 | J | K | М | HE | HE | HE | HG | | | | JE | JK | JK | JK | JN | | | KE | KE | KE | KE | KH | | | |
| 22,000 pF | 223 | J | K | М | HE | HG | HG | HG | | | | JE | JK | JK | JK | JN | | | KE | KF | KF | KF | KJ | | | |
| 27,000 pF | 273 | J | K | М | HE | HG | HG | HG | | | | JE | JK | JK | JK | | | | KE | KF | KF | KF | KJ | | | |
| 33,000 pF | 333 | J | K | М | HE | HG | HG | HE | | | | JE | JK | JK | JK | | | | KE | KF | KF | KF | | | | |
| 39,000 pF | 393 | J | K | М | HE | HG | HG | HG | | | | JE | JK | JK | JE | | | | KE | KF | KF | KF | | | | |
| 47,000 pF | 473 | J | K | М | HE | HG | HG | HJ | | | | JE | JK | JK | JK | | | | KE | KF | KF | KF | | | | |
| 56,000 pF | 563 | J | K | М | HE | HG | HG | HJ | | | | JE | JE | JE | JL | | | | KE | KF | KF | KF | | | | |
| 62,000 pF | 623 | J | к | М | HG | HG | HG | НК | | | | JE | JE | JE | JL | | | | KF | KF | KF | KH | | | | |
| 68.000 pF | 683 | J | к | м | HG | HJ | HJ | нк | | | | JE | JK | JK | JL | | | | KE | KF | KF | KJ | | | | |
| 82.000 pF | 823 | J | к | м | HG | HJ | HJ | | | | | JE | JL | JL | JN | | | | KE | KF | KF | KJ | | | | |
| 0.10 µF | 104 | J | к | м | HG | НК | нк | | | | | JE | JN | JN | | | | | KE | КН | КН | KJ | | | | |
| 0.12 µF | 124 | J | К | М | HG | HE | | | | | | JE | JN | JN | | | | | KE | КН | КН | | | | | |
| 0.15 uF | 154 | J | к | м | HG | HE | | | | | | JK | JE | | | | | | KF | KJ | КJ | | | | | |
| 0.18 µF | 184 | Ĵ | к | м | HG | HG | | | | | | JK | JE | | | | | | KF | KE | | | | | | |
| 0.22 µF | 224 | Ĵ | ĸ | м | HG | HJ | | | | | | JK | JK | | | | | | KF | KF | | | | | | |
| 0.27 µF | 274 | Ĵ | ĸ | м | HJ | HJ | | | | | | JK | JL | | | | | | KF | КН | | | | | | |
| 0.33 µF | 334 | J | K | м | HJ | | | | | | | JL | JN | | | | | | KF | KH | | | | | | |
| 0.39 µF | 394 | Ĵ | ĸ | м | нк | | | | | | | JN | | | | | | | кн | KJ | | | | | | |
| 0.47 µF | 474 | , j | ĸ | м | | | | | | | | JN | | | | | | | кн | K.J | | | | | | |
| 0.56 µF | 564 | Ĵ | ĸ | м | | | | | | | | | | | | | | | КJ | | | | | | | |
| | | Datad | Valtar | | 2 | | 8 | 8 | 8 | 8 | 8 | 9 | | 8 | 8 | 8 | 8 | 8 | 000 000 000 000 000 000 000 000 000 00 | | | | | | | |
| | | Rated | voitage | :(VDC) | 50 | 63 | 9 | 15 | 20 | 25 | 30 | 50 | 63 | 9 | 15 | 20 | 25 | 30 | 50 50 50 50 50 50 50 50 50 50 50 50 50 5 | | | | | | | |
| Capacitance | Cap Code | Vo | ltage C | ode | C | В | D | F | G | Z | H | C | В | D | F | G | Z | H | C | C B D F G Z H | | | | | | |
| | | Case | Size/ S | Series | | | C | ;1825 | X | | | | | C | 2220 | X | | | | C2225X | | | | | | |

KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).



Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic | Quantity |
|-----------|----------------------------|------------------------------------|---------|----------------------|---------|----------|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| CG | 0603 | 0.80 ± 0.10 | 4,000 | 15,000 | 0 | 0 |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| ES FF | 1206 | 1.00 ± 0.20 1.20 + 0.15 | | | 2,500 | |
| FU | 1200 | 1.60 ± 0.15 | 0 | 0 | 2,000 | 8.000 |
| EJ | 1206 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FZ | 1210 | 1.25 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| FL | 1210 | 1.40 ± 0.15 | 0 | 0 | 2,000 | 8,000 |
| FU | 1210 | 1.55 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FS | 1210 | 2.10 ± 0.20 2.50 ± 0.30 | 0 | 0 | 1 000 | 4 000 |
| LE | 1808 | 1.00 ± 0.10 | Ő | Ő | 2.500 | 10.000 |
| LA | 1808 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| LB | 1808 | 1.60 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| LC | 1808 | 2.00 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GC | 181Z | 1.10 ± 0.10 1.20 ± 0.10 | | | 1,000 | 4,000 |
| GH | 1812 | 1.30 ± 0.10 1 40 + 0 15 | 0 | 0 | 1,000 | 4,000 |
| GF | 1812 | 1.50 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GG | 1812 | 1.55 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GK | 1812 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GJ | 1812 | 1.70 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GN | 1812 | 1./0 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GL | 1812 | 1.90 ± 0.20 2.00 + 0.20 | | | 500 | 2,000 |
| GS | 1812 | 2.10 + 0.20 | 0 | 0 | 500 | 2,000 |
| GO | 1812 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| HE | 1825 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| HG | 1825 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| HJ | 1825 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| HK | 1825 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| JE | 2220 | 1.40 ± 0.15 1.60 ± 0.20 | | | 1,000 | 4,000 |
| JI | 2220 | 2.00 ± 0.20 | 0 | 0 | 500 | 2.000 |
| JN | 2220 | 2.50 ± 0.20 | 0 0 | 0 0 | 500 | 2,000 |
| KE | 2225 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| KF | 2225 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| KH | 2225 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| KJ | 2225 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| Thickness | Thickness Case Thickness ± | | | 13" Reel | 7" Reel | 13" Reel |
| Code | Size' | Range (mm) | Paper Q | uantity ¹ | Plastic | Quantity |

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".



Table 2B – Bulk Packaging Quantities

| Deelver | ing Turne | Loose Pa | ackaging |
|----------|-----------------------|------------------------|------------------------|
| Раскад | ing type | Bulk Bag | (default) |
| Packagin | g C-Spec ¹ | N/ | /A ² |
| Case | Size | Packaging Quantities (| pieces/unit packaging) |
| EIA (in) | Metric (mm) | Minimum | Maximum |
| 0402 | 1005 | | |
| 0603 | 1608 | | |
| 0805 | 2012 | | 50,000 |
| 1206 | 3216 | | |
| 1210 | 3225 | 1 | |
| 1808 | 4520 | | |
| 1812 | 4532 | | |
| 1825 | 4564 | | 20,000 |
| 2220 | 5650 | | |
| 2225 | 5664 | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial Grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive Grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size | Metric Size | | Dens Maxi Land Pi | sity Lev mum (I rotrusio | vel A: Most) on (mm |) | | Dens Media Land Pi | sity Lev an (Noi rotrusio | vel B: minal) on (mm |) | | Dens Minii Land Pi | sity Lev num (L rotrusio | rel C: .east) on (mm |) |
|-------------|----------------|------|-------------------------|--------------------------------|---------------------------|------|------|--------------------------|---------------------------------|----------------------------|------|------|--------------------------|--------------------------------|----------------------------|------|
| Coue | Coue | С | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0603 | 1608 | 0.85 | 1.25 | 1.10 | 4.00 | 2.10 | 0.75 | 1.05 | 1.00 | 3.10 | 1.50 | 0.65 | 0.85 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 0.99 | 1.44 | 1.66 | 4.47 | 2.71 | 0.89 | 1.24 | 1.56 | 3.57 | 2.11 | 0.79 | 1.04 | 1.46 | 2.42 | 1.81 |
| 1206 | 3216 | 1.59 | 1.62 | 2.06 | 5.85 | 3.06 | 1.49 | 1.42 | 1.96 | 4.95 | 2.46 | 1.39 | 1.22 | 1.86 | 4.25 | 2.16 |
| 1210 | 3225 | 1.59 | 1.62 | 3.01 | 5.90 | 4.01 | 1.49 | 1.42 | 2.91 | 4.95 | 3.41 | 1.39 | 1.22 | 2.81 | 4.25 | 3.11 |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 |
| 1812 | 4532 | 2.10 | 1.80 | 3.60 | 7.00 | 4.60 | 2.00 | 1.60 | 3.50 | 6.10 | 4.00 | 1.90 | 1.40 | 3.40 | 5.40 | 3.70 |
| 1825 | 4564 | 2.15 | 1.80 | 6.90 | 7.10 | 7.90 | 2.05 | 1.60 | 6.80 | 6.20 | 7.30 | 1.95 | 1.40 | 6.70 | 5.50 | 7.00 |
| 2220 | 5650 | 2.85 | 2.10 | 5.50 | 8.80 | 6.50 | 2.75 | 1.90 | 5.40 | 7.90 | 5.90 | 2.65 | 1.70 | 5.30 | 7.20 | 5.60 |
| 2225 | 5664 | 2.85 | 2.10 | 6.90 | 8.80 | 7.90 | 2.75 | 1.90 | 6.80 | 7.90 | 7.30 | 2.65 | 1.70 | 6.70 | 7.20 | 7.00 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1210 case size.



A YAGEO company

Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Termination Finish | | | |
|--|-----------------------|-----------------------|--|--|
| Tomeredure | SnPb | 100% Matte Sn | | |
| Preheat/Soak | | | | |
| Temperature Minimum (T _{smin}) | 100°C | 150°C | | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | | |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds | | |
| Ramp-Up Rate (T_L to T_p) | 3°C/second maximum | 3°C/second maximum | | |
| Liquidous Temperature (T _L) | 183°C | 217°C | | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | | |
| Peak Temperature (T _P) | 235°C | 260°C | | |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum | 30 seconds maximum | | |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | 6°C/second maximum | | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | | |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test Condition | Limits |
|--|----------------|---|---|
| Visual and Mechanical | KEMET Internal | No defects that may affect performance (10X) | Dimensions according KEMET Spec Sheet |
| Capacitance (Cap) | KEMET Internal | C ≤ 10 µF 1 kHz ±50 Hz and 1.0 ±0.2 V or 0.5 ±0.2 V ms* C > 10 µF120 Hz ±10 Hz and 0.5 ±0.1 V ms * See part number specification sheet for voltage Capacitance measurements (including tolerance) are indexed to a referee time of 48 or 1,000 hours Please refer to a part number specification sheet for referee time details | Within Tolerance |
| Dissipation Factor (DF) | KEMET Internal | $\label{eq:constraint} \begin{array}{l} C \leq 10 \ \mu\text{F} \\ \text{Frequency: 1 kHz } \pm 50 \ \text{Hz} \\ \text{Voltage}^{*}:1.0 \ \pm 0.2 \ \text{V}_{\text{rms}}, \ 0.5 \ \pm 0.2 \ \text{V}_{\text{rms}}, \\ C > 10 \ \mu\text{F} \\ \text{Frequency: 120 Hz } \pm 10 \ \text{Hz} \\ \text{Voltage: 0.5 } \pm 0.1 \ \text{V}_{\text{rms}} \\ \end{array}$ | Within Specification Dissipation factor (DF) maximum limit at 25°C = 2.5% |
| Insulation Resistance (IR) | KEMET Internal | 500 VDC applied for 120 ±5 seconds at 25°C | $eq:spectral_$ |
| Temperature Coefficient of Capacitance (TCC) | KEMET Internal | $C \leq 10 \ \mu\text{F}$ Frequency: 1 kHz ±50 Hz Voltage*: 1.0 ±0.2 V _{rms} , 0.5 ±0.2 V _{rms} , 0.2 ±0.1 V _{rms} C > 10 \ \ \ F Frequency: 120 Hz ±10 Hz Voltage: 0.5 ±0.1 V _{rms} * See part number specification sheet for voltage $\frac{\text{Step} \qquad \text{Temperature (°C)}}{1 \qquad +25^{\circ}\text{C}}$ $\frac{3 \qquad +25^{\circ}\text{C} (\text{Reference Temperature})}{4 \qquad +125^{\circ}\text{C}}$ | Capacitance ±15% over -55°C to +125°C |



Table 4 – Performance & Reliability: Test Methods and Conditions cont.

| Stress | Reference | Test Condition | Limits |
|--|---------------------------|--|---|
| Dielectric Withstanding Voltage (DWV) | KEMET Internal | 150% of rated voltage for voltage rating of < 1,000 V 120% of rated voltage for voltage rating of \ge 1,000 V (5 \pm 1 seconds and charge/discharge not exceeding 50 mA) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit Withstand test voltage without insulation breakdown or damage. |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | KEMET Internal | Capacitance measurements (including tolerance) are indexed to a referee time of 48 or 1,000 hours. Please refer to a part number specific datasheet for referee time details. | Please refer to a part number specification sheet for specific Aging rate |
| Terminal Strength | KEMET Internal | Shear stress test per specific case size, Time: 60 ±1 second. Case Size Force 0603 5N 0805 9N ≥ 1206 18N | No evidence of mechanical damage |
| Board Flex | AEC-Q200-005 | Standard Termination System 2.0 mm Flexible Termination System 3.0 mm Test Time: 60± 5 seconds Ramp Time: 1 mm/second | No evidence of mechanical damage |
| Solderability | J-STD-002 | Condition: 4 hours ±15 minutes at 155°C dry bake apply all methods Test 245 ±5°C (SnPb & Pb-Free) | Visual Inspection. 95% coverage on termination. No leaching |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to +125°C) 2 - 3 cycles per hour Soak Time: 1 or 5 minute | Measurement at 24 hours ±4 hours after test conclusion. Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and 200 VDC maximum Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±20% shift IR: 10% of Initial Limit DF Limit Maximum: 3.0% |
| Moisture Resistance | MIL-STD-202 Method 106 | Number of Cycles Required: 10, 24 hours per cycle. Steps 7a and 7b not required | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±20% shift IR: 10% of Initial Limit DF Limit Maximum: 3.0% |



Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test Condition | Limits |
|--|---|---|---|
| Thermal Shock | MIL-STD-202 Method 107 | Number of Cycles Required: 5, (-55°C to 125°C) Dwell time 15 minutes. | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| High Temperature Life | e All -STD-202 1,000 hours at 125°C with 1.2 X rated voltage applied. | | Within Post Environmental Limits Cap: ±20% shift |
| Storage Life | Method 108 | 1,000 hours at 150°C, Unpowered | DF Limit Maximum: 3.0% |
| Vibration MIL-STD-202 Method 204 | | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Test from 10 – 2,000 Hz | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Mechanical MIL-STD-202 Shock Method 213 | | 1,500 g's 0.5 millisecond Half-sine, Velocity Change: 15.4 feet/second (Condition F) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Resistance to MIL-STD-202 Solvents Method 215 | | Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents. | Visual Inspection 10X Readable marking, no decoloration or stains. No physical damage. |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction





Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a "K" to identify KEMET, followed by two characters (per EIA–198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the "K" character only.

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.
- X7R dielectric products in capacitance values outlined below.

| EIA Case Size | Metric Size Code | Capacitance |
|---------------|------------------|-------------|
| 0603 | 1608 | ≤ 170 pF |
| 0805 | 2012 | ≤ 150 pF |
| 1206 | 3216 | ≤ 910 pF |
| 1210 | 3225 | ≤ 2,000 pF |
| 1808 | 4520 | ≤ 3,900 pF |
| 1812 | 4532 | ≤ 6,700 pF |
| 1825 | 4564 | ≤ 0.018 µF |
| 2220 | 5650 | ≤ 0.027 µF |
| 2225 | 5664 | ≤ 0.033 µF |

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 μ F. Orientation of marking is vendor optional.





Capacitor Marking (Optional) cont.

| | Capacitance (pF) For Various Alpha/Numeral Identifiers | | | | | | | | | |
|-----------|--|-----|----|-----|-------|--------|---------|-----------|------------|-------------|
| Alaba | | | | | | Numera | d I | | | |
| Alpila | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Character | Capacitance (pF) | | | | | | | | | |
| A | 0.10 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 |
| Н | 0.20 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 |
| М | 0.30 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 |
| d | 0.40 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 |
| f | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 |
| у | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punched Paper | |
|----------------------|------|---------|--------------------|---------------|--------------------|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| | (W)* | Pitch | (P ₁)* | Pitch | (P ₁)* |
| 01005 - 0402 | 8 | | | 2 | 2 |
| 0603 | 8 | | | 2/4 | 2/4 |
| 0805 | 8 | 4 | 4 | 4 | 4 |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 |
| 1805 - 1808 | 12 | 4 | 4 | | |
| ≥ 1812 | 12 | 8 | 8 | | |
| KPS 1210 | 12 | 8 | 8 | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | |
| Array 0612 | 8 | 4 | 4 | | |

*Refer to Figures 1 and 2 for W and P₁ carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|--|---------------------------------------|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 16 mm | | (0.059) | | | | (1.181) | | | |
| | | , | Variable Dime | ensions – Mil | limeters (Incl | nes) | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | te 5 |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | | | |
|--|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | |
|--|-----------------|---------------------------------------|--|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | |
| 8 mm | 178 ±0.20 | | | | | | |
| 12 mm | Or 220 10 20 | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 | | | |
| 16 mm | (13.000 ±0.008) | | | | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | |


Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Application Guide

Solder Fluxes and Cleaning

The use of water-soluble fluxes provides advantages of excellent solderability due to high activation. However, these fluxes contain organic acids that can induce arcing under high DC or AC voltages. Notable problem areas are underneath the MLCC where flux can be trapped between the ceramic material and PCB. It is therefore critical that PCBs are properly cleaned to remove all flux residue to maintain reliability.

Coating for High Voltage MLCCs

For MLCC ratings \geq 1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

| Dielectric | CTE (ppm/°C) |
|----------------------------|--------------|
| Class II BaTiO₃ | 10.7 |
| Class I CaZrO ₃ | 9.8 |

Slits in PCB

It is recommended to apply a slit in the PCB under the MLCC to improve washing of flux residue that may get trapped underneath. In some cases, it is not possible to slit entirely through the PCB due to underlying metal planes. It is also acceptable to apply a recessed slit under the MLCC which will also promote cleaning.

- Recommended for case sizes ≥1206
- The width (w) of the slit should be 1mm
- Length of the slit should be as short as possible to prevent damaging the MLCC due to mechanical stress of the PCB.
- Slits also reduce the risk of solder balls under MLCC which decreased the creepage distance.



Solder Resist

If a slit cannot be applied as above, it is recommended to not use solder resist directly under the MLCC. The use of solder resist material reduces the distance between MLCC ceramic material and PCB thus making it difficult to clean.

Solder Balls

Improper reflow techniques and/or improper washing can induce solder balls under or adjacent to the MLCC. Solder balls reduce the creepage distance between the MLCC terminations and increase the risk of arcing or damage to the ceramic material. To reduce the risk of solder balls:

- Follow KEMET's solder recommendations as outlined in the datasheet.
- If performing a cleaning procedure, properly clean the PCB per KEMET's cleaning recommendations.
- Add slit to the PCB as shown above.





Overview

KEMET's COTS program is an extension of KEMET knowledge of high reliability test regimes and requirements. KEMET regularly supplies "up-screened" products by working with customer drawings and imposing specified design and test requirements. The COTS program offers the same high quality and high reliability components as up-screened products, but at a lower cost to the customer. This is accomplished by eliminating the need for customer-specific drawings to achieve the reliability level required for customer applications. A series of tests and inspections have been selected to provide the accelerated conditioning and 100% screening necessary to eliminate infant mortal failures from the population.

KEMET's COG dielectric features a 125°C maximum operating temperature and is considered "stable." The Electronics Components, Assemblies & Materials Association (EIA) characterizes COG dielectric as a Class I material. Components of this classification are temperature compensating and are suited for resonant circuit applications or those where Q and stability of capacitance characteristics are required. COG exhibits no change in capacitance with respect to time and voltage and boasts a negligible change in capacitance with reference to ambient temperature. Capacitance change is limited to \pm 30 ppm/°C from -55°C to +125°C. All COTS testing includes voltage conditioning and postelectrical testing as per MIL–PRF–55681. For enhanced reliability, KEMET also provides the following test level options and conformance certifications:





Ordering Information

| С | 1206 | Т | 104 | K | 5 | G | Α | С | TU |
|---------|--|--------------------------|--|---|---|------------|---|--|--|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance ¹ | Rated Voltage (VDC) | Dielectric | Test Level | Termination Finish ² | Packaging/ Grade (C-Spec) |
| | 0402 0603 0805 1206 1210 1812 2220 | T = COTS | Two significant digits and number of zeros Use 9 for 1.0 - 9.9 pF Use 8 for 0.599 pF e.g., 2.2 pF = 229 e.g., 0.5 pF = 508 | $B = \pm 0.10 \text{ pF}$ $C = \pm 0.25 \text{ pF}$ $D = \pm 0.5 \text{ pF}$ $F = \pm 1\%$ $G = \pm 2\%$ $J = \pm 5\%$ $K = \pm 10\%$ $M = \pm 20\%$ | 8 = 10 4 = 16 3 = 25 6 = 35 5 = 50 1 = 100 2 = 200 A = 250 | G = COG | A = Testing per MIL- PRF-55681 PDA 8% B = Testing per MIL- PRF-55681 PDA 8%, DPA per EIA-469 C = Testing per MIL- PRF-55681 PDA 8%, DPA per EIA-469, Humidity per MIL-STD-202, Method 103, Condition A | C = 100% Matte Sn L = SnPb (5% Pb minimum) G = Gold (Au) 100 µin min. | See "Packaging C-Spec Ordering Options Table" |

¹ Additional capacitance tolerance offerings may be available. Contact KEMET for details.

² Additional termination finish options may be available. Contact KEMET for details.



Benefits

- -55°C to +125°C operating temperature range
- Lead (Pb)-free, RoHS and REACH compliant
- Voltage conditioning and post-electrical testing per MIL-PRF-55681, Paragraph 4.8.3.1, Standard Voltage Conditioning
- Destructive Physical Analysis (DPA) per EIA-469
- Humidity, steady state, low voltage (85/85) per MIL-STD-202, Method 103, Condition A
- RoHS Compliant (excluding SnPb end metallization option)
 No capacitance change with respect to applied rated DC
- EIA 0402, 0603, 0805, 1206, 1210, 1812, and 2220 case sizes
- DC voltage ratings of 10 V, 16 V, 25 V, 50 V, 100 V, 200 V and 250 V
- Capacitance offerings ranging from 0.5 pF up to 0.47 μ F
- Available capacitance tolerances of ±0.10 pF, ±0.25 pF, ±0.5

- pF, ±1%, ±2%, ±5%, ±10%, and ±20%
- Certificate of compliance
- No piezoelectric noise
- · Extremely low ESR and ESL
- · High thermal stability
- High ripple current capability
- Preferred capacitance solution at line frequencies and into the MHz range
- No capacitance change with respect to applied rated DC voltage
- Negligible capacitance change with respect to temperature
- · No capacitance decay with time
- · Non-polar device, minimizing installation concerns
- SnPb end metallization option available upon request (5% Pb minimum)

Applications

Typical applications include military, space quality and high reliability electronics.

Packaging C-Spec Ordering Options Table (100% Matte Sn and SnPb Terminations)

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) |
|---|---|
| Bulk Bag/Unmarked | Not required (Blank) |
| 7" Reel/Unmarked | TU |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2 mm pitch ² | 7081 |
| 13" Reel/Unmarked/2 mm pitch ² | 7082 |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices. For more information see "Capacitor Marking".
 ² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".



Packaging C-Spec Ordering Options Table (Gold Termination)

| Termination Finish Options | Packaging Type/Options | Packaging Ordering Code (C-Spec) |
|-------------------------------|--|---|
| | Standard Packaging – Unmarked ³ | |
| | Bulk Bag | Blank ¹ |
| | Waffle Tray ² | 7292 |
| | 7" Tape & Reel | TU |
| | 13" Reel | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) |
| G = Gold (Au) 100 uin minimum | 7" Tape & Reel/2 mm pitch ⁴ | 7081 |
| | 7" Tape & Reel – 50 pieces | T050 |
| | 7" Tape & Reel – 100 pieces | T100 |
| | 7" Tape & Reel – 250 pieces | T250 |
| | 7" Tape & Reel – 500 pieces | T500 |
| | 7" Tape & Reel – 1,000 pieces | Т1К0 |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ "Bulk Bag" packaging option is not available for Gold (Au) termination finish options and case sizes larger than 2225 (5664 Metric).

² "Waffle Tray" packaging option is not available for case sizes larger than 2225 (5664 Metric).

³ The terms "Marked" and "Unmarked" pertain to laser marking option of components. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices.

³ Reeling quantities are dependent upon chip size and thickness dimension. When ordering using the "T1K0" packaging option, 1812 through 2225 case size devices with chip thickness of ≥ 1.9 mm (nominal) may be shipped on multiple 7" reels or a single 13" reel. Additional reeling or packaging options may be available. Contact KEMET for details.

⁴ The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

⁵ Additional reeling or packaging options may be available. Contact KEMET for details.



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|----------------------------|---------------------------------|
| 0402 | 1005 | 1.00 (0.040) ±0.05 (0.002) | 0.50 (0.020) ±0.05 (0.002) | | 0.30 (0.012) ±0.10 (0.004) | 0.30 (0.012) | Solder Reflow Only |
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | |
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave or Solder Reflow |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | See Table 2 for Thickness | 0.50 (0.02) ±0.25 (0.010) | | |
| 1210 | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | N1/A | |
| 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | | 0.60 (0.024) ±0.35 (0.014) | N/A | Solder Reflow Only |
| 2220 | 5650 | 5.70 (0.224) ±0.40 (0.016) | 5.00 (0.197) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | |

Qualification/Certification

Commercial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance & Reliability.

Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions (excluding SnPb termination finish option).



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±30 ppm/°C |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 0% |
| ¹ Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5±1 seconds and charge/discharge not exceeding 50 mA) |
| ² Dissipation Factor (DF) Maximum Limit at 25°C | 0.1% |
| ³ Insulation Resistance (IR) Limit at 25°C | 1,000 megohm microfarads or 100 GΩ (Rated voltage applied for 120±5 seconds at 25°C) |

¹ DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

² Capacitance and dissipation factor (DF) measured under the following conditions:

1 MHz ±100 kHz and 1.0 Vrms ±0.2 V if capacitance \leq 1,000 pF

1 kHz ±50 Hz and 1.0 Vrms ±0.2 V if capacitance > 1,000 pF

³ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Capacitance and Dissipation Factor (DF) measured under the following conditions:

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

Post Environmental Limits

| | High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | | | | | | | |
|------------|---|----------------------|-----------------------------------|----------------------|--------------------------|--|--|--|--|--|--|--|--|--|--|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | | | | | | | | | | |
| COG | All | All | 0.5 | 0.3% or ±0.25 pF | 10% of Initial Limit | | | | | | | | | | |



Table 1A - Capacitance Range/Selection Waterfall (0402 - 0805 Case Sizes)

| | | Ca | ase Size/Series | | | | | es | | | C | 040 | 2T | | | | | C | 0603 | BT | | | | | С | 080 | 5T | | | |
|----------------|------------|------------------|-----------------|------|------------|------|--------------|-------------|----------|----|----|-----|----|------|-----|------|-------|---------|--------|-------|----------|--------|-------|-----------|----------|------------|----|-----|---------|--------|
| 0 | Сар | | ١ | /oli | tag | je (|) od | e | | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | Α |
| Capacitance | Code | R | ate | d \ | /olt | tag | e (' | /DC | ;) | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 10 | 16 | 25 | 50 | 100 | 200 | 250 |
| | | | | Caj | pac | ita | nce | ; | | | | | | | | Prod | uct A | vailat | oility | and C | hip T | hickn | ess C | odes | | | 1 | | | |
| 0.50 % 0.75 pE | 509 8 759 | D | C | To | olei | ran | ce | | | DD | DD | DD | DD | | | See | | le 2 fo | or Chi | p Thi | CKNes | S Din | nensi | ONS | DN | DN | DN | DN | DN | DN |
| 10-91 nF* | 100 - 010* | B | c | D | | | | | | BR | BB | BB | BB | | | | CF | CF | CF | CF | CF | CE | CF | | | | | | | |
| 10 - 91 pF* | 100 - 910* | | Ŭ | U | F | G | J | к | м | BB | BB | BB | BB | | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN |
| 100 pF | 101 | | | | F | G | J | K | M | BB | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN |
| 110 - 180 pF* | 111 -181* | | | | F | G | J | к | м | BB | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN |
| 200 - 270 pF* | 201 - 271* | | | | F | G | J | К | М | BB | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN |
| 300 pF | 301 | | | | F | G | J | к | м | BB | BB | BB | BB | BB | BD | BD | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN |
| 330 pF | 331 | | | | F | G | J | K | М | BB | BB | BB | BB | BB | BD | BD | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN |
| 360 pF | 361 | | | | F | G | J | K | м | BB | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN |
| 390 pF | 391 | | | | F | G | J | K | М | BB | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN |
| 430 pF | 431 | | | | F | G | J | K | Μ | BB | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN |
| 470 pF | 471 | | | | F | G | J | K | Μ | BB | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DP | DP |
| 510 - 820 pF* | 511 - 821* | | | | F | G | J | K | Μ | BB | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN |
| 910 pF | 911 | | | | F | G | J | K | Μ | BB | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DP | DP | DP |
| 1,000 pF | 102 | | | | F | G | J | K | Μ | BB | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DP | DP | DP |
| 1,100 pF | 112 | | | | F | G | J | K | М | BB | BB | BB | BB | | | | CF | CF | CF | CF | CF | СН | СН | DN | DN | DN | DN | DN | DN | DN |
| 1,200 pF | 122 | | | | F | G | J | K | М | BB | BB | BB | BB | | | | CF | CF | CF | CF | CF | СН | СН | DN | DN | DN | DN | DN | DN | DN |
| 1,300 pF | 132 | | | | F | G | J | K | M | BB | BB | BB | BB | | | | CF | CF | CF | CF | CF | СН | CH | DP | DP | DP | DP | DP | DN | DN |
| 1,500 pF | 152 | | | | F | G | J | K | M | BB | BB | BB | BB | | | | CF | CF | CF | CF | CF | CH | CH | DP | DP | DP | DP | DP | DN | DN |
| 1,600 pF | 162 | | | _ | F | G | J | K | M | BB | BB | BB | | | | | CF | CF | CF | CF | CF | CH | CH | DP | DP | DP | DP | DP | DN | DN |
| 1,800 pF | 182 | | | | F | G | J | K | M | BB | RR | BB | | | | | | CF | CF | CF | CF | CH | CH | DP | DP | DP | DP | DP | DN | DN |
| 2,000 pF | 202 | | | | F | 6 | J | K | IVI | BB | BB | BB | | | | | | | | | | CH | CH | | | | | | | |
| 2,200 pF | 222 | | | | F | 6 | J | K | | BB | BB | BB | | | | | | | | | CF CF | СH | CH | | | | | | | |
| 2,400 pF | 242 | | | | F | 6 | J | ĸ | M | | | | | | | | | | | | | | | | | | | | | |
| 2,700 pF | 302 | | | | F | G | J | ĸ | M | | | | | | | | | CF | CF | | CF | | | | | | | | | |
| 3,000 pF | 302 | | | | F | 6 | | ĸ | M | | | | | | | | CE | CE | CE | CF | CE | | | | | | | | | |
| 3,500 pr | 362 | | | | F | G | 1 | ĸ | M | | | | | | | | CF | CE | CF | CF | CE | | | | | | | | | |
| 3 900 pF | 392 | | | | F | G | J | ĸ | M | | | | | | | | CF | CF | CF | CF | CF | | | DF | DF | DF | DF | | DP | DP |
| 4 300 pF | 432 | | | | F | G | L, | ĸ | м | | | | | | | | CF | CF | CF | CF | CF | | | DF | DF | DF | DF | DN | DP | DP |
| 4.700 pF | 472 | | | | F | G | J | K | M | | | | | | | | CF | CF | CF | CF | CF | | | DE | DE | DE | DE | DN | DP | DP |
| 5.100 pF | 512 | | | | F | G | J | K | M | | | | | | | | CF | CF | CF | CF | | | | DE | DE | DE | DE | DN | DP | DP |
| 5.600 pF | 562 | | | | F | G | J | K | M | | | | | | | | CF | CF | CF | CF | | | | DN | DN | DN | DN | DN | DP | DP |
| 6,200 pF | 622 | | | | F | G | J | к | М | | | | | | | | CF | CF | CF | CF | | | | DN | DN | DN | DN | DN | DG | DG |
| 6,800 pF | 682 | | | | F | G | J | К | М | | | | | | | | CF | CF | CF | CF | | | | DN | DN | DN | DN | DN | DG | DG |
| 7,500 pF | 752 | | | | F | G | J | K | М | | | | | | | | CF | CF | CF | | | | | DN | DN | DN | DN | DN | DG | DG |
| 8,200 pF | 822 | | | | F | G | J | K | М | | | | | | | | CF | CF | CF | | | | | DN | DN | DN | DN | DN | DG | DG |
| 9,100 pF | 912 | | | | F | G | J | K | М | | | | | | | | CF | CF | CF | | | | | DN | DN | DN | DN | DN | | |
| 10,000 pF | 103 | | | | F | G | J | K | M | | | | | | | | CF | CF | CF | | | | | DN | DN | DN | DN | DP | | |
| 12,000 pF | 123 | | | | F | G | J | K | М | | | | | | | | CF | CF | CF | | | | | DN | DN | DN | DN | DE | | |
| 15,000 pF | 153 | | | | F | G | J | K | Μ | | | | | | | | CF | CF | CF | | | | | DN | DN | DN | DP | DG | | |
| 18,000 pF | 183 | | | | F | G | J | K | Μ | | | | | | | | | | | | | | | DN | DN | DN | DP | | | |
| 22,000 pF | 223 | | | | F | G | J | K | М | | | | | | | | | | | | | | | DP | DP | DP | DF | | | |
| 27,000 pF | 273 | | | | F | G | J | K | Μ | | | | | | | | | | | | | | | DF | DF | DF | | | | |
| 33,000 pF | 333 | | | | F | G | J | K | M | | | | | | | | | | | | | | | DG | DG | DG | | | | |
| 39,000 pF | 393 | | | | F | G | J | K | M | | | | | | | | | | | | | | | DG | DG | DG | | | | |
| 47,000 pF | 4/3 | R | ate | d V | ∣⊦ /olt | tan | _ J le (1 | / K / D(| ∣M 2) | 0 | 16 | 25 | 00 | 8 | 8 | 50 | 2 | 16 | 25 | 00 | 8 | 0 | 50 | <u>DG</u> | 90 91 | 10G 12G | 00 | 8 | 8 | 50 |
| Capacitance | Cap Code | | 1 | /oli | taa | e C | od | e | -, | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | ~ 2 | A | 8 | 4 | 3 | 5 | 1 | _∾ 2 | ⊳ A |
| | | Case Size/Series | | | | C | 0402 | T | 1 | 1 | | | C | 0603 | Т | | L | | L | C | :0805 | Т | | | | | | | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).

These products are protected under US Patents 7,172,985 & 7,670,981, other patents pending, and any foreign counterparts.



Table 1B - Capacitance Range/Selection Waterfall (1210 - 2225 Case Sizes)

| | | C | Case Size/Series | | | | | | | C | 120 | 6T | | | | | C | 1210 |)T | | | | C18 | 312T | | C | 2220 | T | | |
|---------------|------------|---|------------------|----------|------|------|-------|-----|-----|----|-----|----|-------|-----|-------|------|--------|----------|----------|----------|-------|-------|--------|------------|-----|------|------|----|------|-----|
| | Cap | | | Vol | tag | je C | Cod | е | | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 5 | 1 | 2 |
| Capacitance | Code | | Rate | ed ' | Vol | tag | je (N | VDC | C) | 10 | 16 | 25 | 50 | 00 | 00 | 250 | 10 | 16 | 25 | 50 | 00 | 00 | 250 | 50 | 00 | 00 | 250 | 50 | 00 | 00 |
| | | | | Ca | pac | cita | nce | 9 | | | | | | | | Prod | uct A | vailat | oility | and C | hip T | hickn | less (| l Codes | ; | | | | | |
| | 100 010+ | | 0 | <u>T</u> | ole | ran | ce | | _ | 50 | 50 | 50 | 50 | 50 | 50 | See | e Tabl | e 2 fc | or Chi | p Thi | cknes | s Din | nensi | ons | | _ | | | | |
| 1.0 - 9.1 pF* | 109 - 919* | в | C | U | E | G | | K | м | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 100 - 430 nF* | 100 - 910 | | | | F | G | 1 | K | M | FR | FR | FR | FR | FR | FR | FR | FR | FR | FB | FB | FR | FR | FB | | | | | | | |
| 470 - 910 nF* | 471 - 911* | | | | F | G | J | ĸ | M | FB | FB | FB | FB | FB | FB | FB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | | | |
| 1.000 pF | 102 | | | | F | G | J | K | M | EB | EB | EB | EB | EB | EE | EE | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | | | |
| 1.100 pF | 112 | | | | F | G | J | K | M | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | | | |
| 1,200 pF | 122 | | | | F | G | J | K | М | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | | | |
| 1,300 pF | 132 | | | | F | G | J | K | М | EB | EB | EB | EB | EC | EC | EC | FB | FB | FB | FB | FB | FC | FC | GB | GB | GB | GB | | | |
| 1,500 pF | 152 | | | | F | G | J | K | М | EB | EB | EB | EB | ED | EC | EC | FB | FB | FB | FB | FB | FE | FE | GB | GB | GB | GB | | | |
| 1,600 pF | 162 | | | | F | G | J | K | М | EB | EB | EB | EB | ED | ED | ED | FB | FB | FB | FB | FB | FE | FE | GB | GB | GB | GB | | | |
| 1,800 pF | 182 | | | | F | G | J | K | Μ | EB | EB | EB | EB | ED | ED | ED | FB | FB | FB | FB | FB | FE | FE | GB | GB | GB | GB | | | |
| 2,000 pF | 202 | | | | F | G | J | K | M | EB | EB | EB | EB | ED | ED | ED | FB | FB | FB | FB | FC | FE | FE | GB | GB | GB | GB | | | |
| 2,200 pF | 222 | | | | F | G | J | K | Μ | EB | EB | EB | EB | EE | EE | ED | FB | FB | FB | FB | FC | FG | FG | GB | GB | GB | GB | | | |
| 2,400 pF | 242 | | | | F | G | J | K | Μ | EB | EB | EB | EB | EC | EC | EC | FB | FB | FB | FB | FC | FC | FC | | | | | | | |
| 2,700 pF | 272 | | | | F | G | J | K | Μ | EB | EB | EB | EB | EC | EC | EC | FB | FB | FB | FB | FC | FC | FC | GB | GB | GB | GB | | | |
| 3,000 pF | 302 | | | | F | G | J | K | M | EC | EC | EC | EC | EC | EB | EB | FB | FB | FB | FB | FC | FF | FF | | | | | | | |
| 3,300 pF | 332 | | | | F | G | J | K | M | EC | EC | EC | EC | EE | EB | EB | FB | FB | FB | FB | FF | FF | FF | GB | GB | GB | GB | | | |
| 3,600 pF | 362 | | | | F | G | J | K | M | EC | EC | EC | EC | EE | EB | EB | FB | FB | FB | FB | FF | FF | FF | | | | | | | |
| 3,900 pF | 392 | | | | F | G | J | K | M | EC | EC | EC | EC | EF | EB | EB | FB | FB | FB | FB | FF | FF | FF | GB | GB | GB | GB | | | |
| 4,300 pF | 432 | | | | F | G | J | K | Μ | EC | EC | EC | EC | EC | EB | EB | FB | FB | FB | FB | FF | FF | FF | | | | | | | |
| 4,700 pF | 472 | | | | F | G | J | K | M | EC | EC | EC | EC | EC | EB | EB | FF | FF | FF | FF | FG | FG | FG | GB | GB | GD | GD | | | |
| 5,100 pF | 512 | | | | F | G | J | K | M | ED | ED | ED | ED | ED | EB | EB | FB | FB | FB | FB | FG | FG | FG | | | | | | | |
| 5,600 pF | 562 | | | | F | G | J | K | M | ED | ED | ED | ED | ED | EB | EB | FB | FB | FB | FB | FG | FG | FG | GB | GB | GH | GH | | | |
| 6,200 pF | 622 | | | | F | G | J | K | M | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FG | FB | FB | 0.0 | 0.0 | | | | | |
| 6,800 pF | 682 | | | | F | G | J | K | M | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FG | FB | FB | GB | GB | GJ | GJ | JE | JE | JB |
| 7,500 pF | /52 | | | | | G | J | K | M | EB | EB | EB | EB | EB | EB | EB | FC | FC | FC | FC | FC | FB | FB | 0.0 | 0.1 | 0.0 | 0.0 | | | |
| 8,200 pF | 822 | | | | | 6 | J | K | IVI | EU | EU | EU | EU | EB | EU | EU | | | | | | FB | FB | GB | GH | GB | GB | JE | JE | JB |
| 9,100 pF | 912 | | | | | 6 | J | K | IVI | | EU | EU | | EB | EU | EU | | FE FE | FE FE | FE FF | FE | FB | FB | CD | 011 | CD | CD | | | п |
| 10,000 pF | 103 | | | | F | 6 | J | N N | IVI | | | | | ED | EU | | | | | | | | | GB | | GB | GB | | JE | |
| 12,000 pF | 123 | | | | F | C | J | ĸ | IVI | | ED | ED | ED | ED | ED | ED | FG | FG | FG | FG | FD | FD | FD | GB | CP | GB | GB | JE | JE | JB |
| 19,000 pF | 100 | | | | | G | J | | M | | | | | ED | | | | | | | | | | GD | GR | GB | GB | | JE | |
| 22 000 pF | 223 | | | | F | G | J | K | M | FR | FR | FR | EB | FC | FH | FH | FB | FB | FB | FB | FB | FE | FE | GB | GB | GB | GB | IF | IR | IR |
| 22,000 pF | 223 | | | | F | G | | K | M | FR | FR | FR | FR | FF | L.1.1 | L | FB | FB | FB | FB | FB | FG | FC | GB | GB | GB | GB | IF | IB | IR |
| 33 000 pF | 273 | | | | F | G | | K | M | FR | FR | FR | FR | FF | | | FR | FR | FR | FR | FR | FH | FH | GB | GB | GB | GB | IR | IR | IR |
| 39,000 pF | 393 | | | | Ē | G | | K | M | FC | FC | FC | FF | FH | | | FR | FB | FB | FB | FF | FH | FH | GB | GB | GB | GB | JB | JB | JB |
| 47 000 pF | 473 | | | | F | G | J | ĸ | м | FC | FC | FC | FF | FH | | | FB | FB | FB | FB | FF | EJ | F.J | GB | GB | GD | GD | JB | JB | JB |
| 56 000 pF | 563 | | | | F | G | J | ĸ | м | FD | FD | FD | FF | | | | FB | FB | FB | FB | FF | | | GB | GB | GD | GD | JB | JB | JB |
| 68.000 pF | 683 | | | | F | G | J | K | M | EF | EF | EF | EH | | | | FB | FB | FB | FC | FG | | | GB | GB | GK | GK | JB | JB | JB |
| 82,000 pF | 823 | | | | F | G | J | к | М | EH | EH | EH | EH | | | | FC | FC | FC | FF | FH | | | GB | GB | GM | GM | JB | JB | JB |
| 0.10 µF | 104 | | | | F | G | J | K | Μ | EH | EH | EH | | | | | FE | FE | FE | FG | FM | | | GB | GD | GM | GM | JB | JB | JD |
| 0.12 µF | 124 | | | | F | G | J | K | М | | | | | | | | FG | FG | FG | FH | | | | GB | GH | | | JB | JB | JD |
| 0.15 µF | 154 | | | | F | G | J | K | M | | | | | | | | FH | FH | FH | FM | | | | GD | GN | | | JB | JB | JG |
| 0.18 µF | 184 | | | | F | G | J | K | Μ | | | | | | | | FJ | FJ | FJ | | | | | GH | | | | JB | JD | JG |
| 0.22 µF | 224 | | | | F | G | J | K | Μ | | | | | | | | FK | FK | FK | | | | | GK | | | | JB | JD | JL |
| 0.27 µF | 274 | | | | F | G | J | K | М | | | | | | | | | | | | | | | | | | | JB | JF | |
| 0.33 µF | 334 | | | | F | G | J | K | Μ | | | | | | | | | | | | | | | | | | | JD | JG | |
| 0.39 µF | 394 | | | | F | G | J | K | Μ | | | | | | | | | | | | | | | | | | | JG | | |
| 0.47 µF | 474 | | | | F | G | J | K | Μ | | | | | | | | | | | | | | | | | | | JG | | |
| | 0 | | Rate | ed ' | Voli | tag | je (N | VDC | C) | 9 | 16 | 25 | 50 | 100 | 200 | 250 | 9 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | 50 | 100 | 200 |
| Capacitance | Code | | | Vol | tag | je C | Cod | е | | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 5 | 1 | 2 |
| | | | Ca | ase | Siz | ze/ | Seri | ies | | | | (| :1206 | т | | | | | (| ;1210 | т | | | | C18 | 812T | | C | 2220 | т |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).

These products are protected under US Patents 7,172,985 & 7,670,981, other patents pending, and any foreign counterparts.



Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic | Quantity | |
|-----------|-------------------|------------------------------------|---------|----------------------|---------|----------|--|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| BB | 0402 | 0.50 ± 0.05 | 10,000 | 50,000 | 0 | 0 | |
| BD | 0402 | 0.55 ± 0.05 | 10,000 | 50,000 | 0 | 0 | |
| CF | 0603 | 0.80 ± 0.07 | 4,000 | 15,000 | 0 | 0 | |
| CH | 0603 | 0.85 ± 0.07 | 4,000 | 10,000 | 0 | 0 | |
| DN | 0805 | 0.78 ± 0.10 | 4,000 | 15,000 | 0 | 0 | |
| DP | 0805 | 0.90 ± 0.10 | 4,000 | 15,000 | 0 | 0 | |
| DE | 0805 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 | |
| DF | 0805 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 | |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | |
| EB | 1206 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 | |
| EC | 1206 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 | |
| ED | 1206 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 | |
| EE FF | 1206 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 | |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 | |
| EH | 1200 | 1.60 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| FB FC | 1210 | 0.78 ± 0.10 | | 0 | 4,000 | | |
| | 1210 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 | |
| | 1210 | 1.00 ± 0.10 | | 0 | 2,500 | | |
| | 1210 | 1.10 ± 0.10 | | 0 | 2,500 | 10,000 | |
| | 1210 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | |
| | 1210 | 1.55 ± 0.15 | | 0 | 2,000 | 8,000 | |
| | 1210 | 1./U ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| | 1210 | 1.00 ± 0.20 | | | 2,000 | | |
| | 1210 | 2.10 ± 0.20 | | | 2,000 | 0,000 | |
| GB CD | 1012 | 1.00 ± 0.10 1.05 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| GD GH | 1012 | 1.25 ± 0.15 1 10 ± 0.15 | | 0 | 1,000 | 4,000 | |
| GG | 1012 | 1.40 ± 0.13 1 55 ± 0.10 | 0 | 0 | 1,000 | 4,000 | |
| CK GG | 1812 | 1.55 ± 0.10 1.60 + 0.20 | | 0 | 1,000 | 4,000 | |
| | 1812 | 1 70 + 0 15 | 0 | 0 | 1,000 | 4,000 | |
| GN | 1812 | 1 70 + 0 20 | 0 | 0 | 1,000 | 4,000 | |
| GM | 1812 | 2.00 ± 0.20 | 0 | 0 | 500 | 2 000 | |
| JB | 2220 | 1.00 ± 0.20 | 0 | 0 | 1 000 | 4 000 | |
| JD | 2220 | 1.30 + 0.15 | 0 | 0 | 1,000 | 4,000 | |
| JF | 2220 | 1.40 + 0.15 | 0 | 0 | 1,000 | 4,000 | |
| JF | 2220 | 1.50 + 0.15 | 0 | 0 | 1,000 | 4,000 | |
| JG | 2220 | 1.70 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| JL | 2220 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 | |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| Code | Size1 | Range (mm) | Paper Q | uantity ¹ | Plastic | Quantity | |

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".



Table 2B – Bulk Packaging Quantities

| Deekee | uing Tuno | Loose Packaging | | | | | | | | |
|----------|------------------------|---|-----------------|--|--|--|--|--|--|--|
| Раска | Jing Type | Bulk Bag | (default) | | | | | | | |
| Packagi | ng C-Spec ¹ | N, | /A ² | | | | | | | |
| Cas | e Size | Packaging Quantities (pieces/unit packaging | | | | | | | | |
| EIA (in) | Metric (mm) | Minimum | Maximum | | | | | | | |
| 0402 | 1005 | | | | | | | | | |
| 0603 | 1608 | | | | | | | | | |
| 0805 | 2012 | | 50,000 | | | | | | | |
| 1206 | 3216 | | | | | | | | | |
| 1210 | 3225 | 1 | | | | | | | | |
| 1808 | 4520 | | | | | | | | | |
| 1812 | 4532 | | | | | | | | | |
| 1825 | 4564 | | 20,000 | | | | | | | |
| 2220 | 5650 | | | | | | | | | |
| 2225 | 5664 | | | | | | | | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial Grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive Grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size | Metric Size | | Dens Maxi Land P | sity Lev mum (I rotrusio | vel A: Most) on (mm |) | | Dens Media Land Pi | sity Lev an (Nor rotrusio | vel B: ninal) on (mm |) | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | |
|-------------------|----------------|------|------------------------|--------------------------------|---------------------------|------|------|--------------------------|---------------------------------|----------------------------|------|---|------|------|------|------|--|--|
| Coue | Coue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | | |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 | | |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 | | |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 | | |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 | | |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 | | |
| 1210 ¹ | 3225 | 1.50 | 1.60 | 2.90 | 5.60 | 3.90 | 1.40 | 1.40 | 2.80 | 4.70 | 3.30 | 1.30 | 1.20 | 2.70 | 4.00 | 3.00 | | |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 | | |
| 2220 | 5650 | 2.75 | 1.70 | 5.50 | 8.20 | 6.50 | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | 2.55 | 1.30 | 5.30 | 6.60 | 5.60 | | |

¹ Only for capacitance values $\ge 22 \ \mu F$

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805, and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Termination Finish | | | |
|--|-----------------------|-----------------------|--|--|
| Fromereature | SnPb | 100% Matte Sn | | |
| Preheat/Soak | | | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C | | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | | |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds | | |
| Ramp-Up Rate (T_L to T_p) | 3°C/second maximum | 3°C/second maximum | | |
| Liquidous Temperature (T _L) | 183°C | 217°C | | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | | |
| Peak Temperature (T _P) | 235°C | 260°C | | |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 30 seconds maximum | | |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | 6°C/second maximum | | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | | |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method |
|------------------------|---------------------------|--|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds. |
| Board Flex | JIS-C-6429 | Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm for COG. Flexible termination system – 3.0 mm (minimum). |
| | | Magnification 50 X. Conditions: |
| O-Idenskiliter | 1-STD-002 | a) Method B, 4 hours at 155°C, dry heat at 235°C |
| Solderability | J-31D-002 | b) Method B at 215°C category 3 |
| | | c) Method D, category 3 at 260°C |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 Cycles (-55°C to +125°C). Measurement at 24 hours +/- 4 hours after test conclusion. |
| | MIL_STD_202 Mathad | Load Humidity: 1,000 hours 85°C/85% RH and rated voltage. Add 100 K ohm resistor. |
| Biased Humidity | 103 | Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. |
| | | Measurement at 24 hours +/- 4 hours after test conclusion. |
| Moisturo Posistanoo | MIL-STD-202 Method | t = 24 hours/cycle. Steps 7a and 7b not required. |
| WOISTURE RESISTANCE | 106 | Measurement at 24 hours +/- 4 hours after test conclusion. |
| Thermal Shock | MIL-STD-202 Method 107 | –55°C/+125°C. Note: Number of cycles required – 300, maximum transfer time – 20 seconds, dwell time – 15 minutes. Air – Air. |
| | MIL-STD-202 Method | |
| High Temperature Life | 108 /EIA-198 | 1,000 hours at 125°C (85°C for X5R, Z5U and Y5V) with 2 X rated voltage applied. |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC for 1,000 hours. |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 min., 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts |
| | | mounted within 2 from any secure point. Test from 10 – 2,000 Hz |
| Mechanical Shock | 213 | Figure 1 of Method 213, Condition F. |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature-reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction



Capacitor Marking (Optional)

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- · EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punched Paper | | |
|----------------------|------|---------|--------------------|---------------|--------------------|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | (W)* | Pitch | (P ₁)* | Pitch | (P ₁)* | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 | |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | |
| Array 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | |
| 16 mm | | (0.059) | | | | (1.181) | | | | |
| | | , | Variable Dime | ensions – Mil | limeters (Incl | nes) | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | te 5 | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_n and B_n are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | |
|--|---------------------------------------|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|
| Tape Size | D _o | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | |
| | | Variable D | imensions — M | illimeters (Inche | es) | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | Note I | |

1. The cavity defined by $A_{a'}B_{a}$ and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | |
|--|-----------------|---------------------------------------|--|--|--|--|--|
| Tape Size | А | B Minimum | C | D Minimum | | | |
| 8 mm | 178 ±0.20 | | | | | | |
| 12 mm | Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | |
| 16 mm | (13.000 ±0.008) | | X | | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Overview

KEMET's COTS program is an extension of KEMET knowledge of high reliability test regimes and requirements. KEMET regularly supplies "up-screened" products by working with customer drawings and imposing specified design and test requirements. The COTS program offers the same high quality and high reliability components as up-screened products, but at a lower cost to the customer. This is accomplished by eliminating the need for customer-specific drawings to achieve the reliability level required for customer applications. A series of tests and inspections have been selected to provide the accelerated conditioning and 100% screening necessary to eliminate infant mortal failures from the population.

KEMET's X7R dielectric features a 125°C maximum operating temperature and is considered "temperature stable." The Electronics Components, Assemblies & Materials Association (EIA) characterizes X7R dielectric as a Class II material. Components of this classification are fixed, ceramic dielectric capacitors suited for bypass and decoupling applications or for frequency discriminating circuits where Q and stability of capacitance characteristics are not critical. X7R exhibits a predictable change in capacitance with respect to time and voltage and boasts a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to $\pm 15\%$ from -55° C to $+125^{\circ}$ C. All COTS testing includes voltage conditioning and post-electrical testing as per MIL–PRF–55681. For enhanced reliability, KEMET also provides the following test level options and conformance certifications:





Ordering Information

| С | 1210 | Т | 104 | K | 5 | R | Α | C | TU |
|---------|--|--------------------------|--|---------------------------------|--|------------|--|--|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Test Level | Termination Finish ¹ | Packaging/ Grade (C-Spec) |
| | 0402 0603 0805 1206 1210 1805 1808 1812 2220 | T = COTS | Two significant digits and number of zeros | J = ±5% K = ±10% M = ±20% | 9 = 6.3 8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 2 = 200 A = 250 | R = X7R | A = Testing per MIL- PRF-55681 PDA 8% B= Testing per MIL- PRF-55681 PDA 8%, DPA per EIA-469 C = Testing per MIL- PRF-55681 PDA 8%, DPA per EIA-469, Humidity per MIL-STD-202, Method 103, Condition A | C = 100% Matte Sn L = SnPb (5% Pb minimum) G = Gold (Au) 100 µin min. | See "Packaging C-Spec Ordering Options Table" |

¹ Additional termination finish options may be available. Contact KEMET for details.

Built Into Tomorrow

1



Benefits

- -55°C to +125°C operating temperature range
- Lead (Pb)-free, RoHS and REACH compliant
- Voltage conditioning and post-electrical testing per MIL-PRF-55681
- Destructive Physical Analysis (DPA) per EIA-469
- Biased humidity testing (85/85) per MIL-STD-202
- Certificate of Compliance
- · Temperature stable dielectric
- EIA 0402, 0603, 0805, 1206, 1210, 1812, and 2220 case sizes

- DC voltage ratings of 6.3 V, 10 V, 16 V, 25 V, 50 V, 100 V, 200 V, and 250 V
- Capacitance offerings ranging from 10 pF to 22 μF
- Available capacitance tolerances of ±5%, ±10%, and ±20%
- · Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish allowing for excellent solderability
- SnPb termination finish option available upon request (5% Pb minimum)

Applications

Typical applications include military, space quality and high reliability electronics.

Packaging C-Spec Ordering Options Table (100% Matte Sn and SnPb Terminations)

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) |
|---|---|
| Bulk Bag/Unmarked | Not required (Blank) |
| 7" Reel/Unmarked | TU |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2 mm pitch ² | 7081 |
| 13" Reel/Unmarked/2 mm pitch ² | 7082 |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices. For more information see "Capacitor Marking".
² The 2 mm nich option allows for double the packaging quantity of capacitors on a given real size. This option is limited to EIA 0603 (1608 metric) case.

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".



Packaging C-Spec Ordering Options Table (Gold Termination)

| Termination Finish Options | Packaging Type/Options | Packaging Ordering Code (C-Spec) |
|-------------------------------|--|---|
| | | |
| | Bulk Bag | Blank ¹ |
| | Waffle Tray ² | 7292 |
| | 7" Tape & Reel | TU |
| | 13" Reel | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) |
| G = Gold (Au) 100 uin minimum | 7" Tape & Reel/2 mm pitch ⁴ | 7081 |
| | 7" Tape & Reel – 50 pieces | T050 |
| | 7" Tape & Reel – 100 pieces | T100 |
| | 7" Tape & Reel – 250 pieces | T250 |
| | 7" Tape & Reel – 500 pieces | T500 |
| | 7" Tape & Reel – 1,000 pieces | Т1К0 |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ "Bulk Bag" packaging option is not available for Gold (Au) termination finish options and case sizes larger than 2225 (5664 Metric).

² "Waffle Tray" packaging option is not available for case sizes larger than 2225 (5664 Metric).

³ The terms "Marked" and "Unmarked" pertain to laser marking option of components. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices.

³ Reeling quantities are dependent upon chip size and thickness dimension. When ordering using the "T1K0" packaging option, 1812 through 2225 case size devices with chip thickness of ≥ 1.9 mm (nominal) may be shipped on multiple 7" reels or a single 13" reel. Additional reeling or packaging options may be available. Contact KEMET for details.

⁴ The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

⁵ Additional reeling or packaging options may be available. Contact KEMET for details.



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|-------------------|---------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|----------------------------|---------------------------------|
| 0402 | 1005 | 1.00 (0.040) ±0.05 (0.002) | 0.50 (0.020) ±0.05 (0.002) | | 0.30 (0.012) ±0.10 (0.004) | 0.30 (0.012) | Solder Reflow Only |
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | |
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) +0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave or Solder Reflow |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | | |
| 1210 ¹ | 3225 | 3.20 (0.126) +0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | See Table 2 for Thickness | 0.50 (0.02) ±0.25 (0.010) | - N/A | Solder Reflow Only |
| 1805 | 4513 | 4.50 (0.177) ±0.50 (0.020) | 1.27 (0.050) ±0.38 (0.015) | | 0.60 (0.024) ±0.35 (0.014) | | |
| 1808 | 4520 | 4.70 (0.185) ±0.50 (0.020) | 2.00 (0.079) ±0.20 (0.008) | | 0.60 (0.024) ±0.35 (0.014) | | |
| 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | | 0.60 (0.024) ±0.35 (0.014) | | |
| 2220 | 5650 | 5.70 (0.224) ±0.40 (0.016) | 5.00 (0.197) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | |

¹ For capacitance values \geq 4.7 μ F add 0.02 (0.001) to the width tolerance dimension and 0.10 (0.004) to the length tolerance dimension.

Qualification/Certification

Commercial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance & Reliability.

Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions (excluding SnPb termination finish option).



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|--|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 Vdc Applied (TCC) | ±15% |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| ² Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5±1 seconds and charge/discharge not exceeding 50mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | 5%(6.3V & 10V), 3.5%(16V & 25V) and 2.5%(50V to 250V) |
| ^₄ Insulation Resistance (IR) Minimum Limit at 25°C | See Insulation Resistance Limit Table (Rated voltage applied for 120±5 seconds at 25°C) |

¹ Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours.

² DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

 $^{\scriptscriptstyle 3}$ Capacitance and dissipation factor (DF) measured under the following conditions:

1kHz ± 50Hz and 1.0 ± 0.2 Vrms if capacitance ≤10 μ F

120Hz \pm 10Hz and 0.5 \pm 0.1 Vrms if capacitance >10 μF

⁴ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 & Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON".

Post Environmental Limits

| | High Temperatu | ure Life, Biased | l Humidity, Moist | ture Resistance | 9 |
|------------|---------------------|----------------------|-----------------------------------|----------------------|--------------------------|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance |
| | > 25 | | 3.0 | | 100/ - 6 :+:- |
| X7R | 16/25 | All | 5.0 | ±20% | 10% of Initial |
| | < 16 | | 7.5 | | Linit |

Insulation Resistance Limit Table

| EIA Case Size | 1,000 Megohm Microfarads or 100 GΩ | 500 Megohm Microfarads or 10 GΩ |
|---------------|---------------------------------------|------------------------------------|
| 0201 | N/A | ALL |
| 0402 | < 0.012 µF | ≥ 0.012 µF |
| 0603 | < 0.047 µF | ≥ 0.047 µF |
| 0805 | < 0.15 µF | ≥ 0.15 µF |
| 1206 | < 0.47 µF | ≥ 0.47 µF |
| 1210 | < 0.39 µF | ≥ 0.39 µF |
| 1805 | ALL | N/A |
| 1808 | ALL | N/A |
| 1812 | < 2.2 µF | ≥ 2.2 µF |
| 1825 | ALL | N/A |
| 2220 | < 10 µF | ≥ 10 µF |
| 2225 | ALL | N/A |



Table 1A - Capacitance Range/Selection Waterfall (0402 - 1206 Case Sizes)

| | | Cas S | se Si Serie | ize/ es | | CO | 40 | 2C | | | | CO | 60 | 3C | | | | | C | :08 | 050 |) | | | | | (| :12 | 060 | ; | | |
|------------------|-------------|----------|-----------------|------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|-----|----|----|------|---------------|------|-------------|-----------------|------------|---------------|------|---------------|------|-----|-----|-----|----|----|------------|-----|-----|-----|-----|
| Capacitance | Сар | Vol | tage C | ode | 9 | 8 | 4 | 3 | 5 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A |
| | Code | Rat | ed Vol (VDC) | tage) | 6.3 | 9 | 16 | 25 | 20 | 6.3 | 5 | 16 | 25 | 20 | 100 | 200 | 6.3 | 2 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 5 | 16 | 25 | 50 | 100 | 200 | 250 |
| | | Cap | oacita | ince | | | | | | | | | Pro | oduc See T | t Av | aila 2 f | bility or Ch | and and | l Chi hick | p Th | ickn s Din | less | Cod | les | | | | | | | | |
| 10 - 91 pF* | 100 - 910* | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | | EB | EB | EB | EB | EB | EB | EB | |
| 100 - 150 pF** | 101 - 151** | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | | EB | EB | EB | EB | EB | EB | EB | |
| 180 - 820 pF** | 181 - 821** | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | _ |
| 1,000 pF | 102 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB |
| 1,200 pF | 122 | J | K | M | RR RR | B B B B B B B B B B B B B B B B B B B | B B B B B B B B B B B B B B B B B B B | B B B B B B B B B B B B B B B B B B B | B B B B B B B B B B B B B B B B B B B | | CF | CF | CF | CF | CF | CF | | | | | DN | | | | EB | EB | EB | EB | EB | EB | EB | EB |
| 1,500 pF | 192 | J | ĸ | M | | BB | BB | | BB | | CF | | | | | | | | | | | | | | ED | FR | FR | ED | ED | ED | ED | ED |
| 2 200 pF | 222 | | ĸ | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | | | | | | | | | FR | FB | FR | FR | FR | FR | FR | FR |
| 2,200 pF | 272 | Ĵ | ĸ | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB |
| 3,300 pF | 332 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB |
| 3,900 pF | 392 | J | K | М | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB |
| 4,700 pF | 472 | J | K | М | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB |
| 5,600 pF | 562 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB |
| 6,800 pF | 682 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB |
| 8,200 pF | 822 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB |
| 10,000 pF | 103 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB | EB |
| 12,000 pF | 123 | J | K | M | RR | BB | BB | BB | BB | | CF | CF | CF | | CF | | | | | | DN | DN | | | EB | EB | EB | EB | EB | EB | EB | EB |
| 15,000 pF | 100 | J | K | | B B B B B B B B B B B B B B B B B B B | BB | BB | BB | BB | | | | | | | | | | | | | | | | EB | EB | EB | EB | EB | ED | ED | ED |
| 18,000 pF | 183 | J | r v | M | | | | | DD | | CF | | | | | | | | | | | | | | | | | | | | | |
| 22,000 pF | 223 | J | K | M | BB | BB | BB | BB | 00 | CF | CE | CF | CF | CF | CF | | | | | | DN | DP | DE | DN | FR | FR | FR | FR | FR | FR | FR | FR |
| 33 000 pF | 333 | J | K | M | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DN | DP | DF | | FB | FB | FB | FB | FB | FB | FB | FB |
| 39.000 pF | 393 | Ĵ | K | M | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF. | | DN | DN | DN | DN | DN | DP | DE | | EB | EB | EB | EB | EB | EC | EB | EB |
| 47,000 pF | 473 | J | K | M | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DN | DE | DG | | EB | EB | EB | EB | EB | EC | ED | ED |
| 56,000 pF | 563 | J | K | М | BB | BB | BB | | | CF | CF | CF | CF | CF | | | DP | DP | DP | DP | DP | DE | DG | | EB | EB | EB | EB | EB | EB | ED | ED |
| 68,000 pF | 683 | J | K | М | BB | BB | BB | | | CF | CF | CF | CF | CF | | | DP | DP | DP | DP | DP | DE | | | EB | EB | EB | EB | EB | EB | ED | ED |
| 82,000 pF | 823 | J | K | M | BB | BB | BB | | | CF | CF | CF | CF | CF | | | DP | DP | DP | DP | DP | DE | | | EB | EB | EB | EB | EB | EB | ED | ED |
| 0.10 µF | 104 | J | K | M | BB | BB | BB | | | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DE | | | EB | EB | EB | EB | EB | EB | EM | ΕM |
| 0.12 µF | 124 | J | K | M | | | | | | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DP | DG | | | EC | EC | EC | EC | EC | EC | EG | |
| 0.15 µF | 154 | J | K | М | | | | | | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DP | DG | | | EC | EC | EC | EC | EC | EC | EG | |
| 0.18 µF | 184 | J | K | M | | | | | | CF | CF | CF | CF | | | | DN | DN | DN | DN | DP | DG | | | EC | EC | EC | EC | EC | EC | | |
| 0.22 µF | 224 | J | K | M | | | | | | CF | CF | CF | CF | | | | DN | DN | DN | DN | DP | DG | | | EC | EC | EC | EC | EC | EC | | |
| 0.27 μF | 2/4 | J | K | M | | | | | | | | | | | | | | | | | DP | | | | EB | EB | EB | EB | EC | EM | | |
| 0.33 µF | 204 | J | r v | M | | | | | | | CF | | | | | | | DC | DC | DC | | | | | | ED | ED | ED | EC | EG | | |
| 0.39 µF | 394 474 | J | K | M | | | | | | CF | CF | CF | | | | | | | DG | DG | DE | | | | ED | ED | ED | ED | EC | EG | | |
| 0.56 µF | 564 | J | ĸ | M | | | | | | 01 | | | | | | | DP | DP | DP | DG | DH | | | | FD | FD | FD | FD | FC | 20 | | |
| 0.68 µF | 684 | Ĵ | K | M | | | | | | | | | | | | | DP | DP | DP | DG | DH | | | | EE | EE | EE | EE | ED | | | |
| 0.82 µF | 824 | J | к | м | | | | | | | | | | | | | DP | DP | DP | DG | | | | | EF | EF | EF | EF | ED | | | |
| 1.0 μF | 105 | J | К | М | | | | | | | | | | | | | DP | DP | DP | DG | | | | | EF | EF | EF | EG | ED | | | |
| 1.2 μF | 125 | J | K | M | | | | | | | | | | | | | DE | DE | DE | | | | | | ED | ED | ED | EG | EH | | | |
| 1.5 µF | 155 | J | K | M | | | | | | | | | | | | | DG | DG | DG | | | | | | EF | EF | EF | EG | EH | | | |
| 1.8 µF | 185 | J | K | M | | | | | | | | | | | | | DG | DG | DG | | | | | | ED | ED | ED | EF | EH | | | |
| 2.2 µF | 225 | J | K | M | | | | | | | | | | | | | DG | DG | DG | | | | | | ED | ED | ED | EF | EH | | | |
| 2.7 µF | 275 | J | K | M | | | | | | | | | | | | | | | | | | | | | EN | EN | EN | EH | | | | |
| 3.3 µ⊦ 2 0 ⊶⊏ | 335 | J | K | M | | | | | | | | | | | | | | | | | | | | | ED | ED | ED | EH | | | | |
| 3.9 μF 4 7 μE | 395 | J | K V | M | | | | | | | | | | | | | | | | | | | | | | | | EH | | | | |
| 4.7μr 56μF | 565 | | ĸ | M | | | | | | | | | | | | | | | | | | | | | FH | FH | FH | | | | | |
| 6.8 IIF | 685 | , I | K | M | | | | | | | | | | | | | | | | | | | | | EH | EH | EH | | | | | |
| | | Pat | od Vol | tano | 1 | | | | | - | 1 | | | | _ | - | - | | | | | _ | - | - | | | | | | _ | | _ |
| 0 | Cap | | (VDC) | lage) | 6.3 | 9 | 16 | 25 | 20 | 6.3 | 9 | 16 | 25 | 20 | 10 | 20(| 6.3 | 9 | 16 | 25 | 50 | 10 | 20(| 25(| 6.3 | 9 | 16 | 25 | 20 | 10 | 20(| 25(|
| Capacitance | Code | Vol | tage C | ode | 9 | 8 | 4 | 3 | 5 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A |
| | | | Series | 20/ S | | C |)402 | 20 | | | | C | 0603 | C | | | | | | C08 | 05C | | | | | | | C12 | 06C | | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) **Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, and 82)

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Table 1A – Capacitance Range/Selection Waterfall (0402 – 1206 Case Sizes) cont.

| | | Case Se | e Siz eries | ze/ S | | CO | 40 | 2C | | | | CO | 60 | 3C | | | | | C | :08 | 050 |) | | | | | C | ;12 | 060 |) | | |
|-------------|---|-----------------|-----------------|----------|-----|----|------|----|----|-----|----|----|---------------|---------------|---------------|-----------------|----------------|---------------|---------------|---------------|-------------|--------------|---------|-----|-----|----|----|-----|-----|-----|-----|-----|
| Canacitance | Сар | Volta | nge Co | de | 9 | 8 | 4 | 3 | 5 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A |
| oapacitance | Code | Rateo | d Volta VDC) | age | 6.3 | 10 | 16 | 25 | 50 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 |
| | Capa Tol | acitan eranc | ice ;e | | | | , | | | , | | Pr | oduc See 1 | t Av Table | aila e 2 f | bility or Cl | / and nip T | l Chi hick | ip Th ines | ickn s Din | ess nens | Cod sions | es s | | | | | | | | | |
| 8.2 µF | 825 | J | K | М | | | | | | | | | | | | | | | | | | | | | EH | EH | EH | | | | | |
| 10 µF | 106 | J | K | М | | | | | | | | | | | | | | | | | | | | | EH | EH | EH | | | | | |
| | Can | Rateo | d Volta VDC) | age | 6.3 | 9 | 16 | 25 | 50 | 6.3 | 9 | 16 | 25 | 50 | 100 | 200 | 6.3 | 9 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 9 | 16 | 25 | 50 | 100 | 200 | 250 |
| Capacitance | Code | Volta | nge Co | de | 9 | 8 | 4 | 3 | 5 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A |
| | Capacitance Code Voltage Case S Serie | | | | | C |)402 | 20 | | | | C |)603 | C | | | | | | C08 | 05C | | | | | | | C12 | 06C | | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) **Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, and 82)

Table 1B – Capacitance Range/Selection Waterfall (1210 – 1808 Case Sizes)

| | | Cas S | e Sizo eries | e/ | | | | C12 | 10C | | | | C | 1805 | С | C | 1808 | С |
|----------------|-------------|----------|-----------------|--------|-----|----|----|----------|------------------|---------------------|--------------------|-------------------|-------------------|-------------------|-----------|----|--------|-----|
| Canacitanco | Сар | Volt | age Cod | e | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | 5 | 1 | 2 |
| Gapacitance | Code | Rated V | oltage (' | VDC) | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 50 | 100 | 200 |
| | | Capacita | nce Tol | erance | | | | Pro S | duct A ee Tab | vailabi le 2 foi | lity and Chip 1 | d Chip Thickne | Thickn ess Din | ess Co nensior | des 1s | | | |
| 10 - 91 pF* | 100 - 910* | J | K | М | FB | FB | FB | FB | FB | FB | FB | | | | | ĺ | | |
| 100 -180 pF** | 101 - 181** | J | K | М | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 220 pF | 221 | J | K | M | FB | FB | FB | FB | FB | FB | FB | | NC | NC | NC | | | |
| 270 pF | 271 | J | K | M | FB | FB | FB | FB | FB | FB | FB | | NC | NC | NC | | | |
| 330 pF | 331 | J | K | М | FB | FB | FB | FB | FB | FB | FB | | NC | NC | NC | LF | LF | LF |
| 390 pF | 391 | J | K | M | FB | FB | FB | FB | FB | FB | FB | | NC | NC | NC | LF | LF | LF |
| 470 - 820 pF** | 471 - 821** | J | K | M | FB | FB | FB | FB | FB | FB | FB | | NC | NC | NC | LF | LF | LF |
| 1,000 pF | 102 | J | K | M | FB | FB | FB | FB | FB | FB | FB | | NC | NC | NC | LF | LF | LF |
| 1,200 pF | 122 | J | K | M | FB | FB | FB | FB | FB | FB | FB | | NC | NC | | LF | LF | LF |
| 1,500 pF | 152 | J | K | M | FB | FB | FB | FB | FB | FB | FE | | NC | NC | | LF | LF | LF |
| 1,800 pF | 182 | J | K | М | FB | FB | FB | FB | FB | FB | FE | | NC | NC | | LF | LF | LF |
| 2,200 pF | 222 | J | K | M | FB | FB | FB | FB | FB | FB | FB | FB | NC | NC | | LF | LF | LF |
| 2,700 pF | 272 | J | K | M | FB | FB | FB | FB | FB | FB | FB | FB | NA | | | LF | LF | LF |
| 3,300 pF | 332 | J | К | М | FB | FB | FB | FB | FB | FB | FB | FB | NA | | | LF | LF | |
| 3,900 pF | 392 | J | К | М | FB | FB | FB | FB | FB | FB | FB | FB | NA | | | LF | LF | |
| 4,700 pF | 472 | J | K | М | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | |
| 5,600 pF | 562 | J | К | м | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | |
| 6,800 pF | 682 | J | К | м | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | |
| 8,200 pF | 822 | J | K | м | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | |
| 10,000 pF | 103 | J | К | м | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | |
| 12,000 pF | 123 | J | K | М | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | |
| 15,000 pF | 153 | J | К | М | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | |
| 18,000 pF | 183 | J | К | М | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | |
| | | Rated V | oltage (| VDC) | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 50 | 100 | 200 |
| Capacitance | Cap Code | Volt | age Cod | e | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | 5 | 1 | 2 |
| | | Case S | Size/Se | ries | | | | C12 | 10C | | | | | C18050 | : | | C18080 | ; |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) **Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, and 82)



Table 1B – Capacitance Range/Selection Waterfall (1210 – 2220 Case Sizes) cont.

| | | Cas So | e Sizo eries | e/ | | | | C12 | 10C | | | | C | 1805 | С | C | 1808 | С |
|-------------|-------------|-----------|-----------------|--------|-----|----|----|----------|------------------|---------------------|--------------------|-------------------|-------------------|-------------------|-----------|----|--------|-----|
| Canacitance | Сар | Volt | age Cod | e | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | 5 | 1 | 2 |
| oapacitance | Code | Rated V | oltage (' | VDC) | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 50 | 100 | 200 |
| | | Capacitar | nce Tol | erance | | | | Pro S | duct A ee Tab | vailabi le 2 for | lity and Chip 1 | d Chip Thickne | Thickn ess Dim | ess Co nensior | des 1s | | | |
| 22,000 pF | 223 | J | K | М | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | |
| 27,000 pF | 273 | J | K | M | FB | FB | FB | FB | FB | FB | FB | FB | NA | NA | | LD | LD | |
| 33,000 pF | 333 | J | K | M | FB | FB | FB | FB | FB | FB | FB | FB | NA | | | LD | LD | |
| 39,000 pF | 393 | J | K | M | FB | FB | FB | FB | FB | FB | FB | FB | NA | | | LD | LD | |
| 47,000 pF | 473 | J | K | M | FB | FB | FB | FB | FB | FB | FB | FB | NA | | | LD | LD | |
| 56,000 pF | 563 | J | K | M | FB | FB | FB | FB | FB | FB | FC | FC | NA | | | LD | LD | |
| 68,000 pF | 683 | J | K | М | FB | FB | FB | FB | FB | FB | FC | FC | NA | | | LD | | |
| 82,000 pF | 823 | J | K | M | FB | FB | FB | FB | FB | FC | FF | FF | NA | | | LD | | |
| 0.10 µF | 104 | J | K | M | FB | FB | FB | FB | FB | FD | FG | FG | NA | | | LD | | |
| 0.12 µF | 124 | J | K | M | FB | FB | FB | FB | FB | FD | FH | FH | | | | LD | | |
| 0.15 μF | 154 | J | K | M | FC | FC | FC | FC | FC | FD | FM | FM | | | | LD | | |
| 0.18 µF | 184 | J | K | M | FC | FC | FC | FC | FC | FD | FK | FK | | | | LD | | |
| 0.22 µF | 224 | J | K | M | FC | FC | FC | FC | FC | FD | FK | FK | | | | | | |
| 0.27 µF | 274 | J | K | M | FC | FC | FC | FC | FC | FD | | | | | | | | |
| 0.33 µF | 334 | J | K | M | FD | FD | FD | FD | FD | FD | | | | | | | | |
| 0.39 µF | 394 | J | K | M | FD | FD | FD | FD | FD | FD | | | | | | | | |
| 0.47 µF | 474 | J | K | М | FD | FD | FD | FD | FD | FD | | | | | | | | |
| 0.56 µF | 564 | J | K | M | FD | FD | FD | FD | FD | FF | | | | | | | | |
| 0.68 µF | 684 | J | K | M | FD | FD | FD | FD | FD | FG | | | | | | | | |
| 0.82 µF | 824 | J | K | M | FF | FF | FF | FF | FF | FL | | | | | | | | |
| 1.0 µF | 105 | J | K | M | FH | FH | FH | FH | FH | FM | | | | | | | | |
| 1.2 µF | 125 | J | K | M | FH | FH | FH | FH | FG | | | | | | | | | |
| 1.5 µF | 155 | J | K | M | FH | FH | FH | FH | FG | | | | | | | | | |
| 1.8 µF | 185 | J | K | M | FH | FH | FH | FH | FG | | | | | | | | | |
| 2.2 µF | 225 | J | K | M | FJ | FJ | FJ | FJ | FG | | | | | | | | | |
| 2.7 μF | 275 | J | K | M | FE | FE | FE | FG | FH | | | | | | | | | |
| 3.3 µF | 335 | J | K | М | FF | FF | FF | FM | FM | | | | | | | | | |
| 3.9 µF | 395 | J | K | M | FG | FG | FG | FG | FK | | | | | | | | | |
| 4.7 μF | 475 | J | K | M | FC | FC | FC | FG | FS | | | | | | | | | |
| 5.6 µF | 565 | J | K | M | FF | FF | FF | FH | | | | | | | | | | |
| 6.8 µF | 685 | J | K | М | FG | FG | FG | FM | | | | | | | | | | |
| 8.2 µF | 825 | J | K | М | FH | FH | FH | FK | | | | | | | | | | |
| 10 µF | 106 | J | K | M | FH | FH | FH | FS | | | | | | | | | | |
| 22 μF | 226 | J | K | M | FS | FS | | | | | | | | | | | | |
| | | Rated V | oltage (' | VDC) | 6.3 | 10 | 16 | 25 | 20 | 100 | 200 | 250 | 50 | 100 | 200 | 50 | 100 | 200 |
| Capacitance | Cap Code | Volt | age Cod | e | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | 5 | 1 | 2 |
| | | Case S | ize/Se | ries | | | | C12 | 10C | | | | | C18050 | ; | | C1808C | ; |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) **Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, and 82)



Table 1C - Capacitance Range/Selection Waterfall (1812 - 2220 Case Sizes)

| | | Cas S | e Siz eries | e/ | | C | :1812 | С | | | C18 | 25C | | | C | 2220 | С | |
|----------------|-------------|----------|------------------|----------|----|--------|--------|-----|-----|----|-----|-----|-----|-------------|----------|-------|-----|-----|
| Capacitance | Cap | Volt | age Cod | e | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 3 | 5 | 1 | 2 | A |
| | Code | Rated V | oltage (| VDC) | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | 25 | 50 | 100 | 200 | 250 |
| | | Capacita | nce Tol | erance | | | | | | | | | | | | | | |
| 470 - 820 pF** | 471 - 821** | J | K | М | GB | GB | GB | GB | | 1 | | | | | | | | |
| 1,000 pF | 102 | J | K | M | GB | GB | GB | GB | | | | | | | | | | |
| 1,200 pF | 122 | J | K | M | GB | GB | GB | GB | | | | | | | | | | |
| 1,500 pF | 152 | J | K | | GB | GB | GB | GB | | | | | | | | | | |
| 1,800 pF | 182 | J | ĸ | IVI M | GB | GB | GB | GB | | | | | | | | | | |
| 2,200 pF | 222 | J | ĸ | M | GB | GB | GB | GB | | | | | | | | | | |
| 2,700 pF | 332 | J | ĸ | M | GB | GB | GB | GB | | | | | | | | | | |
| 3,500 pF | 392 | J | K | M | GB | GB | GB | GB | | | | | | | | | | |
| 4 700 pF | 472 | J | ĸ | M | GB | GB | GB | GD | | | | | | | | | | |
| 5.600 pF | 562 | J | K | M | GB | GB | GB | GH | | | | | | | | | | |
| 6.800 pF | 682 | J | K | M | GB | GB | GB | GB | GB | | | | | JE | JE | JE | | |
| 8,200 pF | 822 | J | ĸ | M | GB | GB | GB | GB | GB | | | | | JE | JE | JE | | |
| 10,000 pF | 103 | J | к | м | GB | GB | GB | GB | GB | | | | | JE | JE | JE | | |
| 12,000 pF | 123 | J | К | М | GB | GB | GB | GB | GB | | | | | JE | JE | JE | | |
| 15,000 pF | 153 | J | K | M | GB | GB | GB | GB | GB | | | | | JE | JE | JE | | |
| 18,000 pF | 183 | J | K | M | GB | GB | GB | GB | GB | | | | | JE | JE | JE | | |
| 22,000 pF | 223 | J | K | M | GB | GB | GB | GB | GB | HB | HB | HB | HB | JE | JE | JE | | |
| 27,000 pF | 273 | J | K | M | GB | GB | GB | GB | GB | HB | HB | HB | HB | JE | JE | JE | | |
| 33,000 pF | 333 | J | K | М | GB | GB | GB | GB | GB | HB | HB | HB | HB | JB | JB | JB | | |
| 39,000 pF | 393 | J | K | M | GB | GB | GB | GB | GB | HB | HB | HB | HB | JB | JB | JB | | |
| 47,000 pF | 473 | J | K | M | GB | GB | GB | GB | GB | HB | HB | HB | HB | JB | JB | JB | | |
| 56,000 pF | 563 | J | K | M | GB | GB | GB | GB | GB | HB | HB | HB | HB | JB | JB | JB | | |
| 68,000 pF | 683 | J | K | M | GB | GB | GB | GB | GB | HB | HB | HB | HB | JB | JB | JB | | |
| 82,000 pF | 823 | J | K | M | GB | GB | GB | GB | GB | НВ | HB | HB | HB | JB | JB | JC | JC | JC |
| 0.10 µF | 104 | J | K | M | GB | GB | GB | GB | GB | НВ | HB | HB | HB | JB | JB | JC | JC | JC |
| 0.12 µF | 124 | J | ĸ | | GB | GB | GB | GB | GB | НВ | НВ | НВ | НВ | JB | JB | JC | JC | JU |
| 0.15 µF | 104 | J | ĸ | M | GB | GB | GB | GC | GC | | | | | JD | JB | 10 | 10 | JC |
| 0.10 µF | 224 | J | ĸ | M | GB | GB | GB | 00 | 00 | | | нв | | JD IR | JD IR | 10 | 10 | 10 |
| 0.22 µi | 224 | 1 | K | M | GB | GB | 00 | 00 | 00 | HB | HB | HB | HB | IC | 10 | 10 | 10 | 10 |
| 0.33 uF | 334 | J | ĸ | M | GB | GB | GG | GG | GG | HB | HB | HB | HB | JC | JC | JC | JC | JC |
| 0.39 µF | 394 | J | ĸ | M | GB | GB | GG | GG | GG | HD | HD | HD | HD | JC | JC | JC | JC | JC |
| 0.47 uF | 474 | J | ĸ | M | GB | GB | GG | GJ | GJ | HD | HD | HD | HD | JC | JC | JC | JC | JC |
| 0.56 µF | 564 | J | K | M | GC | GC | GG | | | HD | HD | HD | HD | JC | JD | JD | JD | JD |
| 0.68 µF | 684 | J | К | М | GC | GC | GG | | | HD | HD | HD | HD | JC | JD | JD | JD | JD |
| 0.82 µF | 824 | J | ĸ | M | GE | GE | GG | | | HF | HF | HF | HF | JC | JF | JF | JF | JF |
| 1.0 µF | 105 | J | к | M | GE | GE | GG | | | HF | HF | HF | HF | JC | JF | JF | JF | JF |
| 1.2 µF | 125 | J | К | M | | | | | | | | | | JC | JC | | | |
| 1.5 µF | 155 | J | К | М | | | | | | | | | | JC | JC | | | |
| 1.8 µF | 185 | J | K | M | | | | | | | | | | JD | JD | | | |
| 2.2 µF | 225 | J | K | M | GO | GO | | | | | | | | JF | JF | | | |
| 3.9 µF | 395 | J | K | M | GK | GK | | | | | | | | | | | | |
| 4.7 μF | 475 | J | K | M | GK | GK | | | | | | | | JF | JF | | | |
| 10 μF | 106 | J | K | M | GK | | | | | | | | | JF | JU | | | |
| 15 µF | 150 | J | ĸ | M | | | | | | | | | | 10 | | | | |
| 2 hL | 220 | Rated V | oltane (| | 5 | | 8 | 00 | 20 | | 00 | 00 | 20 | - <u>10</u> | | 00 | 00 | 20 |
| Conocitores | Сар | | | - | 5 | г С | 7 | 2(| . 2 | 5 | ¥ | 2(| 2, | 3 | 5 | 7 | 2(| 2; |
| Capacitance | Code | Volt | age Cod | | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 3 | 5 | 1 | 2 | A |
| | | Case S | Case Size/Series | | | | C18120 | ; | | | C18 | 25C | | | (| 22200 | ; | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) **Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, and 82)

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Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic (| Quantity |
|-----------|-------------------|------------------------------------|---------|----------------------|-----------|----------|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| BB | 0402 | 0.50 ± 0.05 | 10,000 | 50,000 | 0 | 0 |
| CF | 0603 | 0.80 ± 0.07 | 4,000 | 15,000 | 0 | 0 |
| DN | 0805 | 0.78 ± 0.10 | 4,000 | 15,000 | 0 | 0 |
| DP | 0805 | 0.90 ± 0.10 | 4,000 | 15,000 | 0 | 0 |
| DE | 0805 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| | 1206 | 1.25 ± 0.20 0.79 ± 0.10 | 0 | | 2,500 | |
| ED | 1200 | 0.78 ± 0.10 0.00 + 0.10 | 0 | 0 | 4,000 | 10,000 |
| EC FN | 1200 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| FD | 1200 | 1.00 ± 0.10 | 0 | 0 | 2 500 | 10,000 |
| FF | 1206 | 1.10 + 0.10 | 0 | 0 | 2,500 | 10,000 |
| EF | 1206 | 1.20 ± 0.15 | Ő | Ő | 2,500 | 10,000 |
| EM | 1206 | 1.25 ± 0.15 | 0 | 0 | 2.500 | 10.000 |
| EG | 1206 | 1.60 ± 0.15 | 0 | 0 | 2,000 | 8,000 |
| EH | 1206 | 1.60 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FB | 1210 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| FC | 1210 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| FD | 1210 | 0.95 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| FE | 1210 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FF | 1210 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FG | 1210 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| FL | 1210 | 1.40 ± 0.15 | 0 | 0 | 2,000 | 8,000 |
| FH | 1210 | 1.55 ± 0.15 | 0 | 0 | 2,000 | 8,000 |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| | 1210 | 1.85 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FN | 1210 | 2.10 ± 0.20 2.50 ± 0.20 | 0 | 0 | 2,000 | |
| F3 NA | 1210 | 2.30 ± 0.30 0.00 + 0.10 | 0 | 0 | 1,000 | 4,000 |
| | 1805 | 1 00 + 0 15 | 0 | 0 | 4,000 | 10,000 |
| | 1808 | 0.90 + 0.10 | 0 | 0 | 2 500 | 10,000 |
| IF | 1808 | 1 00 + 0 15 | Ő | Ő | 2,500 | 10,000 |
| GB | 1812 | 1.00 ± 0.10 | 0 0 | Ő | 1.000 | 4.000 |
| GC | 1812 | 1.10 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GD | 1812 | 1.25 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GE | 1812 | 1.30 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GH | 1812 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GG | 1812 | 1.55 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GK | 1812 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GJ | 1812 | 1.70 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GO | 1812 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| HB | 1825 | 1.10 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| | 1025 | 1.30 ± 0.15 1.50 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| | 2220 | 1.30 ± 0.15 1.00 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| | 2220 | 1 10 + 0 15 | 0 | 0 | 1,000 | 4,000 |
| .in | 2220 | 1.30 ± 0.15 1.30 ± 0.15 | 0 | 0 0 | 1,000 | 4,000 |
| JF | 2220 | 1.40 + 0.15 | Ő | Ő | 1.000 | 4,000 |
| JF | 2220 | 1.50 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JO | 2220 | 2.40 ± 0.15 | 0 | 0 | 500 | 2,000 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic | Quantity |

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".



Table 2B – Bulk Packaging Quantities

| Dookoo | | Loose Pa | ackaging |
|----------|------------------------|------------------------|------------------------|
| Раскау | inig type | Bulk Bag | (default) |
| Packagi | ng C-Spec ¹ | N, | /A ² |
| Cas | e Size | Packaging Quantities (| pieces/unit packaging) |
| EIA (in) | Metric (mm) | Minimum | Maximum |
| 0402 | 1005 | | |
| 0603 | 1608 | | |
| 0805 | 2012 | | 50,000 |
| 1206 | 3216 | | |
| 1210 | 3225 | 1 | |
| 1808 | 4520 | | |
| 1812 | 4532 | | |
| 1825 | 4564 | | 20,000 |
| 2220 | 5650 | | |
| 2225 | 5664 | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial Grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive Grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size | Metric Size | | Dens Maxi Land P | sity Lev mum (I rotrusio | vel A: Most) on (mm |) | | Dens Media Land Pi | sity Lev an (Nor rotrusio | vel B: ninal) on (mm |) | | Dens Minii Land Pi | sity Lev mum (L rotrusio | vel C: .east) on (mm |) |
|-------------------|----------------|------|------------------------|--------------------------------|---------------------------|------|------|--------------------------|---------------------------------|----------------------------|------|------|--------------------------|--------------------------------|----------------------------|------|
| ooue | ooue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 |
| 1210 ¹ | 3225 | 1.50 | 1.60 | 2.90 | 5.60 | 3.90 | 1.40 | 1.40 | 2.80 | 4.70 | 3.30 | 1.30 | 1.20 | 2.70 | 4.00 | 3.00 |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 |
| 2220 | 5650 | 2.75 | 1.70 | 5.50 | 8.20 | 6.50 | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | 2.55 | 1.30 | 5.30 | 6.60 | 5.60 |

¹ Only for capacitance values $\ge 22 \ \mu F$

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805, and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.



Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Terminati | ion Finish |
|--|-----------------------|-----------------------|
| Tomeredure | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate (T_L to T_p) | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T _L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T_p to T_L)$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.







Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method |
|------------------------|-----------------------------------|---|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds. |
| Board Flex | JIS-C-6429 | Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm for COG. Flexible termination system – 3.0 mm (minimum). |
| Solderability | J-STD-002 | Magnification 50 X. Conditions: |
| | | a) Method B, 4 hours at 155°C, dry heat at 235°C |
| | | b) Method B at 215°C category 3 |
| | | c) Method D, category 3 at 260°C |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 Cycles (-55°C to +125°C). Measurement at 24 hours +/-4 hours after test conclusion. |
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and rated voltage. Add 100 K ohm resistor. Measurement at 24 hours +/-4 hours after test conclusion. Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours +/-4 hours after test conclusion. |
| Thermal Shock | MIL-STD-202 Method 107 | -55°C/+125°C. Note: Number of cycles required - 300, maximum transfer time - 20 seconds, dwell time - 15 minutes. Air - Air. |
| High Temperature Life | MIL-STD-202 Method 108/EIA-198 | 1,000 hours at 125°C (85°C for X5R, Z5U and Y5V) with 2 X rated voltage applied. |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC for 1,000 hours. |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 min., 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Condition F. |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. |

Storage & Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature-reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction




Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a "K" to identify KEMET, followed by two characters (per EIA–198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the "K" character only.

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.
- X7R dielectric products in capacitance values outlined below.

| EIA Case Size | Metric Size Code | Capacitance |
|---------------|------------------|-------------|
| 0603 | 1608 | ≤ 170 pF |
| 0805 | 2012 | ≤ 150 pF |
| 1206 | 3216 | ≤ 910 pF |
| 1210 | 3225 | ≤ 2,000 pF |
| 1808 | 4520 | ≤ 3,900 pF |
| 1812 | 4532 | ≤ 6,700 pF |
| 1825 | 4564 | ≤ 0.018 µF |
| 2220 | 5650 | ≤ 0.027 µF |
| 2225 | 5664 | ≤ 0.033 µF |

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 μ F. Orientation of marking is vendor optional.





Capacitor Marking (Optional) cont.

| | C | apacita | ance (p | F) For \ | /arious | Alpha/ | Numera | al Identif | iers | | | | | | | |
|-----------|------|------------------|---------|----------|---------|--------|---------|------------|------------|-------------|--|--|--|--|--|--|
| Alaba | | | | | | Numera | d I | | | | | | | | | |
| Alpha | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | | | | |
| Character | | Capacitance (pF) | | | | | | | | | | | | | | |
| A | 0.10 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 | | | | | | |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 | | | | | | |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 | | | | | | |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 | | | | | | |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 | | | | | | |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 | | | | | | |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 | | | | | | |
| Н | 0.20 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 | | | | | | |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 | | | | | | |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 | | | | | | |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 | | | | | | |
| М | 0.30 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 | | | | | | |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 | | | | | | |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 | | | | | | |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 | | | | | | |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 | | | | | | |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 | | | | | | |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 | | | | | | |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 | | | | | | |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 | | | | | | |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 | | | | | | |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 | | | | | | |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 | | | | | | |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 | | | | | | |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 | | | | | | |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 | | | | | | |
| d | 0.40 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 | | | | | | |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 | | | | | | |
| f | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 | | | | | | |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 | | | | | | |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 | | | | | | |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 | | | | | | |
| у | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 | | | | | | |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punche | d Paper | | |
|----------------------|------|---------|--------------------|--------------------------|----------|--|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | |
| | (W)* | Pitch | (P ₁)* | Pitch (P ₁)* | | | |
| 01005 - 0402 | 8 | | | 2 | 2 | | |
| 0603 | 8 | | | 2/4 | 2/4 | | |
| 0805 | 8 | 4 | 4 | 4 | 4 | | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | | |
| 1805 - 1808 | 12 | 4 | 4 | | | | |
| ≥ 1812 | 12 | 8 | 8 | | | | |
| KPS 1210 | 12 | 8 | 8 | | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | | |
| Array 0612 | 8 | 4 | 4 | | | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions — Millimeters (Inches) | | | | | | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|--|--|--|--|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum | | | | | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | | | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | | | | |
| 16 mm | | (0.059) | | | | (1.181) | | | | | | | | |
| | | , | Variable Dime | ensions – Mil | limeters (Incl | nes) | | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ | | | | | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | | | | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | te 5 | | | | | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | | | |
|-----------|--|---|----------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|--|--|--|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | | | | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.104.0 ±0.10(0.069 ±0.004)(0.157 ±0.004) | | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | | | | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | | | | | |
| 8 mm | Single (4 mm) (0.246) | | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | | | | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | | |
|-----------|--|---------------------------------------|--|--|--|--|--|--|--|--|--|--|
| Tape Size | А | B Minimum | C | D Minimum | | | | | | | | |
| 8 mm | 178 ±0.20 | | | | | | | | | | | |
| 12 mm | or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | | | | | | |
| 16 mm | (13.000 ±0.008) | | (, | | | | | | | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | | | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | | | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | | | | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber



HiQ CBR Series, COG Dielectric, Low ESR 6.3 – 500 VDC, 1 MHz – 50 GHz (RF & Microwave)

Overview

KEMET's HiQ CBR RF Capacitor Series features a copper electrode BME (Base Metal Electrode) system that offers ultra-low ESR and High Q in the VHF, UHF, and microwave frequency bands. Low ESR allows for higher RF currents which are ideal for applications such as cellular base stations and telecommunication networks.

CBR Series capacitors exhibit no change in capacitance with respect to time and voltage, and boast a negligible change in capacitance with reference to ambient temperature.

(I) HIQ-CBR RF & MICROWAVE

KEN

a YAGEO company

KEMET's HiQ CBR RF capacitors are characterized using ModelithicsTM substrate scalable models and is available in most EDA software. Contact KEMET Sales for details on accessing models.



Benefits

- Ultra-low ESR and High Q
- High SRF
- High thermal stability
- 1 MHz to 50 GHz frequency range
- Operating temperature range of -55°C to +125°C
- Base metal electrode (BME) dielectric system
- Pb-free and RoHS compliant
- 0201, 0402, 0603 and 0805 case sizes (inches)
- DC voltage ratings from 6.3 500 V
- Capacitance offerings ranging from 0.1 pF up to 100 pF
- Available capacitance tolerances of ± 0.05 pF, ± 0.1 pF, ± 0.25 pF, ± 0.5 pF, $\pm 1\%,$ $\pm 2\%,$ and $\pm 5\%$
- Negligible capacitance change with respect to temperature
- 100% pure matte tin-plated termination finish allowing for excellent solderability

Applications

- RF power amplifiers (PA)
- Cellular base stations (4G, 5G)
- Wireless LAN
- Telecommunication Networks
- GPS
- Bluetooth
- Bypass, coupling, filtering, impedance matching, DC blocking



Ordering Information

| CBR | 02 | C | 330 | F | 9 | G | Α | C | |
|--------|--|--------------------------|--|---|---|------------|----------------------|--------------------|--|
| Series | Case Size (L"x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Termination Style | Termination Finish | Packaging/ Grade (C-Spec) |
| CBR | 02 = 0201 04 = 0402 06 = 0603 08 = 0805 | C = Standard | Two significant digits and number of zeros Use 9 for 1.0 – 9.9 pF Use 8 for 0.1 – 0.99 pF e.g., 2.2 pF = 229 e.g., 0.5 pF = 508 | $A = \pm 0.05 \text{ pF} \\ B = \pm 0.1 \text{ pF} \\ C = \pm 0.25 \text{ pF} \\ D = \pm 0.5 \text{ pF} \\ F = \pm 1\% \\ G = \pm 2\% \\ J = \pm 5\%$ | 9 = 6.3 V 8 = 10 V 3 = 25 V 5 = 50 V 1 = 100 V 2 = 200 V A = 250 V C = 500 V | G = COG | A = N/A | C = 100% Matte Sn | See "Packaging C-Spec Ordering Options Table" |

Tape & Reel Packaging Information

| Packaging Type | Packaging Ordering Code (C-SPEC) |
|----------------|---|
| 7" Reel | Blank |
| 13" Reel | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 case size) |

Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions





Dimensions – Millimeters (Inches)



| Case Size (in.) | Case Size (mm) | L Length | W Width | T Thickness | B Bandwidth | Mounting Technique | |
|--------------------|-------------------|----------------------------|----------------------------|--------------------------------|---|-----------------------|--|
| 0201 | 0603 | 0.60±0.03 (0.024±0.001) | 0.30±0.03 (0.012±0.001) | 0.30±0.03 (0.012±0.001) | 0.15±0.05 (0.006±0.002) | Solder Deflow Only | |
| 0402 | 1005 | 1.00±0.05 (0.040±0.002) | 0.50±0.05 (0.020±0.002) | 0.50±0.05 (0.020±0.002) | 0.25+0.05/-0.10 (0.010+0.002/-0.004) | Solder Reliow Only | |
| 0603 | 1608 | 1.60±0.10 (0.063±0.004) | 0.80±0.10 (0.031±0.004) | 0.80 ± 0.10 (0.031 ± 0.004) | 0.40 ± 0.20 (0.016 ± 0.008) | Solder Wave | |
| 0805 | 2012 | 2.00±0.20 (0.079±0.008) | 1.25±0.20 (0.049±0.008) | 0.85 ± 0.10 (0.031 ± 0.004) | 0.50 ± 0.25 (0.020 ± 0.010) | or Solder Reflow | |

Electrical Characteristics

SRF (MHz) vs. Cap (pF)





Table 1 – CBR Series, Capacitance Range Waterfall

| Case Size - | Inches (mm) | | 020 |)1 (06 | 03) | | | 04 |)2 (10 | 05) | | 06 | 03 (16 | 08) | 0805 (2012) | | |) |
|------------------|---|------|------|--------|---------|------|------|---------|--------|----------|---------|---------|--------|-----|-------------|-----|-----|-----|
| Rated Volt | tage (VDC) | 6.3 | 10 | 25 | 50 | 100 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 250 | 50 | 100 | 250 | 500 |
| Voltag | e Code | 9 | 8 | 3 | 5 | 1 | 3 | 5 | 1 | 2 | A | 5 | 1 | A | 5 | 1 | Α | C |
| Capacitance | Capacitance Tolerance | | | | | | Cap | acitano | e Code | e (Avail | able Ca | apacita | nce) | | • | | | |
| 0.1 pF | | 108* | 108* | 108* | 108* | 108* | 108* | 108* | 108* | 108* | 108* | | | | | | | |
| 0.2 pF | A = ±0.05 pF | 208 | 208 | 208 | 208 | 208 | 208 | 208 | 208 | 208 | 208 | 208 | 208 | 208 | 208 | 208 | 208 | 208 |
| 0.5 pr | D - 10.1 pr | 408 | 408 | 408 | 408 | 408 | 408 | 408 | 408 | 408 | 408 | 408 | 408 | 408 | 408 | 408 | 408 | 408 |
| 0.5 pF | | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 | 508 |
| 0.6 pF | | 608 | 608 | 608 | 608 | 608 | 608 | 608 | 608 | 608 | 608 | 608 | 608 | 608 | 608 | 608 | 608 | 608 |
| 0.7 pF | | 708 | 708 | 708 | 708 | 708 | 708 | 708 | 708 | 708 | 708 | 708 | 708 | 708 | 708 | 708 | 708 | 708 |
| 0.8 pF | - | 808 | 808 | 808 | 808 | 808 | 808 | 808 | 808 | 808 | 808 | 808 | 808 | 808 | 808 | 808 | 808 | 808 |
| 0.9 pF | | 908 | 908 | 908 | 908 | 908 | 908 | 908 | 908 | 908 | 908 | 908 | 908 | 908 | 908 | 908 | 908 | 908 |
| 1.0 pF | | 109 | 109 | 109 | 109 | 109 | 109 | 109 | 109 | 109 | 109 | 109 | 109 | 109 | 109 | 109 | 109 | 109 |
| 1.1 pr 1.2 pF | | 119 | 119 | 179 | 170 | 119 | 119 | 119 | 119 | 119 | 179 | 119 | 119 | 119 | 119 | 119 | 170 | 119 |
| 1.2 pi | | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 | 139 |
| 1.4 pF | | 149 | 149 | 149 | 149 | 149 | 149 | 149 | 149 | 149 | 149 | 149 | 149 | 149 | 149 | 149 | 149 | 149 |
| 1.5 pF | | 159 | 159 | 159 | 159 | 159 | 159 | 159 | 159 | 159 | 159 | 159 | 159 | 159 | 159 | 159 | 159 | 159 |
| 1.6 pF | | 169 | 169 | 169 | 169 | 169 | 169 | 169 | 169 | 169 | 169 | 169 | 169 | 169 | 169 | 169 | 169 | 169 |
| 1.7 pF | | 179 | 179 | 179 | 179 | 179 | 179 | 179 | 179 | 179 | 179 | 179 | 179 | 179 | 179 | 179 | 179 | 179 |
| 1.8 pF | - | 189 | 189 | 189 | 189 | 189 | 189 | 189 | 189 | 189 | 189 | 189 | 189 | 189 | 189 | 189 | 189 | 189 |
| 1.9 pF | | 199 | 199 | 199 | 199 | 199 | 199 | 199 | 199 | 199 | 199 | 199 | 199 | 199 | 199 | 199 | 199 | 199 |
| 2.0 pF | | 209 | 209 | 209 | 209 | 209 | 209 | 209 | 209 | 209 | 209 | 209 | 209 | 209 | 209 | 209 | 209 | 209 |
| 2.1 pF | - | 219 | 219 | 219 | 219 | 219 | 219 | 219 | 219 | 219 | 219 | 219 | 219 | 219 | 219 | 219 | 219 | 219 |
| 2.2 pr | | 229 | 229 | 229 | 229 | 229 | 229 | 229 | 229 | 229 | 229 | 229 | 229 | 229 | 229 | 229 | 229 | 229 |
| 2.4 pF | | 249 | 249 | 249 | 249 | 249 | 249 | 249 | 249 | 249 | 249 | 249 | 249 | 249 | 249 | 249 | 249 | 249 |
| 2.5 pF | | 259 | 259 | 259 | 259 | 259 | 259 | 259 | 259 | 259 | 259 | 259 | 259 | 259 | 259 | 259 | 259 | 259 |
| 2.6 pF | | 269 | 269 | 269 | 269 | 269 | 269 | 269 | 269 | 269 | 269 | 269 | 269 | 269 | 269 | 269 | 269 | 269 |
| 2.7 pF | A = ±0.05 pF | 279 | 279 | 279 | 279 | 279 | 279 | 279 | 279 | 279 | 279 | 279 | 279 | 279 | 279 | 279 | 279 | 279 |
| 2.8 pF | $B = \pm 0.1 \text{ pr}$ C = $\pm 0.25 \text{ pF}$ | 289 | 289 | 289 | 289 | 289 | 289 | 289 | 289 | 289 | 289 | 289 | 289 | 289 | 289 | 289 | 289 | 289 |
| 2.9 pF | 0 10.20 pi | 299 | 299 | 299 | 299 | 299 | 299 | 299 | 299 | 299 | 299 | 299 | 299 | 299 | 299 | 299 | 299 | 299 |
| 3.0 pF | | 309 | 309 | 309 | 309 | 309 | 309 | 309 | 309 | 309 | 309 | 309 | 309 | 309 | 309 | 309 | 309 | 309 |
| 3.1 pF | | 319 | 319 | 319 | 319 | 319 | 319 | 319 | 319 | 319 | 319 | 319 | 319 | 319 | 319 | 319 | 319 | 319 |
| 3.2 µF | | 329 | 329 | 329 | 329 | 329 | 329 | 329 | 329 | 329 | 329 | 329 | 329 | 329 | 329 | 329 | 329 | 329 |
| 3.5 pr | | 349 | 349 | 349 | 339 | 349 | 349 | 349 | 349 | 349 | 339 | 349 | 3.39 | 349 | 3.39 | 339 | 339 | 349 |
| 3.5 pF | | 359 | 359 | 359 | 359 | 359 | 359 | 359 | 359 | 359 | 359 | 359 | 359 | 359 | 359 | 359 | 359 | 359 |
| 3.6 pF | | 369 | 369 | 369 | 369 | 369 | 369 | 369 | 369 | 369 | 369 | 369 | 369 | 369 | 369 | 369 | 369 | 369 |
| 3.7 pF | | 379 | 379 | 379 | 379 | 379 | 379 | 379 | 379 | 379 | 379 | 379 | 379 | 379 | 379 | 379 | 379 | 379 |
| 3.8 pF |] | 389 | 389 | 389 | 389 | 389 | 389 | 389 | 389 | 389 | 389 | 389 | 389 | 389 | 389 | 389 | 389 | 389 |
| 3.9 pF | | 399 | 399 | 399 | 399 | 399 | 399 | 399 | 399 | 399 | 399 | 399 | 399 | 399 | 399 | 399 | 399 | 399 |
| 4.0 pF | | 409 | 409 | 409 | 409 | 409 | 409 | 409 | 409 | 409 | 409 | 409 | 409 | 409 | 409 | 409 | 409 | 409 |
| 4.1 pF | - | 419 | 419 | 419 | 419 | 419 | 419 | 419 | 419 | 419 | 419 | 419 | 419 | 419 | 419 | 419 | 419 | 419 |
| 4.2 pF | | 429 | 429 | 429 | 429 | 429 | 429 | 429 | 429 | 429 | 429 | 429 | 429 | 429 | 429 | 429 | 429 | 429 |
| 4.3 µr | | 439 | 439 | 439 | 439 | 439 | 439 | 439 | 439 | 439 | 439 | 439 | 439 | 439 | 439 | 439 | 439 | 439 |
| 4.4 pr | | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 | 459 |
| 4.6 pF | | 469 | 469 | 469 | 469 | 469 | 469 | 469 | 469 | 469 | 469 | 469 | 469 | 469 | 469 | 469 | 469 | 469 |
| 4.7 pF | | 479 | 479 | 479 | 479 | 479 | 479 | 479 | 479 | 479 | 479 | 479 | 479 | 479 | 479 | 479 | 479 | 479 |
| 4.8 pF | | 489 | 489 | 489 | 489 | 489 | 489 | 489 | 489 | 489 | 489 | 489 | 489 | 489 | 489 | 489 | 489 | 489 |
| 4.9 pF | | 499 | 499 | 499 | 499 | 499 | 499 | 499 | 499 | 499 | 499 | 499 | 499 | 499 | 499 | 499 | 499 | 499 |
| 5.0 pF | | 509 | 509 | 509 | 509 | 509 | 509 | 509 | 509 | 509 | 509 | 509 | 509 | 509 | 509 | 509 | 509 | 509 |
| Rated Volt | tage (VDC) | 6.3 | 10 | 25 | 50 F | 100 | 25 | 50 F | 100 | 200 | 250 | 50 | 100 | 250 | 50 F | 100 | 250 | 500 |
| i voitad | e ouue | י ש | 0 | 5 | 3 | | 1 3 |) J | | L 2 | A | 1 3 | | A | 1 3 | | A | . U |

* Available only in "B" (±0.1pF) capacitance tolerance.

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Table 1 – CBR Series, Capacitance Range Waterfall cont.

| Case Size – Inches (mm) | | | 020 |)1 (06 | 03) | | 0402 (1005) | | | | | 06 | 03 (16 | 08) | 0805 (2012) | | | |
|-------------------------|--------------------------|------------|--|------------|------------|------------|-------------|------------|------------|------------|-----|------------|------------|------------|-------------|------------|------------|------------|
| Rated Volt | age (VDC) | 6.3 | 10 | 25 | 50 | 100 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 250 | 50 | 100 | 250 | 500 |
| Voltag | e Code | 9 | 8 | 3 | 5 | 1 | 3 | 5 | 1 | 2 | A | 5 | 1 | A | 5 | 1 | A | C |
| Capacitance | Capacitance Tolerance | | Capacitance Code (Available Capacitance) | | | | | | | | | | | | | | | |
| 5.1 pF | | 519 | 519 | 519 | 519 | 519 | 519 | 519 | 519 | 519 | 519 | 519 | 519 | 519 | 519 | 519 | 519 | 519 |
| 5.2 pF | | 529 | 529 | 529 | 529 | 529 | 529 | 529 | 529 | 529 | 529 | 529 | 529 | 529 | 529 | 529 | 529 | 529 |
| 5.3 pF | | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 | 539 |
| 5.4 pr | | 559 | 559 | 559 | 559 | 559 | 559 | 559 | 559 | 559 | 559 | 559 | 559 | 559 | 559 | 559 | 559 | 559 |
| 5.6 pF | | 569 | 569 | 569 | 569 | 569 | 569 | 569 | 569 | 569 | 569 | 569 | 569 | 569 | 569 | 569 | 569 | 569 |
| 5.7 pF | | 579 | 579 | 579 | 579 | 579 | 579 | 579 | 579 | 579 | 579 | 579 | 579 | 579 | 579 | 579 | 579 | 579 |
| 5.8 pF | | 589 | 589 | 589 | 589 | 589 | 589 | 589 | 589 | 589 | 589 | 589 | 589 | 589 | 589 | 589 | 589 | 589 |
| 5.9 pF | | 599 | 599 | 599 | 599 | 599 | 599 | 599 | 599 | 599 | 599 | 599 | 599 | 599 | 599 | 599 | 599 | 599 |
| 6.0 pF | | 609 | 609 | 609 | 609 | 609 | 609 | 609 | 609 | 609 | 609 | 609 | 609 | 609 | 609 | 609 | 609 | 609 |
| 6.1 pF | | 619 | 619 | 619 | 619 | 619 | 619 | 619 | 619 | 619 | 619 | 619 | 619 | 619 | 619 | 619 | 619 | 619 |
| 6.2 pF | | 629 | 629 | 629 | 629 | 629 | 629 | 629 | 629 | 629 | 629 | 629 | 629 | 629 | 629 | 629 | 629 | 629 |
| 6.3 pF | | 639 | 639 | 639 | 639 | 639 | 639 | 639 | 639 | 639 | 639 | 639 | 639 | 639 | 639 | 639 | 639 | 639 |
| 6.4 pF | | 649 | 649 | 649 | 649 | 649 | 649 | 649 | 649 | 649 | 649 | 649 | 649 | 649 | 649 | 649 | 649 | 649 |
| 0.5 pF | | 659 | 659 | 660 | 659 | 659 | 659 | 659 | 659 | 659 | 660 | 659 | 659 | 660 | 659 | 659 | 660 | 659 |
| 6.0 pr | | 670 | 670 | 670 | 670 | 670 | 670 | 670 | 670 | 670 | 670 | 670 | 670 | 670 | 670 | 670 | 670 | 670 |
| 6.8 nF | | 689 | 689 | 689 | 689 | 689 | 689 | 689 | 689 | 689 | 689 | 689 | 689 | 689 | 689 | 689 | 689 | 689 |
| 6.0 pr | | 699 | 699 | 699 | 699 | 699 | 699 | 699 | 699 | 699 | 699 | 699 | 699 | 699 | 699 | 699 | 699 | 699 |
| 7.0 pF | | 709 | 709 | 709 | 709 | 709 | 709 | 709 | 709 | 709 | 709 | 709 | 709 | 709 | 709 | 709 | 709 | 709 |
| 7.1 pF | | 719 | 719 | 719 | 719 | 719 | 719 | 719 | 719 | 719 | 719 | 719 | 719 | 719 | 719 | 719 | 719 | 719 |
| 7.2 pF | | 729 | 729 | 729 | 729 | 729 | 729 | 729 | 729 | 729 | 729 | 729 | 729 | 729 | 729 | 729 | 729 | 729 |
| 7.3 pF | | 739 | 739 | 739 | 739 | 739 | 739 | 739 | 739 | 739 | 739 | 739 | 739 | 739 | 739 | 739 | 739 | 739 |
| 7.4 pF | B = ±0.1 pF | 749 | 749 | 749 | 749 | 749 | 749 | 749 | 749 | 749 | 749 | 749 | 749 | 749 | 749 | 749 | 749 | 749 |
| 7.5 pF | C = ±0.25 pF | 759 | 759 | 759 | 759 | 759 | 759 | 759 | 759 | 759 | 759 | 759 | 759 | 759 | 759 | 759 | 759 | 759 |
| 7.6 pF | D = ±0.5 pF | 769 | 769 | 769 | 769 | 769 | 769 | 769 | 769 | 769 | 769 | 769 | 769 | 769 | 769 | 769 | 769 | 769 |
| 7.7 pF | | 779 | 779 | 779 | 779 | 779 | 779 | 779 | 779 | 779 | 779 | 779 | 779 | 779 | 779 | 779 | 779 | 779 |
| 7.8 pF | | 789 | 789 | 789 | 789 | 789 | 789 | 789 | 789 | 789 | 789 | 789 | 789 | 789 | 789 | 789 | 789 | 789 |
| 7.9 pF | | 799 | 799 | /99 | /99 | 799 | 799 | 799 | /99 | 799 | 799 | 799 | 799 | 799 | 799 | 799 | /99 | /99 |
| 8.0 pF | | 809 910 | 009 010 | 809 910 | 809 910 | 809 910 | 809 910 | 809 910 | 010 010 | 809 910 | 010 | 809 910 | 809 910 | 809 910 | 010 | 809 910 | 010 010 | 809 910 |
| 8.2 nF | | 829 | 829 | 829 | 829 | 829 | 829 | 829 | 829 | 829 | 829 | 829 | 829 | 829 | 829 | 829 | 829 | 829 |
| 8.3 nF | | 839 | 839 | 839 | 839 | 839 | 839 | 839 | 839 | 839 | 839 | 839 | 839 | 839 | 839 | 839 | 839 | 839 |
| 8.4 pF | | 849 | 849 | 849 | 849 | 849 | 849 | 849 | 849 | 849 | 849 | 849 | 849 | 849 | 849 | 849 | 849 | 849 |
| 8.5 pF | | 859 | 859 | 859 | 859 | 859 | 859 | 859 | 859 | 859 | 859 | 859 | 859 | 859 | 859 | 859 | 859 | 859 |
| 8.6 pF | | 869 | 869 | 869 | 869 | 869 | 869 | 869 | 869 | 869 | 869 | 869 | 869 | 869 | 869 | 869 | 869 | 869 |
| 8.7 pF | | 879 | 879 | 879 | 879 | 879 | 879 | 879 | 879 | 879 | 879 | 879 | 879 | 879 | 879 | 879 | 879 | 879 |
| 8.8 pF | | 889 | 889 | 889 | 889 | 889 | 889 | 889 | 889 | 889 | 889 | 889 | 889 | 889 | 889 | 889 | 889 | 889 |
| 8.9 pF | | 899 | 899 | 899 | 899 | 899 | 899 | 899 | 899 | 899 | 899 | 899 | 899 | 899 | 899 | 899 | 899 | 899 |
| 9.0 pF | | 909 | 909 | 909 | 909 | 909 | 909 | 909 | 909 | 909 | 909 | 909 | 909 | 909 | 909 | 909 | 909 | 909 |
| 9.1 pF | | 919 | 919 | 919 | 919 | 919 | 919 | 919 | 919 | 919 | 919 | 919 | 919 | 919 | 919 | 919 | 919 | 919 |
| 9.2 pF | | 929 | 929 | 929 | 929 | 929 | 929 | 929 | 929 | 929 | 929 | 929 | 929 | 929 | 929 | 929 | 929 | 929 |
| 9.3 pF | - | 939 | 939 | 939 | 939 | 939 | 939 | 939 | 939 | 939 | 939 | 939 | 939 | 939 | 939 | 939 | 939 | 939 |
| 9.4 µr 9.5 nF | | 959 | 949 | 949 | 949 | 949 | 949 | 949 | 949 | 949 | 949 | 949 | 949 | 949 | 949 | 949 | 949 | 949 |
| 9.5 pr | | 969 | 969 | 969 | 969 | 969 | 969 | 969 | 969 | 969 | 969 | 969 | 969 | 969 | 969 | 969 | 969 | 969 |
| 9.7 pF | | 979 | 979 | 979 | 979 | 979 | 979 | 979 | 979 | 979 | 979 | 979 | 979 | 979 | 979 | 979 | 979 | 979 |
| 9.8 pF | | 989 | 989 | 989 | 989 | 989 | 989 | 989 | 989 | 989 | 989 | 989 | 989 | 989 | 989 | 989 | 989 | 989 |
| 9.9 pF | | 999 | 999 | 999 | 999 | 999 | 999 | 999 | 999 | 999 | 999 | 999 | 999 | 999 | 999 | 999 | 999 | 999 |
| Rated Volt | age (VDC) | 6.3 | 10 | 25 | 50 | 100 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 250 | 50 | 100 | 250 | 500 |
| Voltag | e Code | 9 | 8 | 3 | 5 | 1 | 3 | 5 | 1 | 2 | A | 5 | 1 | A | 5 | 1 | A | C |

| Case Size – Inches (mm) 0201 (0603) | | | | 040 |)2 (10 | 05) | | 0603 (1608) | | | 0805 (2012) | | | | | | | |
|-------------------------------------|--------------------------|--|--|-----|--------|-----|-----|-------------|-----|-----|-------------|-----|-----|-----|-----|-----|-----|-----|
| Rated Volt | tage (VDC) | 6.3 | 10 | 25 | 50 | 100 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 250 | 50 | 100 | 250 | 500 |
| Voltage Code 9 8 3 5 | | | | 1 | 3 | 5 | 1 | 2 | A | 5 | 1 | A | 5 | 1 | A | C | | |
| Capacitance | Capacitance Tolerance | | Capacitance Code (Available Capacitance) | | | | | | | | | | | | | | | |
| 10 pF | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 11 pF | | 110 | 110 | 110 | 110 | | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 |
| 12 pF | | 120 | 120 | 120 | 120 | | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| 13 pF | | 130 | 130 | 130 | 130 | | 130 | 130 | 130 | 130 | 130 | 130 | 130 | 130 | 130 | 130 | 130 | 130 |
| 15 pF | | 150 | 150 | 150 | 150 | | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| 16 pF | | 160 | 160 | 160 | 160 | | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 |
| 18 pF | | 180 | 180 | 180 | 180 | | 180 | 180 | 180 | 180 | 180 | 180 | 180 | 180 | 180 | 180 | 180 | 180 |
| 20 pF | | 200 | 200 | 200 | 200 | | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 |
| 22 pF | | 220 | 220 | 220 | 220 | | 220 | 220 | 220 | 220 | 220 | 220 | 220 | 220 | 220 | 220 | 220 | 220 |
| 24 pF | | 240 | 240 | 240 | 240 | | 240 | 240 | 240 | 240 | 240 | 240 | 240 | 240 | 240 | 240 | 240 | 240 |
| 27 pF | | 270 | 270 | 270 | 270 | | 270 | 270 | 270 | 270 | 2/0 | 270 | 270 | 270 | 270 | 270 | 2/0 | 2/0 |
| 30 pF | F = ±1% | 300 | 300 | 300 | 300 | | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 |
| 33 pF | $G = \pm 2\%$ | 330 | 330 | 330 | 330 | | 330 | 330 | 330 | 330 | 330 | 330 | 330 | 330 | 330 | 330 | 330 | 330 |
| 36 pF | J = ±5% | 360 | 360 | 360 | 360 | | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 |
| 39 pF | | 390 | 390 | 390 | 390 | | 390 | 390 | 390 | 390 | 390 | 390 | 390 | 390 | 390 | 390 | 390 | 390 |
| 43 pF | | | | | | | 430 | 430 | 430 | 430 | 430 | 430 | 430 | 430 | 430 | 430 | 430 | 430 |
| 4/ pF | | | | | | | 4/0 | 4/0 | 4/0 | 4/0 | 4/0 | 4/0 | 4/0 | 4/0 | 4/0 | 4/0 | 4/0 | 4/0 |
| 51 pF | | | | | | | 510 | 510 | 510 | 510 | 510 | 510 | 510 | 510 | 510 | 510 | 510 | 510 |
| 50 pF | | | | | | | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 |
| 62 pF | | | | | | | 600 | 600 | 600 | 620 | 600 | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| 08 pr | | | | | | | 750 | 750 | 750 | 750 | 750 | 750 | 750 | 750 | 750 | 750 | 750 | 080 |
| 70 pF | | | | | | | 020 | 20 | 020 | 020 | 020 | 730 | 020 | 020 | 020 | 020 | 020 | |
| 91 nF | | | | | | | 910 | 910 | 910 | 910 | 910 | 910 | 910 | 910 | 910 | 910 | 910 | |
| 100 pF | | | | | | | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | |
| Rated Volt | age (VDC) | 6.3 | 10 | 25 | 50 | 100 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 250 | 50 | 100 | 250 | 500 |
| Voltag | e Code | 6.3 10 25 50 100 200 250 50 100 250 100 <t< td=""><td>C</td></t<> | | | | | C | | | | | | | | | | | |

Table 1 – CBR Series, Capacitance Range Waterfall cont.

Table 2 – Chip Thickness/Reeling Quantities

| Chip Size | Chip | Reel Quantity | | | | | |
|-------------|------------|---------------|-----------|--|--|--|--|
| Inches (mm) | (mm) | 7" Paper | 13" Paper | | | | |
| 0201 (0603) | 0.30 ±0.03 | 15,000 | 50,000 | | | | |
| 0402 (1005) | 0.50 ±0.05 | 10,000 | 50,000 | | | | |
| 0603 (1608) | 0.80 ±0.10 | 4,000 | 15,000 | | | | |
| 0805 (2012) | 0.85 ±0.10 | 4,000 | 15,000 | | | | |



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351 (mm)

| Case Size | Case Size (mm) | N | Density Level A: Maximum (Most) Land Protrusion | | | | N | Density Level B: Median (Nominal) Land Protrusion | | | | | Density Level C: Minimum (Least) Land Protrusion | | | | | |
|--------------|---|------|---|------|------|------|------|---|------|------|------|------|--|------|------|------|--|--|
| (menes) | (,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | | |
| 0201 | 0603 | 0.38 | 0.56 | 0.52 | 1.80 | 1.00 | 0.33 | 0.46 | 0.42 | 1.50 | 0.80 | 0.28 | 0.36 | 0.32 | 1.20 | 0.60 | | |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 | | |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 | | |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 | | |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of 0603(1608) and 0805 (2012) case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1608 case size.



7



Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805, and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

The KEMET families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Termination Finish |
|--|--------------------|
| Fromereature | SnPb |
| Preheat/Soak | |
| Temperature Minimum (T _{Smin}) | 100°C |
| Temperature Maximum (T _{smax}) | 150°C |
| Time (ts) from T_{Smin} to T_{Smax} | 60 – 120 seconds |
| Ramp-Up Rate (T_L to T_P) | 3°C/second maximum |
| Liquidous Temperature (TL) | 183°C |
| Time Above Liquidous (t _L) | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum |
| Ramp-Down Rate (T _P to T _L) | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum |

Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.



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Table 4 – Performance & Reliability: Test Methods & Conditions

| Test | | Test Co | ondition | Limits | |
|---|--|---|--|--|---|
| Capacitance (Cap) | | 1 MHz ±100 kHz | and 1.0 ±0.2 V _{RMS} | | Within Tolerance |
| Quality Factor (Q) | | 1 MHz ±100 kHz | and 1.0 \pm 0.2 V _{RMS} | | ≥ 1,000 for capacitance values ≥ 30 pF ≥ 400 + 20C for capacitance values < 30 pF (C = Capacitance in pF) |
| Insulation Resistance | Apply | rated voltage fo | or 120 seconds at | 25°C | 10 GΩ minimum |
| Temperature Coefficient of Capacitance (TCC) | | 1 MHz ±100 kHz | and 1.0 ±0.2 V _{RMS} | | 0 ± 30 PPM/°C (0 ± 60PPM/°C for 0201 case size product ≥ 22 pF) |
| Dielectric Withstanding Voltage (DWV) | (5 ±1 seco | Voltage <100 V | DWV Voltage 250% 200% 200% 150% discharge not exc A) | eeding 50 | Cap: Initial Limit DF: Initial Limit IR: Initial Limit Withstand test voltage without insulation breakdown or damage |
| Aging Rate | Capacitance of 1,000 hour | measurements : rs. | are indexed to a r | eferee time | 0% |
| Terminal Strength | Termin | Case Size 0201 0402 0603 0805 nal strength test Time: 10± | Force 2N 5N 5N 10N per specific case 1 seconds | e size, | No evidence of mechanical damage |
| Solderability | Solder Tempo Dipping Time | erature: 245 ±5° e: 3 ±0.5 second: | C s | | 95% minimum coverage of termination finish. |
| Board Flex | Capacitor is i means of ran deflection be 5 ±1 second) Store at roon measuring el | mounted to a su n at a rate of 1 m comes 1 mm. (E n temperature fo lectrical properti | bstrate which is f nm per second un Deflection is main or 24 ±2 hours bef ies. | lexed by til the tained for ore | No visible damage. Capacitance change: within ±5.0% or ±0.5 pF, whichever is larger. (Capacitance change is monitored during flexure.) |
| Resistance to Soldering Heat | Solder Temp Dipping Time Preheating: 1 capacitor in a Store at roon measuring el | erature: 260 ±5° e: 10 ±1 second I20 to 150°C for a eutectic solder n temperature fo ectrical properti | C 1 minute before in r. or 24 ±2 hours bef ies. | mmerse the ore | No visible damage. Capacitance change: within ±2.5% or ±0.25 pF, whichever is larger. Q/DF, IR and dielectric strength: To meet initial requirements. 25% maximum leaching on each edge. |



Table 4 – Performance & Reliability: Test Methods & Conditions cont.

| Test | | Test Condition | | Limi | ts | | | |
|---------------------------------|--|--|---|---|---|--|--|--|
| | 5 cycle | s of steps 1 - 4: | | | | | | |
| | Step | Temperature (°C) | Time (min.) | | | | | |
| | 1 | Minimum operating temperature +0/-3 | 30 ±3 | No visible damage. Capacitance change: within ±2.5% or ±0.25 pF, whichever is larger. | | | | |
| Temperature | 2 | Room temperature | 2 ~ 3 | | | | | |
| Cycling | 3 | Maximum operating temperature +3/-0 | Q/DF, IR and dielectric streng requirements. | yth: To meet initial | | | | |
| | 4 | Room temperature (25°C) | 2 ~ 3 | | | | | |
| | Store a measur | t room temperature for 24 ±2 hours ring electrical properties. | before | | | | | |
| Humidity (Damp Heat) Load | Test ter Humidi Test Tir Appliec Store a measur | mperature: 40 ±2°C ty: 90 ~ 95% RH me: 500 +24/-0 hours d Voltage: Rated voltage t room temperature for 24 ±2 hours ring electrical properties. | before | No visible damage. Capacitance change: within ±7.5% or ±0.75 pF, whichever is larger. Q value: Capacitance ≥ 30 pF, Q ≥ 200, Capacitance < 30 pF, Q ≥ 100+10/3°C | | | | |
| High Temperature Life | Test ter Applied 2 1 Test Tir Store a measur | mperature: 125 ±3°C d Voltage: 00% of rated voltage (6.3 VDC – 100 50% of rated voltage (200 VDC and me: 1,000 +24/-0 hours t room temperature for 24 ±2 hours ring electrical properties. |) VDC) 500 VDC) before | Capacitance change: within ±3.0% or ±0.3 pF, whichever is larger. Q/DF value: Capacitance ≥ 30 pF, Q ≥350, 10 pF ≤ Capacitance < 30 pF, Q ≥ 275 +5°C Capacitance <10 pF, Q ≥ 200 +10°C IR: ≥1 GΩ | | | | |
| | | | | 0201 Case Size | 0402 Case Size | | | |
| | | | | 0.1 pF ≤ Capacitance ≤ 1 pF: < 350 mΩ/pF | 0.1 pF ≤ Capacitance ≤ 1 pF: < 350 mΩ/pF | | | |
| | | | | 1.0 pF < Capacitance ≤ 5.0 pF: < 300 mΩ | 1.0 pF < Capacitance \leq 5.0 pF: < 300 m Ω | | | |
| | The ES | R should be measured at room temp | perature and | 5.0 pF < Capacitance ≤ 22.0 pF: < 250 mΩ | 5.0 pF < Capacitance ≤ 100 pF: < 250 mΩ | | | |
| ESR | tested | at frequency 1 ±0.1 GHz. | | 0603 Case Size | 0805 Case Size | | | |
| | | | | 0.3 pF ≤ Capacitance ≤ 1 pF: < 1,500 mΩ | 0.3 pF ≤ Capacitance ≤ 1 pF: < 1,500 mΩ | | | |
| | | | | 1 pF < Capacitance ≤ 10 pF: < 250 mΩ | 1 pF < Capacitance ≤ 10 pF: < 250 mΩ | | | |
| | | | | 10 pF < Capacitance ≤ 100 pF: < 200 mΩ | Capacitance > 10 pF: < 200 mΩ | | | |
| | The ES tested | R should be measured at room temp at frequency 500 ±50 MHz. | perature and | 0201 case size, 22 pF ≤ Cap s | ≤ 33 pF: < 300 mΩ | | | |



Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.

Construction





Tape & Reel Packaging Information

KEMET offers RF and Microwave Multilayer Ceramic Chip Capacitors packaged in 8 mm tape on 7" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems.

Table 5 – Carrier Tape Configuration (mm)



| EIA Case Size | Tape Size (W)* | Lead Space (P ₁)* |
|---------------|----------------|-------------------------------|
| 0201 - 0402 | 8 | 2 |
| 0603 - 1210 | 8 | 4 |

*Refer to Figure 1 for W and P₁ carrier tape reference locations. *Refer to Table 6 for tolerance specifications.



Figure 1 – Punched (Paper) Carrier Tape Dimensions



Table 6 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|--------------------|--|----------------------------|---------------------------|---------------------------|--|----------------------------|----------|----------------|--|--|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | R Reference Note 2 | K _o | | | | | |
| 8 mm | 1.55+0.05 (0.061+0.002) | 1.55±0.05 (0.061±0.002) | 4.0±0.10 (0.157±0.004) | 2.0±0.05 (0.079±0.002) | 25.0 (0.984) | - | | | | | |
| | Variable Dimensions — Millimeters (Inches) | | | | | | | | | | |
| Tape Size | Pitch | A ₀ | B ₀ | F | P ₁ | Т | W | D ₁ | | | |
| 0 mm | Holf (2 mm) | 0.37±0.03 (0.015±0.001) | 0.67±0.03 (0.03±0.001) | | 2.0±0.05 | 0.42±0.03 (0.017±0.001) | | | | | |
| 0 11111 | | 0.62±0.05 (0.025±0.002) | 1.12±0.05 (0.04±0.002) | 3.5±0.05 | (0.079±0.002) | 0.60±0.05 (0.024±0.002) | 8.0±0.10 | | | | |
| 8 mm Single (4 mm) | 1.00±0.10 (0.040±0.004) | 1.80±0.10 (0.07±0.004) | (0.138±0.002) | 4.0±0.10 | 0.95±0.05 (0.037±0.002) (0.315±0.004) | | - | | | | |
| | Single (4 mm) | 1.50±0.10 (0.06±0.004) | 2.30±0.10 (0.09±0.004) | | (0.157±0.004) | 0.95±0.05 (0.037±0.002) | | | | | |

2. The tape with or without components shall pass around R without damage (see Figure 3).



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 Kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 2 – Bending Radius



Figure 3 – Tape Leader & Trailer Dimensions





Figure 4 – Maximum Camber



Figure 5 – Reel Dimensions



Table 7 – Reel Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | | | | |
|--|--|------------------------------------|----------------------------|--|--|--|--|--|--|--|--|
| Tape Size | С | | | | | | | | | | |
| 8 mm | 7 | 178±0.10 (7.008±0.004) | 13.0±0.20 (0.512±0.008) | | | | | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | | | |
| Tape Size | N Minimum See Note 2, Table 6 | W ₁ | | | | | | | | | |
| 8 mm | 60±0.10 (2.4±0.04) | 8.4+1.5/-0.0 (0.331+0.059/-0.0) | | | | | | | | | |



Overview

KEMET Power Solutions (KPS) MIL Series ceramic stacked capacitors are available in commercial, military and space grades and are well suited for standard and high reliability switch mode power supply (SMPS) and pulse energy applications. Qualified under performance specification MIL-PRF-49470, our military and space grade products meet or exceed the requirements outlined by DSCC (Defense Supply Center, Columbus) and are available in both B (standard reliability) & T (high reliability) product levels. MIL-PRF-49470 was developed as part of a cooperative effort between the U.S. Military, NASA and SMPS suppliers to produce a robust replacement to cancelled DSCC Drawing 87106.

The KPS MIL Series is constructed using large chip multilayer ceramic capacitors (MLCCs), horizontally stacked and secured to a lead-frame termination system using a high melting point (HMP) solder alloy. The lead frame isolates the MLCCs from the printed circuit board (PCB) while establishing a parallel circuit configuration. Mechanically isolating the capacitors from the PCB improves mechanical and thermal stress performance, while the parallel circuit configuration allows for bulk capacitance in the same or smaller design footprint.

Available in BX, BR, BQ, and X7R dielectrics, these devices are available in unencapsulated styles in both surface mountable and through-hole configurations. Their low Equivalent Series Resistance (ESR) and Equivalent Series Inductance (ESL) make them ideally suited for input and output filtering of power supply as well as snubber applications. The encapsulated styles are primarily used where increased mechanical and environmental protection is required, such as in avionics systems.

Benefits

- -55°C to +125°C operating temperature range
- High frequency performance
- Bulk capacitance in a reduced footprint
- MIL-PRF-49470 QPL
- Military Case Codes 3, 4 and 5
- Space Grade available ("T" Level)
- DSCC approved (87106)
- Commercial/Industrial Grade available
- Customer specific requirements available
- Low ESR and ESL
- · High thermal stability
- · High ripple current capability
- · Higher reliability than aluminum electrolytic or tantalum

Applications

- Military
- Space
- Industrial
- Input and output filtering on power supplies often found on "capacitor banks"
- Snubber circuits
- Radar filtering (28 V/microwave burst)



MIL-PRF-49470 Ordering Information

| M49470 | R | 01 | 474 | K | C | N |
|--|--|---|--|---------------------------------|---|--|
| Performance Specification Indicating MIL-PRF-49470 ¹ | Dielectric Classification/ Characteristic ² | Performance Specification Sheet Number (Indicating MIL-PRF-49470/1) ³ | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Lead Configuration⁴ |
| M49470 = B level T49470 = T level A T prefix is used in place of the M for T level product. | Q = BQ R = BR X = BX | 01 = Unencapsulated | Two significant digits and number of zeros | J = ±5% K = ±10% M = ±20% | A = 50 B = 100 C = 200 E = 500 | N = Straight Pin L = Formed L J = Formed J |

¹ Indicates performance and reliability requirements. "B" level represents standard reliability."T" level represents high reliability.

¹ Please refer to performance specification sheet MIL-PRF-49470 for details regarding test levels. The latest revision of the specification sheet is available through DSCC.

^{1,3} Test level option "T" is not available on encapsulated stacked devices (i.e. MIL-PRF-49470/2).

² Dielectric classification and characteristic details are outlined in the "Electrical Parameters" section of this document.

⁴Lead configuration and dimension details are outlined in the "Dimensions" section of this document.

KPS MIL Series, SMPS Stacks Ordering Information

(Do not use this ordering code if a QPL MIL-SPEC part type is required. Please order using MIL-SPEC ordering code. Details regarding MIL-PRF-49470 QPL ordering information is outlined above.)

| L1 | R | N | 30 | C | 106 | K | S | 1 | 2 |
|-----------------------------|--|--|-------------------------------------|---|--|---------------------------------|--|--|--|
| Product Family ¹ | Dielectric Classification/ Characteristic ² | Lead Configuration ³ | Case Size/ Case Code (CC) | Rated Voltage (VDC) | Capacitance Code (pF) | Capacitance Tolerance | Testing Option⁴ | Maximur Dimensi | n Height on (in.)⁵ |
| L1 = Unencapsulated | Q = BQ R = BR X = BX W = X7R | N = Straight L = Formed L J = Formed J | 30 = CC 3 40 = CC 4 50 = CC 5 | 3 = 25 5 = 50 1 = 100 2 = 200 C = 500 B = 630 D = 1,000 | Two significant digits and number of zeros | J = ±5% K = ±10% M = ±20% | B = M49470 B level T = M49470 T level C = DSCC87106 S = Commercial X = Non-standard (Customer specific requirements) | Unencapsulated 12 = 0.12" 24 = 0.24" 36 = 0.36" 48 = 0.48" 65 = 0.65" | Encapsulated 27 = 0.27" 39 = 0.39" 53 = 0.53" 66 = 0.66" 80 = 0.80" |

^{1,4} Test level option "T" is not available on encapsulated stacked devices, i.e., MIL–PRF–49470/2. If a QPL MIL–Spec part type is required, please order using the MIL–Spec ordering code.

² Dielectric classification and characteristic details are outlined in the "Electrical Parameters" section of this document.

³ Lead configuration and dimension details are outlined in the "Dimensions" section of this document. Additional lead configurations may be available. Contact KEMET for details.

⁴ Indicates performance and reliability requirements. Testing option details are outlined in the "Performance & Reliability" section of this document.

⁴ Please refer to performance specification sheet MIL-PRF-49470 for additional details regarding test levels. The latest revision of the specification sheet is available through DSCC.

⁴ DSCC Drawing 87106 was cancelled on 01/03/2005. MIL-PRF-49470 capacitors are preferred over DSCC Drawing 87106 capacitors.

⁵ Maximum height dimensions are provided in product tables 1A, 1B, and 1C of this document

Ordering Information Requirements per DSCC Drawing 87106

DSCC Drawing 87106 was cancelled on 01/03/2005. Customers can continue to order per 87106 requirements using the original DSCC ordering code, i.e., 87106–001.

When available, MIL–PRF–49470 devices are preferred over DSCC Drawing 87106. The MIL–PRF–49470 military specification product provides additional quality assurance provisions that are not required by the DSCC drawing. These extra provisions create a more robust replacement.



| Case Code | C Lead Spacing ±0.025 (0.635) | E Length Maximum | D Width Minimum | D Width Maximum | A Height Maximum | Seating Plane ¹ ±0.010 (0.250) | Number of Leads per Side | Mounting Technique |
|--------------|-------------------------------------|------------------------|-----------------------|-----------------------|------------------------|--|--------------------------------|-----------------------|
| 3 | 0.450 (11.43) | 0.500 (12.70) | 0.950 (24.13) | 1.075 (27.30) | Refer to tables | | 10 | |
| 4 | 0.400 (10.16) | 0.440 (11.18) | 0.350 (8.89) | 0.425 (10.80) | for specific | 0.055 (1.40) | 4 | Solder reflow only |
| 5 | 0.250 (6.35) | 0.300 (7.62) | 0.224 (5.69) | 0.275 (6.98) | maximum A | | 3 |] |

(M49470/1 & L1) Product Dimensions – Inches (Millimeters)

¹ Only applies to lead style "N" (straight).



- 1. Dimensions are in inches.
- 2. Metric equivalents are given for general information only.
- 3. Unless otherwise specified, tolerances are ±0.010 inch (0.25 mm).
- 4. Lead frame configuration is shown as typical above the seating plane. The seating plane shall be configured to create a standoff height of 0.055 inch ±0.010 inch when the part is mounted to a printed circuit board (PCB). The standoff height shall be the distance between the PCB and the bottom of the chip stack. A seating plane is only required for lead style N.
- 5. See Table 1 for specific maximum A dimension. For maximum B dimension, add .065 inch (1.65 mm) to the appropriate A dimension. For all lead styles, the number of chips is determined by the capacitance and voltage rating.
- 6. For case code 5, dimensions shall be .100 inch (2.54 mm) maximum and 0.012 inch (0.30 mm) minimum.
- 7. Lead alignment within pin rows shall be within ±0.005 inch (0.13 mm). Lead alignment between pin rows shall be within one half of the lead width (0.010 inch (0.25 mm)).

Lead Configurations - Inches (Millimeters)

| Lead Style Symbol | Lead Style | L Lead Length | | |
|----------------------|--------------|---------------------------|--|--|
| N | (N) Straight | 0.250 Minimum (6.35) | | |
| L | (L) Formed | 0.070 ±0.010 (1.78 ±0.25) | | |
| J | (J) Formed | 0.070 ±0.010 (1.78 ±0.25) | | |

Additional lead configurations may be available. Contact KEMET for details.



Qualification Inspection Per MIL-PRF-49470

| Inspection | Test Method Paragraph | | | | |
|---|-----------------------|--|--|--|--|
| Gro | up l | | | | |
| Thermal shock and voltage conditioning | 4.8.5 | | | | |
| Grou | up II | | | | |
| Visual and mechanical Inspection | 4.8.4 | | | | |
| Group III | | | | | |
| Low temperature storage | 4.8.23 | | | | |
| Barometric pressure | 4.8.9 | | | | |
| Terminal strength | 4.8.10 | | | | |
| Group IV | | | | | |
| Voltage-temperature limits | 4.8.13.1 | | | | |
| Vibration, high frequency | 4.8.14 | | | | |
| Immersion | 4.8.15 | | | | |
| Grou | up V | | | | |
| Shock, specified pulse | 4.8.16 | | | | |
| Resistance to soldering heat | 4.8.17 | | | | |
| Moisture resistance | 4.8.18 | | | | |
| Grou | ıp VI | | | | |
| DPA (T level only) | 4.8.19 | | | | |
| Grou | p VII | | | | |
| Humidity, steady state, low voltage (T level only) | 4.8.21 | | | | |
| Grou | ρ VIII | | | | |
| Life | 4.8.22 | | | | |

Environmental Compliance

These devices do not meet RoHS criteria



Electrical Parameters/Performance Characteristics: BQ Dielectric

| Item | Parameters/Characteristics |
|--|---|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±15% |
| Capacitance Change with Reference to +25°C and 100% Rated VDC Applied | +15%, -50% |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 1% |
| Dielectric Withstanding Voltage (DWV) | 250% of rated DC voltage for voltage rating < 500 V 150% of rated DC voltage for voltage rating of 500 V (5±1 seconds and charge/discharge not exceeding 50 mA) |
| Dissipation Factor (DF) Maximum Limit at 25°C | 2.5% |
| Insulation Resistance (IR) Limit at 25°C | 1,000 megohm microfarads (minimum) or 100 G Ω |
| Insulation Resistance (IR) Limit at 125°C | 100 megohm microfarads (minimum) or 10 GΩ |

Regarding aging rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours. To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits. Capacitance and dissipation factor (DF) measured under the following conditions:

1 kHz ±100 Hz at 1.0 Vrms ±0.2 Vrms

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

Electrical Parameters/Performance Characteristics: BR Dielectric

| Item | Parameters/Characteristics |
|--|---|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±15% |
| Capacitance Change with Reference to +25°C and 100% Rated VDC Applied | +15%, -40% |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 1% |
| Dielectric Withstanding Voltage (DWV) | 250% of rated DC voltage for voltage rating < 500 V 150% of rated DC voltage for voltage rating of 500 V (5±1 seconds and charge/discharge not exceeding 50 mA) |
| Dissipation Factor (DF) Maximum Limit at 25°C | 2.5% |
| Insulation Resistance (IR) Limit at 25°C | 1,000 megohm microfarads (minimum) or 100 G Ω |
| Insulation Resistance (IR) Limit at 125°C | 100 megohm microfarads (minimum) or 10 GΩ |

Regarding aging rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours.

To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Capacitance and dissipation factor (DF) measured under the following conditions:

1 kHz ±100 Hz at 1.0 Vrms ±0.2 Vrms

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."



Electrical Parameters/Performance Characteristics: BX Dielectric

| Item | Parameters/Characteristics |
|--|---|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±15% |
| Capacitance Change with Reference to +25°C and 100% Rated VDC Applied | +15%, -25% |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 1% |
| Dielectric Withstanding Voltage (DWV) | 250% of rated DC voltage for voltage rating < 500 V 150% of rated DC voltage for voltage rating of 500 V (5±1 seconds and charge/discharge not exceeding 50 mA) |
| Dissipation Factor (DF) Maximum Limit at 25°C | 2.5% |
| Insulation Resistance (IR) Limit at 25°C | 1000 megohm microfarads (minimum) or 100 GΩ |
| Insulation Resistance (IR) Limit at 125°C | 100 megohm microfarads (minimum) or 10 GΩ |

Regarding aging rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1000 hours. To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Capacitance and dissipation factor (DF) measured under the following conditions:

1 kHz ±100 Hz at 1.0 Vrms ±0.2 Vrms

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

Electrical Parameters/Performance Characteristics: X7R Dielectric

| Item | Parameters/Characteristics |
|---|--|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±15% |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| Dielectric Withstanding Voltage (DWV) | 250% of rated DC voltage for voltage rating < 500V 150% of rated DC voltage for voltage rating of 500V and 630V 120% of rated DC voltage for voltage rating of 1,000V (5±1 seconds and charge/discharge not exceeding 50mA) |
| Dissipation Factor (DF) Maximum Limit at 25°C | 3.5% (25 V) and 2.5% (50 V to 200 V) |
| Insulation Resistance (IR) Limit at 25°C | 1,000 megohm microfarads or 100 G Ω (Rated voltage applied for 120±5 seconds at 25°C) |

Regarding aging rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1000 hours.

To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Capacitance and dissipation factor (DF) measured under the following conditions:

1 kHz ±50 Hz and 1.0 ±0.2 Vrms if capacitance \leq 10 μ F.

120 Hz ±10 Hz and 0.5 ±0.1 Vrms if capacitance > 10 μ F.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."



Table 1A - MIL-PRF-49470/1, Product Selection 50 - 200 VDC

| MIL-PRF-49470/1 Horizontally Stacked | | | | | | | |
|--|---------------------|--------------|-----------------------|--------------------------|-----------------------|------------------------|--|
| MIL-PRF-49470 P/N ¹ | Capacitance (µF) | Case Code | Height A inch (mm) | Capacitance Tolerance | Lead Configuration | KEMET P/N ¹ | |
| 50 VDC – BX Dielectric | | | | | | | |
| (1)49470X01105(2)A(3) | 1 | 5 | 0.120 (3.05) | К. М | N. L. J | L1X(3)505105(2)(4)12 | |
| (1)49470X01125(2)A(3) | 1.2 | 5 | 0.120 (3.05) | К. М | N. L. J | L1X(3)505125(2)(4)12 | |
| (1)49470X01155(2)A(3) | 1.5 | 5 | 0.240 (6.10) | К. М | N. L. J | L1X(3)505155(2)(4)24 | |
| (1)49470X01185(2)A(3) | 1.8 | 5 | 0.240 (6.10) | К, М | N, L, J | L1X(3)505185(2)(4)24 | |
| (1)49470X01225(2)A(3) | 2.2 | 5 | 0.240 (6.10) | К, М | N, L, J | L1X(3)505225(2)(4)24 | |
| (1)49470X01275(2)A(3) | 2.7 | 5 | 0.360 (9.14) | К, М | N, L, J | L1X(3)505275(2)(4)36 | |
| (1)49470X01335(2)A(3) | 3.3 | 5 | 0.360 (9.14) | К, М | N, L, J | L1X(3)505335(2)(4)36 | |
| (1)49470X01475(2)A(3) | 3.9 | 5 | 0.480 (12.19) | К, М | N, L, J | L1X(3)505475(2)(4)48 | |
| (1)49470X01395(2)A(3) | 3.9 | 5 | 0.480 (12.19) | К, М | N, L, J | L1X(3)505395(2)(4)48 | |
| (1)49470X01565(2)A(3) | 5.6 | 5 | 0.650 (16.51) | К, М | N, L, J | L1X(3)505565(2)(4)65 | |
| (1)49470X01685(2)A(3) | 6.8 | 4 | 0.360 (9.14) | К, М | N, L, J | L1X(3)405685(2)(4)36 | |
| (1)49470X01825(2)A(3) | 8.2 | 4 | 0.360 (9.14) | К, М | N, L, J | L1X(3)405825(2)(4)36 | |
| (1)49470X01106(2)A(3) | 10 | 4 | 0.480 (12.19) | К, М | N, L, J | L1X(3)405106(2)(4)48 | |
| (1)49470X01126(2)A(3) | 12 | 4 | 0.480 (12.19) | К, М | N, L, J | L1X(3)405126(2)(4)48 | |
| (1)49470X01156(2)A(3) | 15 | 4 | 0.650 (16.51) | К, М | N, L, J | L1X(3)405156(2)(4)65 | |
| (1)49470X01186(2)A(3) | 18 | 3 | 0.240 (6.10) | К, М | N, L, J | L1X(3)305186(2)(4)24 | |
| (1)49470X01226(2)A(3) | 22 | 3 | 0.360 (9.14) | К, М | N, L, J | L1X(3)305226(2)(4)36 | |
| (1)49470X01276(2)A(3) | 27 | 3 | 0.360 (9.14) | К, М | N, L, J | L1X(3)305276(2)(4)36 | |
| (1)49470X01336(2)A(3) | 33 | 3 | 0.360 (9.14) | К, М | N, L, J | L1X(3)305336(2)(4)36 | |
| (1)49470X01396(2)A(3) | 39 | 3 | 0.480 (12.19) | К, М | N, L, J | L1X(3)305396(2)(4)48 | |
| (1)49470X01476(2)A(3) | 47 | 3 | 0.650 (16.51) | К, М | N, L, J | L1X(3)305476(2)(4)65 | |
| | | 100 V | DC – BX Dielec | tric | | | |
| (1)49470X01684(2)B(3) | 0.68 | 5 | 0.120 (3.05) | К, М | N, L, J | L1X(3)501684(2)(4)12 | |
| (1)49470X01824(2)B(3) | 0.82 | 5 | 0.240 (6.10) | К, М | N, L, J | L1X(3)501824(2)(4)24 | |
| (1)49470X01105(2)B(3) | 1 | 5 | 0.240 (6.10) | К, М | N, L, J | L1X(3)501105(2)(4)24 | |
| (1)49470X01125(2)B(3) | 1.2 | 5 | 0.240 (6.10) | К, М | N, L, J | L1X(3)501125(2)(4)24 | |
| (1)49470X01155(2)B(3) | 1.5 | 5 | 0.360 (9.14) | К, М | N, L, J | L1X(3)501155(2)(4)36 | |
| (1)49470X01185(2)B(3) | 1.8 | 5 | 0.360 (9.14) | К, М | N, L, J | L1X(3)501185(2)(4)36 | |
| (1)49470X01225(2)B(3) | 2.2 | 5 | 0.480 (12.19) | К, М | N, L, J | L1X(3)501225(2)(4)48 | |
| (1)49470X01275(2)B(3) | 2.7 | 5 | 0.480 (12.19) | К, М | N, L, J | L1X(3)501275(2)(4)48 | |
| (1)49470X01335(2)B(3) | 3.3 | 5 | 0.650 (16.51) | К, М | N, L, J | L1X(3)501335(2)(4)65 | |
| (1)49470X01395(2)B(3) | 3.9 | 4 | 0.360 (9.14) | К, М | N, L, J | L1X(3)401395(2)(4)36 | |
| (1)49470X01475(2)B(3) | 4.7 | 4 | 0.360 (9.14) | К, М | N, L, J | L1X(3)401475(2)(4)36 | |
| (1)49470X01565(2)B(3) | 5.6 | 4 | 0.480 (12.19) | K, M | N, L, J | L1X(3)401565(2)(4)48 | |
| (1)49470X01685(2)B(3) | 6.8 | 4 | 0.480 (12.19) | К, М | N, L, J | L1X(3)401685(2)(4)48 | |
| (1)49470X01825(2)B(3) | 8.2 | 4 | 0.650 (16.51) | К, М | N, L, J | L1X(3)401825(2)(4)65 | |
| (1)49470X01106(2)B(3) | 10 | 3 | 0.240 (6.10) | К, М | N, L, J | L1X(3)301106(2)(4)24 | |
| (1)494/UXU1126(2)B(3) | 12 | 3 | 0.240 (6.10) | К, М | N, L, J | L1X(3)301126(2)(4)24 | |
| (1)49470X01156(2)B(3) | 15 | 3 | 0.360 (9.14) | К, М | N, L, J | L1X(3)301156(2)(4)36 | |
| (1)494/0X01186(2)B(3) | 18 | 3 | 0.360 (9.14) | К, М | N, L, J | L1X(3)301186(2)(4)36 | |
| (1)49470X01226(2)B(3) (1)40470X01075(0)B(3) | 22 | 3 | 0.480 (12.19) | K, M | N, L, J | L1X(3)301226(2)(4)48 | |
| (1)49470X01276(2)B(3) | 27 | 3 | 0.650 (16.51) | К, М | N, L, J | LIX(3)301276(2)(4)65 | |
| | | 200 V | DC – BR Dielec | tric | | | |
| (1)49470R01474(2)C(3) | 0.47 | 5 | 0.240 (6.10) | К, М | N, L, J | L1R(3)502474(2)(4)24 | |
| (1)49470R01564(2)C(3) | 0.56 | 5 | 0.240 (6.10) | К, М | N, L, J | L1R(3)502564(2)(4)24 | |
| (1)49470R01684(2)C(3) | 0.68 | 5 | 0.360 (9.14) | К, М | N, L, J | L1R(3)502684(2)(4)36 | |
| (1)49470R01824(2)C(3) | 0.82 | 5 | 0.360 (9.14) | К, М | N, L, J | L1R(3)502824(2)(4)36 | |
| (1)49470R01105(2)C(3) | 1 | 5 | 0.480 (12.19) | К, М | N, L, J | L1R(3)502105(2)(4)48 | |
| MIL-PRF-49470 P/N ¹ | Capacitance (µF) | Case Code | Height A inch (mm) | Capacitance Tolerance | Lead Configuration | KEMET P/N ¹ | |

¹ Complete P/N requires additional characters in the numbered positions provided in order to indicate product level (B level or T level), capacitance tolerance and lead configuration. For each numbered position, available options are as follows:

(1) Test level character "M" for B level, or "T" for T level (MIL-PRF-49470/1 part number only).

(2) Capacitance tolerance character " K" or " M".

(3) Lead style character " N", "L" or "J".

(4) Test level character "B" for B level, or "T" for T level (KEMET part number only).



Table 1A - MIL-PRF-49470 /1, Product Selection 200 - 500 VDC cont.

| MIL-PRF-49470/1 Horizontally Stacked | | | | | | | |
|--------------------------------------|---------------------|--------------|-----------------------|--------------------------|-----------------------|------------------------|--|
| MIL-PRF-49470 P/N ¹ | Capacitance (µF) | Case Code | Height A inch (mm) | Capacitance Tolerance | Lead Configuration | KEMET P/N ¹ | |
| (1)49470R01125(2)C(3) | 1.2 | 5 | 0.480 (12.19) | К, М | N, L, J | L1R(3)502125(2)(4)48 | |
| (1)49470R01155(2)C(3) | 1.5 | 5 | 0.650 (16.51) | К, М | N, L, J | L1R(3)502155(2)(4)65 | |
| (1)49470R01185(2)C(3) | 1.8 | 4 | 0.360 (9.14) | К, М | N, L, J | L1R(3)402185(2)(4)36 | |
| (1)49470R01225(2)C(3) | 2.2 | 4 | 0.360 (9.14) | К, М | N, L, J | L1R(3)402225(2)(4)36 | |
| (1)49470R01275(2)C(3) | 2.7 | 4 | 0.480 (12.19) | К, М | N, L, J | L1R(3)402275(2)(4)48 | |
| (1)49470R01335(2)C(3) | 3.3 | 4 | 0.480 (12.19) | К, М | N, L, J | L1R(3)402335(2)(4)48 | |
| (1)49470R01395(2)C(3) | 3.9 | 4 | 0.650 (16.51) | К, М | N, L, J | L1R(3)402395(2)(4)65 | |
| (1)49470R01475(2)C(3) | 4.7 | 3 | 0.240 (6.10) | К, М | N, L, J | L1R(3)302475(2)(4)24 | |
| (1)49470R01565(2)C(3) | 5.6 | 3 | 0.240 (6.10) | К, М | N, L, J | L1R(3)302565(2)(4)24 | |
| (1)49470R01685(2)C(3) | 6.8 | 3 | 0.360 (9.14) | К, М | N, L, J | L1R(3)302685(2)(4)36 | |
| (1)49470R01825(2)C(3) | 8.2 | 3 | 0.360 (9.14) | К, М | N, L, J | L1R(3)302825(2)(4)36 | |
| (1)49470R01106(2)C(3) | 10 | 3 | 0.480 (12.19) | К, М | N, L, J | L1R(3)302106(2)(4)48 | |
| (1)49470R01126(2)C(3) | 12 | 3 | 0.650 (16.51) | К, М | N, L, J | L1R(3)302126(2)(4)65 | |
| | | 500 V | DC – BQ Dielec | tric | | | |
| (1)49470Q01154(2)E(3) | 0.15 | 5 | 0.120 (3.05) | К, М | N, L, J | L1Q(3)50C154(2)(4)12 | |
| (1)49470Q01184(2)E(3) | 0.18 | 5 | 0.240 (6.10) | К, М | N, L, J | L1Q(3)50C184(2)(4)24 | |
| (1)49470Q01224(2)E(3) | 0.22 | 5 | 0.240 (6.10) | К, М | N, L, J | L1Q(3)50C224(2)(4)24 | |
| (1)49470Q01274(2)E(3) | 0.27 | 5 | 0.240 (6.10) | К, М | N, L, J | L1Q(3)50C274(2)(4)24 | |
| (1)49470Q01334(2)E(3) | 0.33 | 5 | 0.360 (9.14) | К, М | N, L, J | L1Q(3)50C334(2)(4)36 | |
| (1)49470Q01394(2)E(3) | 0.39 | 5 | 0.360 (9.14) | К, М | N, L, J | L1Q(3)50C394(2)(4)36 | |
| (1)49470Q01474(2)E(3) | 0.47 | 5 | 0.360 (9.14) | К, М | N, L, J | L1Q(3)50C474(2)(4)36 | |
| (1)49470Q01564(2)E(3) | 0.56 | 5 | 0.480 (12.19) | К, М | N, L, J | L1Q(3)50C564(2)(4)48 | |
| (1)49470Q01684(2)E(3) | 0.68 | 5 | 0.650 (16.51) | К, М | N, L, J | L1Q(3)50C684(2)(4)65 | |
| (1)49470Q01824(2)E(3) | 0.82 | 4 | 0.360 (9.14) | К, М | N, L, J | L1Q(3)40C824(2)(4)36 | |
| (1)49470Q01105(2)E(3) | 1 | 4 | 0.360 (9.14) | К, М | N, L, J | L1Q(3)40C105(2)(4)36 | |
| (1)49470Q01125(2)E(3) | 1.2 | 4 | 0.360 (9.14) | К, М | N, L, J | L1Q(3)40C125(2)(4)36 | |
| (1)49470Q01155(2)E(3) | 1.5 | 4 | 0.480 (12.19) | К, М | N, L, J | L1Q(3)40C155(2)(4)48 | |
| (1)49470Q01185(2)E(3) | 1.8 | 4 | 0.650 (16.51) | К, М | N, L, J | L1Q(3)40C185(2)(4)65 | |
| (1)49470Q01225(2)E(3) | 2.2 | 3 | 0.240 (6.10) | К, М | N, L, J | L1Q(3)30C225(2)(4)24 | |
| (1)49470Q01275(2)E(3) | 2.7 | 3 | 0.360 (9.14) | К, М | N, L, J | L1Q(3)30C275(2)(4)36 | |
| (1)49470Q01335(2)E(3) | 3.3 | 3 | 0.360 (9.14) | К, М | N, L, J | L1Q(3)30C335(2)(4)36 | |
| (1)49470Q01395(2)E(3) | 3.9 | 3 | 0.360 (9.14) | К, М | N, L, J | L1Q(3)30C395(2)(4)36 | |
| (1)49470Q01475(2)E(3) | 4.7 | 3 | 0.480 (12.19) | К, М | N, L, J | L1Q(3)30C475(2)(4)48 | |
| (1)49470Q01565(2)E(3) | 5.6 | 3 | 0.650 (16.51) | К, М | N, L, J | L1Q(3)30C565(2)(4)65 | |
| MIL-PRF-49470 P/N ¹ | Capacitance (µF) | Case Code | Height A inch (mm) | Capacitance Tolerance | Lead Configuration | KEMET P/N ¹ | |

¹ Complete P/N requires additional characters in the numbered positions provided in order to indicate product level (B level or T level), capacitance tolerance and lead configuration. For each numbered position, available options are as follows:

(1) Test level character "M" for B level, or "T" for T level (MIL-PRF-49470/1 part number only).

(2) Capacitance tolerance character " K" or " M".

(3) Lead style character " N", "L" or "J".

(4) Test level character "B" for B level, or "T" for T level (KEMET part number only).



Table 1B – Product Selection 25 VDC

| Commercial/Non-Standard – Customer Specific Unencapsulated, Horizontally Stacked | | | | | | | | |
|--|------------------|--------------------|-------------------------|--------------------------|-----------------------|--|--|--|
| KEMET P/N ¹ | Capacitance | Case Code | Height A inch | Capacitance Tolerance | Lead Configuration | | | |
| | (µ) | | | Toterance | oomiguration | | | |
| | | 25 VDC – BX Dielec | tric | | | | | |
| L1X(1)503824(2)(3)12 | 0.82 | 5 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1X(1)503105(2)(3)12 | 1 | 5 | 0.120 (3.05) | К, М | N, L, J | | | |
| LIX(1)503125(2)(3)12 | 1.2 | 5 | 0.120 (3.05) | К, М | N, L, J | | | |
| LIX(1)503155(2)(3)12 | 1.5 | 5 | 0.120 (3.05) | K, M | N, L, J | | | |
| L1X(1)505165(2)(3)24 L1X(1)402225(2)(2)12 | 1.0 | 3 | 0.240 (0.10) | к, IVI К М | N, L, J N I I | | | |
| 11X(1)403225(2)(3)12 | 2.2 | 4 | 0.120 (3.03) | K, M | N, L, J N I I | | | |
| 11X(1)503255(2)(3)24 | 2.2 | 5 | 0.240 (0.10) | K, M | N, L, J | | | |
| 11X(1)403275(2)(3)12 | 2.0 | 4 | 0 120 (3 05) | К,М | N L J | | | |
| L1X(1)503275(2)(3)24 | 2.7 | 5 | 0.240 (6.10) | К. М | N, L, J | | | |
| L1X(1)403335(2)(3)12 | 3.3 | 4 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1X(1)503335(2)(3)36 | 3.3 | 5 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1X(1)403395(2)(3)12 | 3.9 | 4 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1X(1)503395(2)(3)36 | 3.9 | 5 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1X(1)403475(2)(3)12 | 4.7 | 4 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1X(1)503475(2)(3)36 | 4.7 | 5 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1X(1)403565(2)(3)24 | 5.6 | 4 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1X(1)503565(2)(3)48 | 5.6 | 5 | 0.480 (12.19) | К, М | N, L, J | | | |
| L1X(1)403605(2)(3)24 | 6 | 4 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1X(1)503605(2)(3)48 | 6 | 5 | 0.480 (12.19) | К, М | N, L, J | | | |
| L1X(1)303685(2)(3)12 | 6.8 | 3 | 0.120 (3.05) | К, М | N, L, J | | | |
| LIX(1)403685(2)(3)24 | 0.8 | 4 | 0.240 (0.10) | K, M | N, L, J | | | |
| L1X(1)505085(2)(3)05 | 0.8 | 5 | 0.000 (10.01) | K, IVI K M | N, L, J N I I | | | |
| L1X(1)403755(2)(3)24 | 7.5 | 5 | 0.240 (0.10) | K, IVI | N, L, J | | | |
| 11X(1)303733(2)(3)03 | 8.2 | 3 | 0.120 (3.05) | K, M | N, L, J | | | |
| 11X(1)403825(2)(3)24 | 8.2 | 4 | 0 240 (6 10) | К,М | N L J | | | |
| L1X(1)303106(2)(3)12 | 10 | 3 | 0.120 (3.05) | К. М | N, L, J | | | |
| L1X(1)403106(2)(3)24 | 10 | 4 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1X(1)303116(2)(3)12 | 11 | 3 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1X(1)303126(2)(3)12 | 12 | 3 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1X(1)403126(2)(3)36 | 12 | 4 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1X(1)303156(2)(3)12 | 15 | 3 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1X(1)403156(2)(3)36 | 15 | 4 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1X(1)303166(2)(3)24 | 16 | 3 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1X(1)403166(2)(3)48 | 16 | 4 | 0.480 (12.19) | К, М | N, L, J | | | |
| L1X(1)303186(2)(3)24 | 18 | 3 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1X(1)403186(2)(3)48 | 18 | 4 | 0.480 (12.19) | К, М | N, L, J | | | |
| L1X(1)303206(2)(3)24 | 20 | 3 | 0.240 (0.10) | K, M | N, L, J | | | |
| L1X(1)403200(2)(3)40 | 20 | 4 | 0.460 (12.19) | K, IVI K M | N, L, J N I I | | | |
| 11X(1)303226(2)(3)24 | 22 | 4 | 0.650 (16.51) | K, M | N,L,J | | | |
| 11X(1)403246(2)(3)65 | 24 | 4 | 0.650 (16.51) | К,М | NIJ | | | |
| L1X(1)303276(2)(3)24 | 27 | 3 | 0.240 (6.10) | К. М | N, L, J | | | |
| L1X(1)303306(2)(3)24 | 30 | 3 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1X(1)303306(2)(3)36 | 30 | 3 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1X(1)303336(2)(3)36 | 33 | 3 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1X(1)303396(2)(3)36 | 39 | 3 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1X(1)303456(2)(3)36 | 45 | 3 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1X(1)303506(2)(3)48 | 50 | 3 | 0.480 (12.19) | К, М | N, L, J | | | |
| L1X(1)303546(2)(3)48 | 54 | 3 | 0.480 (12.19) | К, М | N, L, J | | | |
| L1X(1)303606(2)(3)48 | 60 | 3 | 0.480 (12.19) | К, М | N, L, J | | | |
| KEMET P/N ¹ | Capacitance (µF) | Case Code | Height A inch (mm) | Capacitance Tolerance | Lead Configuration | | | |

¹ Complete part number requires additional characters in the numbered positions provided in order to indicate testing option, capacitance tolerance and lead configuration. For each numbered position, available options are as follows:

(1) Lead style character " N", "L", "M", "J", or "K".

(2) Capacitance tolerance character " K" or " M".



Table 1B – Commercial/Non-Standard – Product Selection 25 – 50 VDC cont.

| Commercial/Non-Standard – Customer Specific Unencapsulated, Horizontally Stacked | | | | | | | | |
|--|---------------------|--------------------|-----------------------|--------------------------|-----------------------|--|--|--|
| KEMET P/N ¹ | Capacitance (µF) | Case Code | Height A inch (mm) | Capacitance Tolerance | Lead Configuration | | | |
| L1X(1)303666(2)(3)65 | 66 | 3 | 0.650 (16.51) | К, М | N, L, J | | | |
| L1X(1)303726(2)(3)65 | 72 | 3 | 0.650 (16.51) | К, М | N, L, J | | | |
| LIX(1)303756(2)(3)65 | /5 | 3 | 0.650 (16.51) | К, М | N, L, J | | | |
| | | 50VDC - BX Dielect | ric | | | | | |
| L1X(1)505824(2)(3)12 | 0.82 | 5 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1X(1)505105(2)(3)12 | 10 | 5 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1X(1)505125(2)(3)12 | 1.2 | 5 | 0.120 (3.03) | K, IVI | N, L, J | | | |
| 11X(1)505185(2)(3)24 | 1.5 | 5 | 0.120 (5.05) | K, M | N, L, J | | | |
| 11X(1)405225(2)(3)12 | 2.2 | 4 | 0 120 (3 05) | К,М | N, L, J | | | |
| 11X(1)505225(2)(3)24 | 2.2 | 5 | 0 240 (6 10) | К,М | N L J | | | |
| L1X(1)505255(2)(3)24 | 2.5 | 5 | 0.240 (6.10) | К. М | N. L. J | | | |
| L1X(1)405275(2)(3)12 | 2.7 | 4 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1X(1)505275(2)(3)24 | 2.7 | 5 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1X(1)505275(2)(3)36 | 2.7 | 5 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1X(1)405335(2)(3)12 | 3.3 | 4 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1X(1)505335(2)(3)36 | 3.3 | 5 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1X(1)405395(2)(3)12 | 3.9 | 4 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1X(1)505395(2)(3)36 | 3.9 | 5 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1X(1)405475(2)(3)12 | 4.7 | 4 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1X(1)505475(2)(3)36 | 4.7 | 5 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1X(1)405565(2)(3)24 | 5.6 | 4 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1X(1)505565(2)(3)48 | 5.6 | 5 | 0.480 (12.19) | К, М | N, L, J | | | |
| L1X(1)405605(2)(3)24 | 6 | 4 | 0.240 (6.10) | К, М | N, L, J | | | |
| LIX(1)505605(2)(3)48 | 6 | 5 | 0.480 (12.19) | К, М | N, L, J | | | |
| LIX(1)303083(2)(3)12 | 0.8 | 3 | 0.120 (3.05) | К, IVI К. М | N, L, J | | | |
| 11X(1)505685(2)(3)24 | 6.8 | 4 | 0.240 (0.10) | K, W | N, L, J | | | |
| 11X(1)305005(2)(3)05 | 7.5 | 4 | 0.240 (6.10) | K, M | N, L, J | | | |
| 11X(1)505755(2)(3)65 | 7.5 | 5 | 0 650 (16 51) | КМ | N I J | | | |
| L1X(1)305825(2)(3)12 | 8.2 | 3 | 0.120 (3.05) | К. М | N. L. J | | | |
| L1X(1)405825(2)(3)24 | 8.2 | 4 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1X(1)305106(2)(3)12 | 10 | 3 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1X(1)405106(2)(3)24 | 10 | 4 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1X(1)305116(2)(3)12 | 11 | 3 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1X(1)305126(2)(3)12 | 12 | 3 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1X(1)405126(2)(3)36 | 12 | 4 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1X(1)305156(2)(3)12 | 15 | 3 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1X(1)405156(2)(3)36 | 15 | 4 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1X(1)305166(2)(3)24 | 16 | 3 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1X(1)405166(2)(3)48 | 16 | 4 | 0.480 (12.19) | К, М | N, L, J | | | |
| L1X(1)305186(2)(3)24 | 18 | 3 | 0.240 (6.10) | К, М | N, L, J | | | |
| LIX(1)405186(2)(3)48 | 18 | 4 | 0.480 (12.19) | К, М | N, L, J | | | |
| L1X(1)305206(2)(3)24 | 20 | 3 | 0.240 (0.10) | К, М | N, L, J | | | |
| L1X(1)403200(2)(3)46 | 20 | 4 | 0.460 (12.19) | к, IVI К М | N, L, J N I I | | | |
| 11X(1)405226(2)(3)65 | 22 | ۵ ۵ | 0.650 (16.51) | K M | N . | | | |
| L1X(1)405246(2)(3)65 | 24 | 4 | 0.650 (16.51) | K, M | N. L. J | | | |
| L1X(1)305276(2)(3)24 | 27 | 3 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1X(1)305306(2)(3)24 | 30 | 3 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1X(1)305336(2)(3)36 | 33 | 3 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1X(1)305396(2)(3)36 | 39 | 3 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1X(1)305456(2)(3)36 | 45 | 3 | 0.360 (9.14) | К, М | N, L, J | | | |
| KEMET P/N ¹ | Capacitance (µF) | Case Code | Height A inch (mm) | Capacitance Tolerance | Lead Configuration | | | |

¹ Complete part number requires additional characters in the numbered positions provided in order to indicate testing option, capacitance tolerance and lead configuration. For each numbered position, available options are as follows:

(1) Lead style character " N", "L" or "J".

(2) Capacitance tolerance character " K" or " M".



Table 1B – Commercial/Non-Standard – Product Selection 50 – 100 VDC cont.

| Commercial/Non-Standard – Customer Specific Unencapsulated, Horizontally Stacked | | | | | | | |
|--|------------------|----------------|-----------------------|-----------------------|--------------------|--|--|
| | Capacitance | | Height A inch | Capacitance | Lead | | |
| KEMET P/N' | (μF) | (µF) Case Code | (mm) | Tolerance | Configuration | | |
| L1X(1)305506(2)(3)48 | 50 | 3 | 0.480 (12.19) | К, М | N, L, J | | |
| L1X(1)305546(2)(3)48 | 54 | 3 | 0.480 (12.19) | К, М | N, L, J | | |
| L1X(1)305606(2)(3)48 | 60 | 3 | 0.480 (12.19) | К, М | N, L, J | | |
| L1X(1)305666(2)(3)65 | 66 | 3 | 0.650 (16.51) | К, М | N, L, J | | |
| L1X(1)305726(2)(3)65 | 72 | 3 | 0.650 (16.51) | К, М | N, L, J | | |
| L1X(1)305756(2)(3)65 75 3 0.650 (16.51) K, M N, L, J | | | | | | | |
| 100VDC - BR Dielectric | | | | | | | |
| L1R(1)501564(2)(3)12 | 0.56 | 5 | 0.120 (3.05) | К, М | N, L, J | | |
| LIR(1)501064(2)(3)12 | 0.00 | 5 | 0.120 (3.03) | К, М | N, L, J | | |
| L1R(1)501754(2)(3)12 L1R(1)50182A(2)(3)12 | 0.75 | 5 | 0.120 (3.05) | к, м | N, L, J | | |
| I = 1R(1)501024(2)(3)12 | 1 | 5 | 0.120 (3.05) | К,М | N, L, J | | |
| 1 1B(1)501125(2)(3)12 | 12 | 5 | 0 120 (3 05) | К, М | N L J | | |
| L1R(1)401155(2)(3)12 | 1.5 | 4 | 0.120 (3.05) | К. М | N. L. J | | |
| L1R(1)501155(2)(3)24 | 1.5 | 5 | 0.240 (6.10) | К, М | N, L, J | | |
| L1R(1)401185(2)(3)12 | 1.8 | 4 | 0.120 (3.05) | К, М | N, L, J | | |
| L1R(1)501185(2)(3)24 | 1.8 | 5 | 0.240 (6.10) | К, М | N, L, J | | |
| L1R(1)401225(2)(3)12 | 2.2 | 4 | 0.120 (3.05) | К, М | N, L, J | | |
| L1R(1)501225(2)(3)24 | 2.2 | 5 | 0.240 (6.10) | К, М | N, L, J | | |
| L1R(1)501255(2)(3)24 | 2.5 | 5 | 0.240 (6.10) | К, М | N, L, J | | |
| L1R(1)401275(2)(3)12 | 2.7 | 4 | 0.120 (3.05) | К, М | N, L, J | | |
| L1R(1)501275(2)(3)36 | 2.7 | 5 | 0.360 (9.14) | К, М | N, L, J | | |
| L1R(1)401335(2)(3)12 | 3.3 | 4 | 0.120 (3.05) | К, М | N, L, J | | |
| L1R(1)501335(2)(3)36 | 3.3 | 5 | 0.360 (9.14) | К, М | N, L, J | | |
| L1R(1)401395(2)(3)12 | 3.9 | 4 | 0.120 (3.05) | К, М | N, L, J | | |
| LIR(1)501395(2)(3)48 | 3.9 | 5 | 0.480 (12.19) | К, М | N, L, J | | |
| LIR(1)401475(2)(3)24 | 4.7 | 4 | 0.240 (0.10) | K, M | N, L, J | | |
| LTR(1)3014/3(2)(3)46 | 4.7 | 3 | 0.400 (12.19) | к, ім | N, L, J N I I | | |
| L1R(1)401565(2)(3)12 | 5.6 | 4 | 0.120 (5.05) | K, M | N, L, J | | |
| L1R(1)501565(2)(3)65 | 5.6 | 5 | 0.650 (16.51) | К,М | N, L, J | | |
| L1R(1)301605(2)(3)12 | 6 | 3 | 0.120 (3.05) | К, М | N, L, J | | |
| L1R(1)401605(2)(3)24 | 6 | 4 | 0.240 (6.10) | К. М | N. L. J | | |
| L1R(1)501605(2)(3)65 | 6 | 5 | 0.650 (16.51) | К, М | N, L, J | | |
| L1R(1)301685(2)(3)12 | 6.8 | 3 | 0.120 (3.05) | К, М | N, L, J | | |
| L1R(1)401685(2)(3)24 | 6.8 | 4 | 0.240 (6.10) | К, М | N, L, J | | |
| L1R(1)401755(2)(3)24 | 7.5 | 4 | 0.240 (6.10) | К, М | N, L, J | | |
| L1R(1)301825(2)(3)12 | 8.2 | 3 | 0.120 (3.05) | К, М | N, L, J | | |
| L1R(1)401825(2)(3)36 | 8.2 | 4 | 0.360 (9.14) | К, М | N, L, J | | |
| L1R(1)301106(2)(3)12 | 10 | 3 | 0.120 (3.05) | К, М | N, L, J | | |
| L1R(1)401106(2)(3)36 | 10 | 4 | 0.360 (9.14) | К, М | N, L, J | | |
| L1R(1)301116(2)(3)12 | 11 | 3 | 0.120 (3.05) | К, М | N, L, J | | |
| L1R(1)301126(2)(3)24 | 12 | 3 | 0.240 (6.10) | К, М | N, L, J | | |
| LIR(1)401126(2)(3)48 | 12 | 4 | 0.480 (12.19) | К, М | N, L, J | | |
| LIK(1)301150(2)(3)24 | 15 | 3 | 0.240 (0.10) | K, M | N, L, J | | |
| LIR(1)401130(2)(3)40 L1P(1)301166(2)(3)24 | 15 | 4 | 0.400 (12.19) | K, M | N, L, J | | |
| 11R(1)401166(2)(3)65 | 16 | 4 | 0.650 (16.51) | K, WI | N, L, J | | |
| L1R(1)301186(2)(3)24 | 18 | 3 | 0 240 (6 10) | K M | N L .I | | |
| L1R(1)401186(2)(3)65 | 18 | 4 | 0.650 (16 51) | K, M | N. J. J | | |
| L1R(1)301206(2)(3)24 | 20 | 3 | 0.240 (6.10) | К, М | N, L. J | | |
| L1R(1)301226(2)(3)36 | 22 | 3 | 0.360 (9.14) | К, М | N, L, J | | |
| L1R(1)301276(2)(3)36 | 27 | 3 | 0.360 (9.14) | К, М | N, L, J | | |
| KEMET P/N ¹ | Capacitance (µF) | Case Code | Height A inch (mm) | Capacitance Tolerance | Lead Configuration | | |

¹ Complete part number requires additional characters in the numbered positions provided in order to indicate testing option, capacitance tolerance and lead configuration. For each numbered position, available options are as follows:

(1) Lead style character " N", "L" or "J".

(2) Capacitance tolerance character " K" or " M".



Table 1B – Commercial/Non-Standard – Product Selection 100 – 200 VDC cont.

| Commercial/Non-Standard – Customer Specific Unencapsulated, Horizontally Stacked | | | | | | | |
|--|------------------|-----------|-----------------------|-----------------------|--------------------|--|--|
| | Capacitance | | Height A inch | Capacitance | Lead | | |
| KEMET P/N' | (μF) | Case Code | (mm) | Tolerance | Configuration | | |
| L1R(1)301306(2)(3)36 | 30 | 3 | 0.360 (9.14) | К, М | N, L, J | | |
| L1R(1)301336(2)(3)48 | 33 | 3 | 0.480 (12.19) | К, М | N, L, J | | |
| L1R(1)301396(2)(3)48 | 39 | 3 | 0.480 (12.19) | К, М | N, L, J | | |
| L1R(1)301456(2)(3)65 | 45 | 3 | 0.650 (16.51) | К, М | N, L, J | | |
| L1R(1)301506(2)(3)65 | 50 | 3 | 0.650 (16.51) | К, М | N, L, J | | |
| 200 VDC – BQ Dielectric | | | | | | | |
| L1Q(1)502334(2)(3)12 | 0.33 | 5 | 0.120 (3.05) | К, М | N, L, J | | |
| L1Q(1)502394(2)(3)12 | 0.39 | 5 | 0.120 (3.05) | К, М | N, L, J | | |
| L1Q(1)502474(2)(3)12 | 0.47 | 5 | 0.120 (3.05) | К, М | N, L, J | | |
| L1Q(1)502564(2)(3)12 | 0.56 | 5 | 0.120 (3.05) | К, М | N, L, J | | |
| L1Q(1)502684(2)(3)12 | 0.68 | 5 | 0.120 (3.05) | К, М | N, L, J | | |
| L1Q(1)502754(2)(3)12 | 0.75 | 5 | 0.120 (3.05) | К, М | N, L, J | | |
| L1Q(1)402824(2)(3)12 | 0.82 | 4 | 0.120 (3.05) | К, М | N, L, J | | |
| L1Q(1)502824(2)(3)24 | 0.82 | 5 | 0.240 (6.10) | K, M | N, L, J | | |
| L10(1)402105(2)(3)12 | 1 | 4 | 0.120 (3.05) | К.М | N. L. J | | |
| L10(1)502105(2)(3)24 | 1 | 5 | 0.240 (6.10) | к.м | N. L. J | | |
| 110(1)402125(2)(3)12 | 12 | 4 | 0 120 (3 05) | КМ | N L J | | |
| 110(1)502125(2)(3)24 | 12 | 5 | 0 240 (6 10) | КМ | N L .I | | |
| 110(1)402155(2)(3)12 | 15 | 4 | 0.120 (3.05) | к м | N I I | | |
| 110(1)502155(2)(3)36 | 1.5 | 5 | 0.360 (9.14) | K, M | N I I | | |
| 110(1)402185(2)(3)30 | 1.5 | 1 | 0.300 (3.14) | K, M | N, L, J | | |
| 110(1)502195(2)(3)12 | 1.0 | 5 | 0.260 (0.14) | K, M | N L J | | |
| L1Q(1)302163(2)(3)30 | 1.0 | 3 | 0.300 (9.14) | K, IVI | N, L, J | | |
| L1Q(1)402225(2)(3)24 | 2.2 | 4 | 0.240 (0.10) | K, IVI | N, L, J | | |
| L1Q(1)502225(2)(3)48 | 2.2 | 5 | 0.480 (12.19) | K, M | IN, L, J | | |
| LIQ(1)302245(2)(3)12 | 2.4 | 3 | 0.120 (3.05) | К, М | N, L, J | | |
| L1Q(1)502255(2)(3)48 | 2.5 | 5 | 0.480 (12.19) | К, М | N, L, J | | |
| LIQ(1)302275(2)(3)12 | 2.7 | 3 | 0.120 (3.05) | К, М | N, L, J | | |
| L1Q(1)402275(2)(3)24 | 2.7 | 4 | 0.240 (6.10) | К, М | N, L, J | | |
| L1Q(1)502275(2)(3)48 | 2.7 | 5 | 0.480 (12.19) | К, М | N, L, J | | |
| L1Q(1)302335(2)(3)12 | 3.3 | 3 | 0.120 (3.05) | К, М | N, L, J | | |
| L1Q(1)402335(2)(3)24 | 3.3 | 4 | 0.240 (6.10) | К, М | N, L, J | | |
| L1Q(1)502335(2)(3)65 | 3.3 | 5 | 0.650 (16.51) | К, М | N, L, J | | |
| L1Q(1)302365(2)(3)12 | 3.6 | 3 | 0.120 (3.05) | К, М | N, L, J | | |
| L1Q(1)302395(2)(3)12 | 3.9 | 3 | 0.120 (3.05) | К, М | N, L, J | | |
| L1Q(1)402395(2)(3)24 | 3.9 | 4 | 0.240 (6.10) | К, М | N, L, J | | |
| L1Q(1)302475(2)(3)12 | 4.7 | 3 | 0.120 (3.05) | К, М | N, L, J | | |
| L1Q(1)402475(2)(3)36 | 4.7 | 4 | 0.360 (9.14) | К, М | N, L, J | | |
| L1Q(1)302565(2)(3)12 | 5.6 | 3 | 0.120 (3.05) | К, М | N, L, J | | |
| L1Q(1)402565(2)(3)36 | 5.6 | 4 | 0.360 (9.14) | К, М | N, L, J | | |
| L1Q(1)302605(2)(3)12 | 6 | 3 | 0.120 (3.05) | К, М | N, L, J | | |
| L1Q(1)402605(2)(3)36 | 6 | 4 | 0.360 (9.14) | К, М | N, L, J | | |
| L1Q(1)302685(2)(3)24 | 6.8 | 3 | 0.240 (6.10) | К, М | N, L, J | | |
| L1Q(1)402685(2)(3)48 | 6.8 | 4 | 0.480 (12.19) | К, М | N, L, J | | |
| L1Q(1)402755(2)(3)48 | 7.5 | 4 | 0.480 (12.19) | К, М | N, L, J | | |
| L1Q(1)302825(2)(3)24 | 8.2 | 3 | 0.240 (6.10) | К, М | N, L, J | | |
| L1Q(1)402825(2)(3)65 | 8.2 | 4 | 0.650 (16.51) | К, М | N, L, J | | |
| L1Q(1)302106(2)(3)24 | 10 | 3 | 0.240 (6.10) | К, М | N, L. J | | |
| L1Q(1)402106(2)(3)65 | 10 | 4 | 0.650 (16.51) | К, М | N, L. J | | |
| L10(1)302116(2)(3)24 | 11 | 3 | 0.240 (6 10) | К.М | N. I. J | | |
| 110(1)302126(2)(3)36 | 12 | 3 | 0 360 (9 14) | КМ | N I .I | | |
| 110(1)302156(2)(3)36 | 15 | 2 | 0.360 (0.14) | K M | NI I | | |
| | 16 | 2 | 0.360 (9.14) | K M | N I I | | |
| L1Q(1)302186(2)(3)48 | 18 | 3 | 0.480 (12.19) | K, M | N, L, J | | |
| KEMET P/N ¹ | Capacitance (µF) | Case Code | Height A inch (mm) | Capacitance Tolerance | Lead Configuration | | |

¹ Complete part number requires additional characters in the numbered positions provided in order to indicate testing option, capacitance tolerance and lead configuration. For each numbered position, available options are as follows:

(1) Lead style character " N", "L" or "J".

(2) Capacitance tolerance character " K" or " M".



Table 1B – Commercial/Non-Standard – Product Selection 200 – 630 VDC cont.

| Commercial/Non-Standard – Customer Specific Unencapsulated, Horizontally Stacked | | | | | | | | |
|--|------------------|-----------|-----------------------|-----------------------|--------------------|--|--|--|
| | Capacitance | | Height A inch | Capacitance | Lead | | | |
| KEMET P/N' | (µF) Case Code | Case Code | (mm) | Tolerance | Configuration | | | |
| L1Q(1)302206(2)(3)48 | 20 | 3 | 0.480 (12.19) | К, М | N, L, J | | | |
| L1Q(1)302226(2)(3)48 | 22 | 3 | 0.480 (12.19) | К, М | N, L, J | | | |
| L1Q(1)302276(2)(3)65 | 27 | 3 | 0.650 (16.51) | К, М | N, L, J | | | |
| 500VDC - X7R Dielectric | | | | | | | | |
| L1W(1)50C124(2)(3)12 | 0.12 | 5 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)50C154(2)(3)12 | 0.15 | 5 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)50C184(2)(3)12 | 0.18 | 5 | 0.120 (3.05) | К, М | N, L, J | | | |
| LIW(1)50C224(2)(3)12 | 0.22 | 5 | 0.120 (3.05) | K, M | N, L, J | | | |
| L1W(1)50C274(2)(3)12 | 0.27 | 5 | 0.120 (3.05) | K, WI | N, L, J | | | |
| L1W(1)40C204(2)(3)24 | 0.33 | 5 | 0.240 (0.10) | к, IVI К М | N, L, J N I I | | | |
| L1W(1)40C394(2)(3)12 L1W(1)50C204(2)(2)24 | 0.39 | 5 | 0.120 (3.03) | к, IVI К М | N, L, J N I I | | | |
| 11W(1)40C474(2)(3)24 | 0.39 | 4 | 0.240 (0.10) | K M | N, L, J | | | |
| 11W(1)50C474(2)(3)24 | 0.47 | 5 | 0.240 (6.10) | K, M | N L .I | | | |
| 11W(1)50C564(2)(3)24 | 0.56 | 5 | 0.240 (6.10) | К, М | N L .I | | | |
| 11W(1)40C684(2)(3)12 | 0.68 | 4 | 0 120 (3 05) | К, М | N L J | | | |
| 11W(1)50C684(2)(3)36 | 0.68 | 5 | 0 360 (9 14) | К, М | N L J | | | |
| L1W(1)50C754(2)(3)36 | 0.75 | 5 | 0.360 (9.14) | К. М | N. L. J | | | |
| L1W(1)40C824(2)(3)12 | 0.82 | 4 | 0.120 (3.05) | K, M | N. L. J | | | |
| L1W(1)50C824(2)(3)36 | 0.82 | 5 | 0.360 (9.14) | К. М | N. L. J | | | |
| L1W(1)30C105(2)(3)12 | 1 | 3 | 0.120 (3.05) | К. М | N. L. J | | | |
| L1W(1)40C105(2)(3)24 | 1 | 4 | 0.240 (6.10) | К. М | N. L. J | | | |
| L1W(1)50C105(2)(3)48 | 1 | 5 | 0.480 (12.19) | К, М | N, L, J | | | |
| L1W(1)30C125(2)(3)12 | 1.2 | 3 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)40C125(2)(3)24 | 1.2 | 4 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1W(1)50C125(2)(3)65 | 1.2 | 5 | 0.650 (16.51) | К, М | N, L, J | | | |
| L1W(1)30C155(2)(3)12 | 1.5 | 3 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)40C155(2)(3)24 | 1.5 | 4 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1W(1)50C155(2)(3)65 | 1.5 | 5 | 0.650 (16.51) | К, М | N, L, J | | | |
| L1W(1)40C185(2)(3)36 | 1.8 | 4 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1W(1)30C225(2)(3)12 | 2.2 | 3 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)40C225(2)(3)36 | 2.2 | 4 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1W(1)30C245(2)(3)12 | 2.4 | 3 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)30C275(2)(3)12 | 2.7 | 3 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)40C275(2)(3)48 | 2.7 | 4 | 0.480 (12.19) | К, М | N, L, J | | | |
| L1W(1)30C335(2)(3)24 | 3.3 | 3 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1W(1)40C335(2)(3)48 | 3.3 | 4 | 0.480 (12.19) | К, М | N, L, J | | | |
| L1W(1)30C365(2)(3)24 | 3.6 | 3 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1W(1)30C395(2)(3)24 | 3.9 | 3 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1W(1)200475(2)(3)65 | 3.9 | 4 | 0.650 (16.51) | К, М | N, L, J | | | |
| L1W(1)30C475(2)(3)24 | 4./ | 3 | 0.240 (0.10) | K, IVI | N, L, J | | | |
| L1W(1)20C605(2)(2)24 | 5.0 | 2 | 0.240 (0.10) | к, IVI К М | N, L, J N I I | | | |
| L1W(1)30C605(2)(3)24 | 6.9 | 2 | 0.240 (0.10) | K, IVI K M | N, L, J | | | |
| L1W(1)30C825(2)(3)36 | 8.2 | 3 | 0.360 (9.14) | к, м | N, L, J | | | |
| 11W(1)30C106(2)(3)48 | 10 | 3 | 0.480 (12 19) | K M | N I J | | | |
| 11W(1)30C116(2)(3)65 | 11 | 3 | 0 650 (16 51) | K M | N . | | | |
| L1W(1)30C126(2)(3)65 | 12 | 3 | 0.650 (16.51) | К, М | N, L, J | | | |
| 630VDC - X7R Dielectric | | | | | | | | |
| L1W(1)50B683(2)(3)12 | 0.068 | 5 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)40B104(2)(3)12 | 0.1 | 4 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)50B104(2)(3)12 | 0.1 | 5 | 0.120 (3.05) | К, М | N, L, J | | | |
| KEMET P/N ¹ | Capacitance (µF) | Case Code | Height A inch (mm) | Capacitance Tolerance | Lead Configuration | | | |

¹ Complete part number requires additional characters in the numbered positions provided in order to indicate testing option, capacitance tolerance and lead configuration. For each numbered position, available options are as follows:

(1) Lead style character " N", "L" or "J".

(2) Capacitance tolerance character " K" or " M".


Table 1B – Commercial/Non-Standard – Product Selection 630 – 1,000 VDC cont.

| Commercial/Non-St | andard – Cust | omer Specific | Unencapsulate | ed, Horizontally | / Stacked | | | |
|------------------------|---------------------|---------------------|-------------------------|--------------------------|-----------------------|--|--|--|
| KEMET P/N ¹ | Capacitance (µF) | Case Code | Height A inch (mm) | Capacitance Tolerance | Lead Configuration | | | |
| L1W(1)50B124(2)(3)12 | 0.12 | 5 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)50B154(2)(3)12 | 0.15 | 5 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)50B184(2)(3)24 | 0.18 | 5 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1W(1)30B224(2)(3)12 | 0.22 | 3 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)40B224(2)(3)12 | 0.22 | 4 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)50B224(2)(3)24 | 0.22 | 5 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1W(1)50B274(2)(3)24 | 0.27 | 5 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1W(1)30B334(2)(3)12 | 0.33 | 3 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)50B334(2)(3)36 | 0.33 | 5 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1W(1)50D204(2)(3)12 | 0.39 | 4 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)20D474(2)(3)30 | 0.39 | 5 | 0.300 (9.14) | K, M | N, L, J | | | |
| L1W(1)30B474(2)(3)12 | 0.47 | 3 | 0.120 (3.05) | K, IVI K M | N, L, J | | | |
| L1W(1)40B474(2)(3)24 | 0.47 | 4 | 0.240 (0.10) | к, ім К М | N, L, J N I I | | | |
| L1W(1)50B564(2)(3)30 | 0.47 | 5 | 0.300 (9.14) | к, м | N, L, J N I I | | | |
| L1W(1)30B684(2)(3)40 | 0.50 | 3 | 0.120 (3.05) | K, M | N, L, J | | | |
| 11W(1)40B684(2)(3)24 | 0.68 | 4 | 0.240 (6.10) | K M | N, L, J | | | |
| L1W(1)50B684(2)(3)65 | 0.68 | 5 | 0.650 (16.51) | к м | N L .I | | | |
| 11W(1)50B754(2)(3)65 | 0.75 | 5 | 0 650 (16 51) | К,М | N L J | | | |
| 11W(1)40B824(2)(3)24 | 0.82 | 4 | 0 240 (6 10) | КМ | N I J | | | |
| L1W(1)30B105(2)(3)12 | 1 | 3 | 0.120 (3.05) | К. М | N. L. J | | | |
| L1W(1)40B105(2)(3)36 | 1 | 4 | 0.360 (9.14) | К. М | N. L. J | | | |
| L1W(1)30B125(2)(3)12 | 1.2 | 3 | 0.120 (3.05) | К. М | N. L. J | | | |
| L1W(1)40B125(2)(3)36 | 1.2 | 4 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1W(1)30B155(2)(3)12 | 1.5 | 3 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)40B155(2)(3)48 | 1.5 | 4 | 0.480 (12.19) | К, М | N, L, J | | | |
| L1W(1)40B185(2)(3)48 | 1.8 | 4 | 0.480 (12.19) | К, М | N, L, J | | | |
| L1W(1)30B225(2)(3)24 | 2.2 | 3 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1W(1)40B225(2)(3)65 | 2.2 | 4 | 0.650 (16.51) | К, М | N, L, J | | | |
| L1W(1)30B245(2)(3)24 | 2.4 | 3 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1W(1)30B275(2)(3)24 | 2.7 | 3 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1W(1)30B335(2)(3)36 | 3.3 | 3 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1W(1)30B365(2)(3)36 | 3.6 | 3 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1W(1)30B395(2)(3)36 | 3.9 | 3 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1W(1)30B475(2)(3)36 | 4.7 | 3 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1W(1)30B565(2)(3)48 | 5.6 | 3 | 0.480 (12.19) | К, М | N, L, J | | | |
| L1W(1)30B605(2)(3)65 | 6 | 3 | 0.650 (16.51) | К, М | N, L, J | | | |
| L1W(1)30B685(2)(3)65 | 6.8 | 3 | 0.650 (16.51) | К, М | N, L, J | | | |
| | | 1000VDC - X7R Diele | ctric | | | | | |
| L1W(1)50D473(2)(3)12 | 0.047 | 5 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)50D683(2)(3)12 | 0.068 | 5 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)30D104(2)(3)12 | 0.1 | 3 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)40D104(2)(3)12 | 0.1 | 4 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)50D104(2)(3)24 | 0.1 | 5 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1W(1)50D124(2)(3)24 | 0.12 | 5 | 0.240 (6.10) | К, М | N, L, J | | | |
| L1W(1)50D154(2)(3)36 | 0.15 | 5 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1W(1)50D184(2)(3)36 | 0.18 | 5 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1W(1)30D224(2)(3)12 | 0.22 | 3 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)40D224(2)(3)12 | 0.22 | 4 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)50D224(2)(3)36 | 0.22 | 5 | 0.360 (9.14) | К, М | N, L, J | | | |
| L1W(1)50D274(2)(3)48 | 0.27 | 5 | 0.480 (12.19) | К, М | N, L, J | | | |
| L1W(1)30D334(2)(3)12 | 0.33 | 3 | 0.120 (3.05) | К, М | N, L, J | | | |
| L1W(1)50D334(2)(3)65 | 0.33 | 5 | 0.650 (16.51) | К, М | N, L, J | | | |
| KEMET P/N ¹ | Capacitance (µF) | Case Code | Height A inch (mm) | Capacitance Tolerance | Lead Configuration | | | |

¹ Complete part number requires additional characters in the numbered positions provided in order to indicate testing option, capacitance tolerance and lead configuration. For each numbered position, available options are as follows:

(1) Lead style character " N", "L" or "J".

(2) Capacitance tolerance character " K" or " M".

(3) Testing option character "S" for Commercial, or "X" for non-standard (customer specific).



| Commercial/Non-St | Commercial/Non-Standard – Customer Specific Unencapsulated, Horizontally Stacked | | | | | | | | | | | | | | |
|------------------------|--|-----------|-----------------------|--------------------------|-----------------------|--|--|--|--|--|--|--|--|--|--|
| KEMET P/N ¹ | Capacitance (µF) | Case Code | Height A inch (mm) | Capacitance Tolerance | Lead Configuration | | | | | | | | | | |
| L1W(1)40D394(2)(3)24 | 0.39 | 4 | 0.240 (6.10) | К, М | N, L, J | | | | | | | | | | |
| L1W(1)50D394(2)(3)65 | 0.39 | 5 | 0.650 (16.51) | К, М | N, L, J | | | | | | | | | | |
| L1W(1)30D474(2)(3)12 | 0.47 | 3 | 0.120 (3.05) | К, М | N, L, J | | | | | | | | | | |
| L1W(1)40D474(2)(3)24 | 0.47 | 4 | 0.240 (6.10) | К, М | N, L, J | | | | | | | | | | |
| L1W(1)30D684(2)(3)12 | 0.68 | 3 | 0.120 (3.05) | К, М | N, L, J | | | | | | | | | | |
| L1W(1)40D684(2)(3)36 | 0.68 | 4 | 0.360 (9.14) | К, М | N, L, J | | | | | | | | | | |
| L1W(1)40D824(2)(3)48 | 0.82 | 4 | 0.480 (12.19) | К, М | N, L, J | | | | | | | | | | |
| L1W(1)30D105(2)(3)24 | 1 | 3 | 0.240 (6.10) | К, М | N, L, J | | | | | | | | | | |
| L1W(1)40D105(2)(3)65 | 1 | 4 | 0.650 (16.51) | К, М | N, L, J | | | | | | | | | | |
| L1W(1)30D125(2)(3)24 | 1.2 | 3 | 0.240 (6.10) | К, М | N, L, J | | | | | | | | | | |
| L1W(1)30D155(2)(3)36 | 1.5 | 3 | 0.360 (9.14) | К, М | N, L, J | | | | | | | | | | |
| L1W(1)30D225(2)(3)36 | 2.2 | 3 | 0.360 (9.14) | К, М | N, L, J | | | | | | | | | | |
| L1W(1)30D245(2)(3)48 | 2.4 | 3 | 0.480 (12.19) | К, М | N, L, J | | | | | | | | | | |
| L1W(1)30D275(2)(3)48 | 2.7 | 3 | 0.480 (12.19) | К, М | N, L, J | | | | | | | | | | |
| L1W(1)30D335(2)(3)65 | 3.3 | 3 | 0.650 (16.51) | К, М | N, L, J | | | | | | | | | | |
| KEMET P/N ¹ | Capacitance (µF) | Case Code | Height A inch (mm) | Capacitance Tolerance | Lead Configuration | | | | | | | | | | |

Table 1B - Commercial/Non-Standard - Product Selection 1,000 VDC cont.

¹ Complete part number requires additional characters in the numbered positions provided in order to indicate testing option, capacitance tolerance and lead configuration. For each numbered position, available options are as follows:

(1) Lead style character " N", "L" or "J".

(2) Capacitance tolerance character " K" or " M".

(3) Testing option character "S" for Commercial, or "X" for non-standard (customer specific).



Soldering Process

The capacitors and assemblies outlined in this specification sheet are susceptible to thermal shock damage due to their large ceramic mass. Temperature profiles used should provide adequate temperature rise and cool-down time to prevent damage from thermal shock. In general, KEMET recommends against hand soldering for these types of large ceramic devices.

Recommended Soldering Technique:

Solder reflow only

Recommended Reflow Soldering Profile:



| - | • | |
|---|----|---|
| | ım | e |

| Profile Feature | Sn-Pb Assembly |
|---|----------------|
| Preheat/Soak | |
| Temperature Minimum (T _{Smin}) | 100°C |
| Temperature Maximum (T _{Smax}) | 150°C |
| Time (t_s) from T_{smin} to T_{smax}) | 60-90 seconds |
| Ramp-up rate $(T_L \text{ to } T_P)$ | 2°C/seconds |
| Liquidous temperature (T_L) | 183°C |
| Time above liquidous (t_L) | 95 seconds |
| Peak Temperature (T _P) | 240°C |
| Time within 5°C of maximum peak temperature (t _P) | 5 seconds |
| Ramp-down rate $(T_P to T_L)$ | 2°C/seconds |
| Time 25° C to peak temperature | 3.5 minutes |

Note 1: All temperatures refer to the center of the package, measured on the package body surface that is facing up during assembly reflow

Preheating and Reflow Profile Notes:

Due to differences in the coefficient of thermal expansion for the different materials of construction, it is critical to monitor and control the heating and cooling rates during the soldering process. During the reflow soldering process, the maximum recommended heating and cooling rate (dT/dt) is 4°C/ second. To ensure optimal component reliability, KEMET's recommended heating and cooling rate is 2°C/second. After soldering, the capacitors should be air cooled to room temperature before further processing. Forced air cooling is not recommended.

Table 4 – Performance & Reliability: Test Methods and Conditions

| | | | 1 | Fest Level Option | n | | |
|--|---|--------------------------------|-------------------------------|--|----------------|---|--|
| Inspection | Test Method | MIL-PRF-49470 B Level (B) | MIL-PRF-49470 T Level (T) | DSSC Drawing 87106 (C) ¹ | Commercial (S) | Non-Standard (X)² | |
| Ultrasonic Scanning (C-SAM) | Meet EIA-469 Criteria | | | | | Optional | |
| DPA Analysis | EIA-469 | Not required | Yes (per lot) | Not required | Not required | per Source Controlled | |
| In-Process Visual Inspection | MIL-PRF-49470 Method 4.8.3 | | (por ros) | | | Drawing (SCD) | |
| | | | | | I | | |
| Thermal Shock | MIL-STD-202 Method 107 | Yes (5 cycles) | Yes (20 cycles) | Yes (5 cycles) | | Optional | |
| Voltage Conditioning ≤ 200 V 500 V | MIL-PRF-49470 Method 4.8.5.2 200%V _R at125°C 120%V _R at125°C | Yes (96 hours minimum) | Yes (168 hours minimum) | Yes (96 hours minimum) | | per Source Controlled Drawing (SCD) | |
| Visual and Mechanical Inspection | MIL-PRF-49470 Method 4.8.4 | Yes (per lot) | | Yes (per lot) | Not required | Yes (per lot) | |
| Solderability | MIL-STD-202 Method 208 | Yes (per Inspection lot) | Yes (per lot) | Yes (per inspection lot) | | Optional per Source Controlled | |
| DPA Analysis | EIA-469 | Not required | | Not required | | Drawing (SCD) | |
| Voltage–Temperature Limits (TCVC) | MIL-PRF-49470 Method 4.8.13.2 | | | | | | |
| Resistance to Solvents | MIL-STD-202 Method 215 | | | | | | |
| Terminal Strength | MIL-STD-202 Method 211 | Yes | | Yes | | | |
| Resistance to Soldering Heat | MIL-STD-202 Method 210 | (periodic) | | (periodic) | | | |
| Moisture Resistance | MIL-STD-202 Method 106 | | Yes | | Not required | Optional per Source | |
| Marking Legibility | MIL-PRF-49470 Method 4.8.4.1 | | (per lot) | | | Controlled Drawing (SCD) | |
| Low Voltage Humidity Testing | MIL-STD-202 Method 103 | Not required | | Not required | | | |
| Life Test ≤ 200 V 500 V | MIL-STD-202 Method 108 200%V _R at125°C 120%V _R at125°C | Yes (periodic) | | Yes (periodic) | | | |
| Thermal Shock | MIL-STD-202 Method 107 | Not required | | Not required | | | |
| Vieual and Machanical | | | | | | | |
| Inspection (100%) | KEMET Standard | Yes | Yes | Yes | Yes | Yes | |
| Voltage Conditioning | | | | | | | |

¹ As per discretionary statement outlined in cancelled DSCC Drawing 87106, KEMET will not perform Group B inspections on a per lot basis. KEMET 87106 orders may include a standard certificate of compliance stating compliance to the 87106 requirements, specifically conformance to Group B inspections. Please contact KEMET for additional details

²Non-standard test level option is designated to satisfy customer specific testing requirements that may deviate from those stated in a Mil-Spec or DSCC drawing.



Construction



Product Marking

MIL-PRF-49470

Capacitors shall be marked with KEMET's name, trademark or (CAGE) code, date, capacitance and capacitance tolerance codes. The date code shall consist of the year and week. For example, the third week of 2011 would be 1103 using a 4-digit date code or 103 using a 3-digit date code. At the option of the manufacturer, the date code may be placed on a separate line. Full marking shall be included on the package.



Case code 4 or 5 example

Capacitor marking will include "JAN" or "J." Case codes 4 and 5 shall be marked with the following sequence of information: J brand (1 digit), product level designator ("B" or "T") Manufacturer's identification (1 to 5 digits) Capacitance code (3 digits) and capacitance tolerance (1 digit) Date code (3 or 4 digits) Case code 3 shall either be fully marked or partially marked like case code 4 or 5 parts at the option of KEMET.

DSCC 87106

Marking shall be in accordance with MIL-STD-1285, except the parts shall be marked with the part number as specified in paragraph 1.2 of DSCC Drawing 87106 with the manufacturer's name or code and date code minimum. Case sizes 4 and 5 shall be marked with coded capacitance and tolerance minimum. Full marking shall be included on the package.

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Packaging

| Shipping Container Packaging Quantities | | | | | | | | | | | | |
|---|------------|---------------------------|---|--|--|--|--|--|--|--|--|--|
| Case code | Lead Style | Numbers of Chips in Stack | Maximum Waffle Pack Quantity ¹ | | | | | | | | | |
| 3 | L/J/N | 1, 2, 3, 4, 5 | 25 | | | | | | | | | |
| | NI / I | 1, 2, 3 | 50 | | | | | | | | | |
| 4 | IN/L | 4, 5 | 25 | | | | | | | | | |
| | J | 1, 2, 3, 4, 5 | 50 | | | | | | | | | |
| | NI | 1, 2, 3 | 50 | | | | | | | | | |
| 5 | IN IN | 4, 5 | 25 | | | | | | | | | |
| | L/J | 1, 2, 3, 4, 5 | 50 | | | | | | | | | |

¹ Minimum order value applies. Contact KEMET for details.

Application Notes

Notice of KEMET MIL-PRF-49470 Qualified Products Listing (QPL) Status.

KEMET is qualified to supply MIL–PRF–49470/1 unencapsulated X7R Case Codes 3, 4, & 5 ceramic SMPS capacitors in DC voltage ratings of 50 V, 100 V, 200 V, and 500 V. This qualification includes both "B" and "T" test levels.

KEMET is also qualified to supply MIL–PRF–49470/2 encapsulated X7R Case Codes 3, 4, & 5 ceramic SMPS capacitors in DC voltage ratings of 50 V, 100 V, 200 V, and 500 V. This qualification includes "B" level testing only.

Notice of Cancellation: DSCC Drawing 87106 was cancelled on January 3rd 2005. MIL-PRF-49470 parts are preferred and direct replacements.

MIL-*PRF*-49470 capacitors are preferred over DSCC 87106 capacitors. The *MIL*-*PRF*-49470 specification was developed as part of a cooperative effort between the U.S. Military, NASA and the switch mode power supply capacitor manufacturers to produce a robust direct replacement for the DSCC drawing. The military specification product provides additional quality assurance provisions that are NOT required by the DSCC drawing. Two product levels are offered in *MIL*-*PRF*-49470: the standard "B" level and the high reliability "T" level. Some of the benefits of the *MIL*-*PRF*-49470 product over the 87106 product include the following: Formal qualification process (*QPL* established), *MIL*-*STD*-790 compliance, DSCC audits, routine qualification maintenance testing, i.e., life testing, group A percent defective allowed (*PDA*) specified, and prohibiting the mixing of chips from different production lots within a single SMPS capacitor stack lot.

MIL-PRF-49470 "T" Level product is recommended for all high reliability applications. MIL-PRF-49470 "T" level product requires the following in-process inspections and additional group A and B screening inspections that are not part of the normal "B" level flow: In-process screening that includes non-destructive internal examination (chip level) and destructive physical analysis (chip level), group A destructive physical analysis (finished stack level), group B lot specific humidity, steady-state, low voltage (lot sample test), and group B lot specific thermal shock and life test (lot sample test).

For additional information regarding KEMET MIL-PRF-49470 QPL status or cancellation of DSCC Drawing 87106, please visit the DSCC website at: www.dscc.dla.mil.

KPS HV, Large Case, SM Series, COG Dielectric, 500 – 10,000 VDC (Industrial Grade)



Overview

KPS HV (KEMET Power Solutions, High Voltage), Large Case (≥ 1515), SM Series capacitors in COG dielectric are designed to meet robust performance standards required in higher reliability industrial applications. Utilizing lead-frame technology, SM Series devices isolate the multilayer ceramic chip component from the printed circuit board providing advanced mechanical and thermal stress performance. Isolation of the chip component also addresses concerns for audible, microphonic noise that may occur when a bias voltage is applied. Although this technology does not eliminate the potential for mechanical damage that may propagate during extreme environmental and handling conditions, it does demonstrate superior performance over non-isolating systems. Available in both formed "L" and "J" lead configurations, SM Series devices offer up to 10 mm of board flex capability and exhibit lower ESR, ESL and higher current discharge capability when compared to other dielectric solutions.

Combined with the stability of an COG dielectric, KEMET's High Voltage SM Series devices exhibit no change in capacitance with respect to time and voltage and boasts a negligible change in capacitance with reference to ambient temperature. Capacitance change is limited to ±30 ppm/°C from -55°C to +125°C.

KEMET's Industrial Grade products offer additional screening options for higher reliability applications. Both Group A and Group B testing/inspection options per MIL-PRF-49467 are available for the SM Series.

Benefits

- -55°C to +125°C operating temperature range
- Large Case Sizes (≥ 1515)
- Formed "L" or "J" leadframe configurations.
- Group A and B screening per MIL-PRF-49467 available
- · Reliable and robust leadframe termination system
- DC voltage ratings of 500 V, 1 KV, 2 KV, 3 KV, 4 KV, 5 KV, 7.5 KV, and 10 KV
- Capacitance offerings ranging from 10 pF up to 0.39 μF

Ordering Information



| SM20 | N | 472 | J | 501 | B | Μ |
|---|------------|--|---------------------------------|---|------------------------------------|---|
| Style/Size | Dielectric | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Lead Configuration ¹ | Testing/ Inspection Option ² |
| SM20 SM30 SM21 SM31 SM22 SM33 SM23 SM34 SM24 SM35 SM25 SM36 SM26 SM26 | N = COG | Two significant digits and number of zeros | J = ±5% K = ±10% M = ±20% | 501 = 500 102 = 1,000 202 = 2,000 302 = 3,000 402 = 4,000 502 = 5,000 752 = 7,500 103 = 10,000 | A = Formed L B = Formed J | Blank = None M = Group A per MIL-PRF-49467 |

¹ Standard lead configuration is formed "J". If the appropriate character is excluded from the ordering code, the assumed lead configuration will be formed "J".

² Group B testing/inspection option per MIL-PRF-49467 is available upon request. Please contact KEMET for ordering details.

Dimensions – Inches (Millimeters)





| Style/ Size | L Length | W Width | T Thickness Maximum | A Lead Width Maximum | LL Lead Length (Formed "L") | LL Lead Length (Formed "J") |
|----------------|--------------------------|--------------------------|---------------------------|----------------------------|-----------------------------------|-----------------------------------|
| SM20 | 0.150±0.015 (3.81±0.38) | 0.150±0.015 (3.81±0.38) | 0.130 (3.30) | | | 0.040.0040 |
| SM21 | 0.200±0.020 (5.08±0.51) | 0.200±0.020 (5.08±0.51) | 0 100 (4 57) | 0.100 (2.54) | | 0.040 ± 0.010 (1.02+0.25) |
| SM22 | 0.250±0.020 (6.35±0.51) | 0.200±0.020 (5.08±0.51) | 0.180 (4.57) | | | (1.0210.23) |
| SM23 | 0.350±0.030 (8.89±0.76) | 0.300±0.030 (7.62±0.76) | | 0.200 (5.08) | | |
| SM24 | 0.450±0.030 (11.43±0.76) | 0.400±0.030 (10.20±0.76) | | 0.300 (7.62) | | |
| SM25 | 0.550±0.030 (14.00±0.76) | 0.500±0.030 (12.70±0.76) | 0.220 (5.59) | 0.400 (10.20) | 0 100 10 000 | |
| SM26 | 0.650±0.030 (16.50±0.76) | 0.600±0.030 (15.20±0.76) | | 0.500 (12.70) | 0.100 ± 0.020 | |
| SM30 | 0.300±0.030 (7.62±0.76) | 0.150±0.015 (3.81±0.38) | 0.140 (3.55) | 0 100 (2 5 4) | (2.3410.31) | 0.100±0.020 |
| SM31 | 0.400±0.030 (10.20±0.76) | 0.200±0.020 (5.08±0.51) | 0.130 (3.30) | 0.100 (2.54) | | (2.54±0.51) |
| SM33 | 0.700±0.030 (17.08±0.76) | 0.300±0.030 (7.62±0.76) | 0.180 (4.57) | 0.200 (5.08) | - | |
| SM34 | 0.900±0.030 (22.90±0.76) | 0.400±0.030 (10.20±0.76) | | 0.300 (7.62) | - | |
| SM35 | 1.100±0.030 (27.90±0.76) | 0.500±0.030 (12.70±0.76) | 0.220 (5.59) | 0.400 (10.2) | 1 | |
| SM36 | 1.350±0.030 (33.00±0.76) | 0.600±0.030 (15.20±0.76) | | 0.500 (12.7) | | |

Benefits cont.

- Advanced protection against thermal and mechanical stress
- · Provides up to 10 mm of board flex capability
- Reduces audible, microphonic noise

- Low ESR and ESL
- · Non-polar device, minimizing installation concerns
- Silver plated copper alloy leadframe termination system

Applications

Typical applications include switch mode power supplies (input filters, resonators, tank circuits, snubber circuits, output filters), high voltage coupling and DC blocking, voltage multiplier circuits, DC/DC converters and coupling capacitors in Ćuk converters, noise reduction (piezoelectric/mechanical), circuits with a direct battery or power source connection, critical and safety relevant circuits without (integrated) current limitation and any application that is subject to high levels of board flexure or temperature cycling. Markets include power supply, LCD fluorescent backlight ballasts, HID lighting, telecom equipment, industrial and medical equipment/control and Military.



Qualification/Certification

Industrial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 3, Performance & Reliability.

Environmental Compliance

RoHS Compliant with Exemption(s).

Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±30 ppm/°C |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 0% |
| Dielectric Withstanding Voltage (DWV) | 150% of rated voltage for voltage rating of \leq 1,250 VDC 120% of rated voltage for voltage rating of > 1,250 VDC (5±1 seconds and charge/discharge not exceeding 50 mA) |
| Dissipation Factor (DF) Maximum Limit at 25°C | 0.15% |
| Insulation Resistance (IR) Limit at 25°C | 1,000 megohm microfarads or 100 GΩ (Rated voltage DC applied for 120±5 seconds at 25°C for voltage rating of ≤ 500 VDC) (500 VDC applied for 120±5 seconds at 25°C for voltage rating of > 500 VDC) |

To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to $G\Omega$ limit. Select the lower of the two limits.

 $Capacitance\ and\ dissipation\ factor\ (DF)\ measured\ under\ the\ following\ conditions:$

1 MHz ±100 kHz and 1.0 Vrms ±0.2 V if capacitance \leq 100 pF

1 kHz ±50 Hz and 1.0 Vrms ±0.2 V if capacitance > 100 pF

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

Post Environmental Limits

| High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | | | | | | |
|---|---------------------|----------------------|-----------------------------------|----------------------|--------------------------|--|--|--|--|--|--|--|--|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | | | | | | | | |
| COG | All | All | 0.5 | 0.3% or ±0.25 pF | 10% of Initial Limit | | | | | | | | |



Table 1A – Capacitance Range/Selection Waterfall SM20 – SM24 Style/Size

| Style/Size | | SN | 120 | | | SN | 121 | | SM22 | | | | SM23 | | | | SM24 | | | | | | | |
|--------------------|-----|---------|--------------------|--------|-----|------------------|--------------------|--------|--------------------------------|------------------|--------------------|-------|-------------------|------------|-------------------|--------------|---------------------------------|----------------|-------|------------------|--------------------|-----|------------|---------------|
| | | | | | | | | Dime | nsions – inches (mm) | | | | | | | | | | | | | | | |
| Lenath | | 0.150 | ± 0.015 | 5 | | 0.200 | ± 0.02 | 0 | 0.250 ± 0.020 | | | | 0.350 ± 0.030 | | | | | | 0.450 | ± 0.030 |) | | | |
| | | (3.81) | ± 0.38) + 0.015 |) 5 | | (5.08) 0.200 | ± 0.51) + 0.021 |) N | (6.35 ± 0.51) 0 200 + 0 020 | | | | (8.89 ± 0.76) | | | | (11.43 ± 0.76) 0.400 ± 0.030 | | | | | | | |
| Width | | (3.81 | ± 0.38) |) | | (5.08 | ± 0.51) |) | (5.08 ± 0.51) | | | | | (7. | 62 ± 0 | .76) | | (10.20 ± 0.76) | | | | | | |
| Thickness | | 0.1 | 130 30) | | | 0.180 | | | | 0.1 | 180 57) | | | | 0.220 |) | | | | 0.2 | 220 | | | |
| Lead Width | | 0.1 | 100 | | | 0.1 | 100 | | | (4. | 100 | | | | 0.200 |) | | | | 0.3 | 39) | | | |
| Maximum | | (2. | 54) | | | (2. | 54) | | | (2. | 54) | | | | (5.08) |) | | | | (7. | 62) | | | |
| Lead Length "L" | | 0.100 : | ± 0.02(± 0.51) | D) | | 0.100 : (2.54 | ± 0.02(± 0.51) | D) | | 0.100 : (2.54 | ± 0.02(± 0.51) |) | | 0.1 (2. | 00 ± 0. 54 ± 0 | .020 .51) | | | | 0.100 : (2.54 | ± 0.020 ± 0.51) |) | | |
| Lead Length | | 0.040 | ± 0.01 | , D | | 0.040 | ± 0.01 | , D | | 0.040 | ± 0.01 |) | | 0.1 | 00 ± 0. | .020 | | | | 0.100 : | ± 0.020 |) | | |
| "J" | | (1.02 : | ± 0.25) |) | | (1.02 : | ± 0.25) |) | | (1.02 : | ± 0.25) |) | | (2. | 54 ± 0 | .51) | | | | (2.54 | ± 0.51) | | | |
| Valtara Oada | 501 | 100 | 200 | 200 | 501 | 100 | 000 | 200 | | Diele | | 200 | 501 | 100 | 202 | 200 | 400 | 501 | 100 | 200 | 200 | 400 | 500 | |
| Voltage Code | 501 | 102 | 202 | 302 | 501 | 102 | 202 | 302 | 501 | 102 | 202 | 302 | 501 | 102 | 202 | 302 | 402 | 501 | 102 | 202 | 302 | 402 | 502 | Capacitance |
| Voltage DC | 500 | TK | 2 K | 3 K | 500 | 1 K | 2 K | 3 K | 500 | 1 K | 2 K | 3 K | 500 | 1 K | ZK | 3 K | 4 K | 500 | TK | 2 K | 3 K | 4 K | 5 K | Tolerance |
| | | 1 | 1 | 1 | r – | 1 | 220 | 220 | 1 | C | арас | itanc | | le | | 1 | | r | | | | 1 | | |
| 22 pF 27 pF | | | | | | | 270 | 270 | | | | | | | | | | | | | | 270 | 270 | |
| 33 pF | | | | | | | 330 | 330 | 330 | 330 | 330 | 330 | | | | | | | | | | 330 | 330 | |
| 39 pF | 390 | 390 | 390 | 390 | 390 | 390 | 390 | 390 | 390 | 390 | 390 | 390 | | | | | | | | | | 390 | 390 | |
| 4/pF | 4/0 | 4/0 | 4/0 | 4/0 | 4/0 | 4/0 | 4/0 | 4/0 | 4/0 | 4/0 | 4/0 | 4/0 | | | | | | 560 | 560 | 560 | 560 | 4/0 | 4/0 | |
| 68 pF | 680 | 680 | 680 | 680 | 680 | 680 | 680 | 680 | 680 | 680 | 680 | 680 | | | | | | 680 | 680 | 680 | 680 | 680 | 680 | |
| 82 pF | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | |
| 100 pF | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | |
| 120 pF | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | |
| 150 pF | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | |
| 180 pF | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | |
| 220 pF | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | |
| 270 pF | 271 | 271 | 271 | 271 | 271 | 271 | 271 | 271 | 271 | 271 | 271 | 271 | 271 | 271 | 271 | 271 | 271 | 271 | 271 | 271 | 271 | 271 | 271 | |
| 330 pF | 331 | 331 | 331 | | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | |
| 390 pr 470 pF | 171 | 171 | 171 | | 171 | 171 | 171 | 171 | 171 | 171 | 171 | 171 | 171 | 171 | 171 | 171 | 171 | 171 | 171 | 171 | 171 | 171 | 391 171 | |
| 560 pF | 561 | 561 | 561 | | 561 | 561 | 561 | 561 | 561 | 561 | 561 | 561 | 561 | 561 | 561 | 561 | 561 | 561 | 561 | 561 | 561 | 561 | 561 | |
| 680 pF | 681 | 681 | 681 | | 681 | 681 | 681 | | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | |
| 820 pF | 821 | 821 | 821 | | 821 | 821 | 821 | | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | | 821 | 821 | 821 | 821 | 821 | 821 | |
| 1,000 pF | 102 | 102 | | | 102 | 102 | 102 | | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | | 102 | 102 | 102 | 102 | 102 | 102 | |
| 1,200 pF | 122 | 122 | | | 122 | 122 | 122 | | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | | 122 | 122 | 122 | 122 | 122 | 122 | J, K, M, P, Z |
| 1,500 pF | 152 | 152 | | | 152 | 152 | 152 | | 152 | 152 | 152 | | 152 | 152 | 152 | 152 | | 152 | 152 | 152 | 152 | 152 | 152 | |
| 1,800 pF | 182 | 182 | | | 182 | 182 | 182 | | 182 | 182 | 182 | | 182 | 182 | 182 | 182 | | 182 | 182 | 182 | 182 | | | |
| 2,200 pF | 222 | 222 | | | 222 | 222 | | | 222 | 222 | 222 | | 222 | 222 | 222 | 222 | | 222 | 222 | 222 | 222 | | | |
| 2,700 pF | 2/2 | 212 | | | 332 | 332 | | | 332 | 332 | 332 | | 332 | 332 | 332 | | | 332 | 332 | 332 | 332 | | | |
| 3.900 pF | | | | | 392 | 392 | | | 392 | 392 | 002 | | 392 | 392 | 392 | | | 392 | 392 | 392 | 392 | | | |
| 4,700 pF | | | | | 472 | 472 | | | 472 | 472 | | | 472 | 472 | 472 | | | 472 | 472 | 472 | 472 | | | |
| 5,600 pF | | | | | | | | | 562 | 562 | | | 562 | 562 | 562 | | | 562 | 562 | 562 | | | | |
| 6,800 pF | | | | | | | | | 682 | 682 | | | 682 | 682 | | | | 682 | 682 | 682 | | | | |
| 8,200 pF | | | | | | | | | 822 | | | | 822 | 822 | | | | 822 | 822 | 822 | | | | |
| 0.01 µF | | | | | | | | | 103 | | | | 103 | 103 | | | | 103 | 103 | 103 | | | | |
| 0.012 µF | | | | | | | | | 123 | | | | 123 | 123 | | | | 123 | 123 | | | | | |
| 0.015 µF | | | | | | | | | 183 | | | | 183 | 155 | | | | 183 | 183 | | | | | |
| 0.022 µF | | | | | | | | | | | | | 223 | | | | | 223 | 223 | | | | | |
| 0.027 µF | | | | | | | | | | | | | 273 | | | | | 273 | 273 | | | | | |
| 0.033 µF | | | | | | | | | | | | | 333 | | | | | 333 | 333 | | | | | |
| 0.039 µF | | | | | | | | | | | | | | | | | | 393 | 393 | | | | | |
| 0.047 µF | | | | | | | | | | | | | | | | | | 473 | 473 | | | | | |
| 0.039 µF | | | | | | | | | | | | | | | | | | 393 | | | | | | |
| υ.υ4/μΓ | 1 | 1 | | 1 | | | | | | 1 | 1 | 1 | | | 1 | 1 | | 4/3 | | | | | | |



Table 1B – Capacitance Range/Selection Waterfall SM25 – SM31 Style/Size

| Style/Size | | | SM | 125 | | | | | SN | 126 | | | | | SM3 | 0 | | | | SN | 131 | | | |
|------------------------|-----|-----|--------------------|--------------------|----------|-----|-----|-------|--------------------|-------------------|----------|-------|-------|-----|--------------------|--------------|-----|---------------|-----|------------------|------------------|--------|-----|--------------------------|
| | | | | | | | . [| Dimer | nsion | s – ir | nches | s (mm | ו) | | | | | | | | | | | |
| Lenath | | | 0.550 : | ± 0.030 | Ď | | | (| 0.650 | ± 0.03 | Ď | | | 0.3 | 00 ± 0 | .030 | | | | 0.400 | ± 0.03 | 0 0 | | |
| | | | (14.00 0.500 : | ± 0.76 ± 0.030 |) D | | | (| 0.600 : | ± 0.76 ± 0.030 |) D | | | 0.1 | 62 ± 0. 50 ± 0. | .76) .015 | | | | (10.20 0.200 | ± 0.76 ± 0.02 |) 0 | | |
| Width | | | (12.70 | ± 0.76 |) | | | | (15.20 | ± 0.76 |) | | | (3. | 81 ± 0. | .38) | | (5.08 ± 0.51) | | | | | | |
| Thickness Maximum | | | 0.2 | 220 59) | | | | | 0.2 (5. | 220 59) | | | | | 0.140 |) | | | | 0.1 (3. | 130 30) | | | |
| Lead Width | | | 0.4 | 100 | | | | | 0.5 | 500 | | | | | 0.100 | | | | | 0.1 | 100 | | | |
| Maximum Lead Length | | | (10. + 100 (| .20) E 0 020 | <u>ו</u> | | | | (12 100 - | .70) E 0 021 | <u>ו</u> | | | 0 1 | (2.54) 00 + 0 | 020 | | | | (2. 0 100 · | 54) + 0 020 | n | | |
| "L" | | | (2.54 : | ± 0.52(|) | | | | (2.54 | ± 0.52) |) | | | (2. | 54 ± 0 | .51) | | | | (2.54 | ± 0.51) |) | | |
| Lead Length | | | $0.100 \pm (2.54)$ | ± 0.02(+ 0.51) |) | | | | 0.100 : (2 54 · | ± 0.020 |) | | | 0.1 | 00 ± 0. 54 + 0 | 020 | | | | 0.100 : (2 54 | ± 0.020 | D N | | |
| | | | (2.01) | | · | | | | COG | Diele | ectric | | | | 0.120 | | | | | (2.0. | _ 0.0.1 | / | | |
| Voltage Code | 501 | 102 | 202 | 302 | 402 | 502 | 501 | 102 | 202 | 302 | 402 | 502 | 501 | 102 | 202 | 302 | 402 | 501 | 102 | 202 | 302 | 402 | 502 | |
| Voltage DC | 500 | 1 K | 2 K | 3 K | 4 K | 5 K | 500 | 1 K | 2 K | 3 K | 4 K | 5 K | 500 | 1 K | 2 K | 3 K | 4 K | 500 | 1 K | 2 K | 3 K | 4 K | 5 K | Capacitance Tolerance |
| Capacitance | | | | | | | | | | С | арас | itanc | e Coc | le | | | | | | | | | | |
| 10 pF | | | | | | | | | | | | | | | | | 100 | | | | | | | |
| 15 pF | | | | | | | | | | | | | 150 | 150 | 150 | 150 | 150 | | | | | | | |
| 18 pF | | | | | | | | | | | | | 180 | 180 | 180 | 180 | 180 | | | | | | | |
| 22 pF 27 nF | | | | | | | | | | | | | 220 | 220 | 220 | 220 | 220 | 270 | 270 | 270 | 270 | 220 | 220 | |
| 33 pF | | | | | | | | | | | | | 330 | 330 | 330 | 330 | 330 | 330 | 330 | 330 | 330 | 330 | 330 | |
| 39 pF | | | | | | | | | | | | | 390 | 390 | 390 | 390 | 390 | 390 | 390 | 390 | 390 | 390 | 390 | |
| 47 pF 56 nF | | | | | | | | | | | | | 470 | 470 | 470 | 470 | 470 | 470 | 470 | 470 | 470 | 470 | 470 | |
| 68 pF | | | | | | | | | | | | | 680 | 680 | 680 | 680 | 680 | 680 | 680 | 680 | 680 | 680 | 680 | |
| 82 pF | | | | | | | | | | | 101 | 101 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | |
| 100 pF 120 nF | | | | | | | | | | | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | |
| 150 pF | | | | | | | | | | | 151 | 151 | 151 | 151 | 151 | 151 | | 151 | 151 | 151 | 151 | 151 | 151 | |
| 180 pF | | | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | | 181 | 181 | 181 | 181 | 181 | 181 | |
| 220 pF 270 pF | 271 | 271 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | | 221 | 221 | 221 | 221 | | | |
| 330 pF | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | | 331 | 331 | 331 | 331 | | | |
| 390 pF | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | | 391 | 391 | 391 | 391 | | | |
| 470 pF | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | | 471 | 471 | 471 | 471 | | | |
| 680 pF | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | | 681 | 681 | 681 | 681 | | | |
| 820 pF | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | | | 821 | 821 | 821 | 821 | | | J, K, M, P, Z |
| 1,000 pF | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | | | 102 | 102 | 102 | 102 | | | |
| 1,200 pF 1.500 pF | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | | | 152 | 152 | 152 | 152 | | | |
| 1,800 pF | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | | | 182 | 182 | 182 | | | | |
| 2,200 pF | 222 | 222 | 222 | 222 | | | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | | | | 222 | 222 | 222 | | | | |
| 3,300 pF | 332 | 332 | 332 | 332 | | | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | | | | 332 | 332 | 332 | | | | |
| 3,900 pF | 392 | 392 | 392 | 392 | | | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | | | | 392 | 392 | 392 | | | | |
| 4,700 pF | 472 | 472 | 472 | 472 | | | 472 | 472 | 472 | 472 | | | 472 | 472 | | | | 472 | 472 | 472 | | | | |
| 6.800 pF | 682 | 682 | 682 | 502 | | | 682 | 682 | 682 | 682 | | | 502 | 502 | | | | 682 | 682 | 502 | | | | |
| 8,200 pF | 822 | 822 | 822 | | | | 822 | 822 | 822 | 822 | | | | | | | | 822 | 822 | | | | | |
| 0.01 µF | 103 | 103 | 103 | | | | 103 | 103 | 103 | | | | | | | | | 103 | 103 | | | | | |
| 0.012 µF | 123 | 123 | 123 | | | | 123 | 123 | 123 | | | | | | | | | 123 | 123 | | | | | |
| 0.018 µF | 183 | 183 | | | | | 183 | 183 | 183 | | | | | | | | | 183 | | | | | | |
| 0.022 µF | 223 | 223 | | | | | 223 | 223 | 223 | | | | | | | | | 223 | | | | | | |
| 0.027 µF 0.033 µF | 333 | 333 | | | | | 333 | 333 | | | | | | | | | | 333 | | | | | | |
| 0.039 µF | 393 | 393 | | | | | 393 | 393 | | | | | | | | | | | | | | | | |
| 0.047 µF | 473 | 473 | | | | | 473 | 473 | | | | | | | | | | | | | | | | |
| 0.068 μF | | | | | | | 683 | 683 | | | | | | | | | | | | | | | | |



Table 1C – Capacitance Range/Selection Waterfall SM33 – SM35 Style/Size

| Style/Size | | | | SM3 | 3 | | SM34 | | | | | | | | SM35 | | | | | | | | | |
|----------------------|------------|-----|----------|---------------------|----------------|------------|------------|---------------|------------|------------|------------|--------------------|------------|------------|------------|-----|------------|-----|----------------|--------------------|----------|-------|------|--------------------------|
| | | | | | | | | Dime | ensio | ns – | inche | es (m | m) | | | | | | | | | | | |
| l ength | | | 0.7 | 700 ± 0 | 0.030 | | | | | | 0.900 | ± 0.03 | 0 | | | | | | 1.100 | ± 0.03 | 0 | | | |
| Width | - | | (1) | 7.08 ± 0 300 ± 0 | 0.76)).030 | | | | | | (22.90 |) ± 0.76 ± 0.03 | 5) 0 | | | | | | (27.90 |) ± 0.70 ± 0.03 | 6) 30 | | | |
| Thickness | | | (7 | .62 ± 0 |).76) n | | | | | | (10.20 |) ± 0.76 | 5) | | | | | | (12.70 |) ± 0.7 | 6) | | | |
| Maximum | | | | (4.57 |) | | | | | | 0. (5 | 220 .59) | | | | | | | 0. (5 | 220 .59) | | | | |
| Lead Width | | | | 0.20 | 0 | | | | | | 0. | 300 | | | | | | | 0. | 400 | | | | |
| Lead Length | | | 0.1 | (5.08 00 ± 0 |)).020 | | | 0.100 ± 0.020 | | | | | | | | | | _ | 0.100 | 0.2) ±0.02 | 20 | | | |
| "L" | | | (2 | .54 ± 0 |).51) | | | (2.54 ± 0.51) | | | | | | | | | | | (2.54 | ± 0.51 | l) | | | |
| Lead Length "J" | | | 0. (2 | .54 ± 0 |).020).51) | | | | | | (2.54 | ± 0.02 ± 0.51 |) | | | | | | 0.100 (2.54 | ± 0.02 ± 0.51 | 20 I) | | | |
| | | | | | | | | | C0 | G Die | lectri | ic | | | | | | | | | | | | |
| Voltage Code | 501 | 102 | 202 | 302 | 402 | 502 | 752 | 501 | 102 | 202 | 302 | 402 | 502 | 752 | 103 | 501 | 102 | 103 | | | | | | |
| Voltage DC | 500 | 1 K | 2 K | 3 K | 4 K | 5 K | 7.5 K | 500 | 1 K | 2 K | 3 K | 4 K | 5 K | 7.5 K | 10 K | 500 | 1 K | 2 K | 3 K | 4 K | 5 K | 7.5 K | 10 K | Capacitance Tolerance |
| Capacitance | | | | | | | | | | | Capa | citanc | e Cod | e | | | | | | | | | | |
| 27 pF | | | | | | 270 | 270 | | | | | | | | | | | | | | | | | |
| 39 pF | | | | | | 390 | 390 | | | | | | | 390 | 390 | | | | | | | | | |
| 47 pF | | | | | | 470 | 470 | | | | | 470 | 470 | 470 | 470 | | | | | | | | 470 | |
| 56 pF 68 pF | | | | | | 560 680 | 560 680 | 680 | 680 | 560 680 | 560 680 | 560 680 | 560 680 | 560 680 | 560 680 | | | | | | | | | |
| 82 pF | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | 820 | | | | | | | | | |
| 100 pF | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | | | | | | | | | |
| 120 pF 150 pF | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 151 | 151 | 151 | 151 | 151 | 151 | 151 | | |
| 180 pF | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | 181 | | |
| 220 pF | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | | |
| 270 pF 330 nF | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | 331 | | |
| 390 pF | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | 391 | | |
| 470 pF | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | 471 | | |
| 560 pF 680 pF | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 561 | 681 | 561 681 | 681 | 681 | 681 | 681 | 681 | | |
| 820 pF | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | | 821 | 821 | 821 | 821 | 821 | 821 | 821 | | |
| 1,000 pF | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | |
| 1,200 pF 1,500 pF | 122 | 122 | 122 | 122 | 122 | 122 | | 122 | 122 | 122 | 122 | 122 | 122 | | | 122 | 122 | 122 | 122 | 122 | 122 | 122 | | |
| 1,800 pF | 182 | 182 | 182 | 182 | 182 | 182 | | 182 | 182 | 182 | 182 | 182 | 182 | | | 182 | 182 | 182 | 182 | 182 | 182 | 182 | | |
| 2,200 pF | 222 | 222 | 222 | 222 | 222 | 222 | | 222 | 222 | 222 | 222 | 222 | 222 | | | 222 | 222 | 222 | 222 | 222 | 222 | | | |
| 2,700 pF | 272 | 272 | 272 | 272 | 272 | 272 | | 272 | 272 | 2/2 | 272 | 272 | 272 | | | 272 | 272 | 272 | 2/2 | 272 | 272 | | | J, K, M, P, Z |
| 3,900 pF | 392 | 392 | 392 | 392 | | | | 392 | 392 | 392 | 392 | | | | | 392 | 392 | 392 | 392 | 392 | 392 | | | |
| 4,700 pF | 472 | 472 | 472 | 472 | | | | 472 | 472 | 472 | 472 | | | | | 472 | 472 | 472 | 472 | | | | | |
| 5,600 pF | 562 | 562 | 562 | 562 | | | | 562 | 562 | 562 | 562 | | | | | 562 | 562 | 562 | 562 | | | | | |
| 8,200 pF | 822 | 822 | 822 | 082 | | | | 822 | 822 | 822 | 822 | | | | | 822 | 822 | 822 | 822 | | | | | |
| 0.01 µF | 103 | 103 | 103 | | | | | 103 | 103 | 103 | 103 | | | | | 103 | 103 | 103 | 103 | | | | | |
| 0.012 μF | 123 | 123 | 123 | | | | | 123 | 123 | 123 | 123 | | | | | 123 | 123 | 123 | 123 | | | | | |
| 0.015 µF | 153 | 153 | 153 | | | | | 153 | 153 | 153 | 153 | | | | | 153 | 153 | 153 | 153 | | | | | |
| 0.022 µF | 223 | 223 | 105 | | | | | 223 | 223 | 223 | | | | | | 223 | 223 | 223 | 223 | | | | | |
| 0.027 μF | 273 | 273 | | | | | | 273 | 273 | | | | | | | 273 | 273 | 273 | | | | | | |
| 0.033 µF | 333 | 333 | | | | | | 333 | 333 | | | | | | | 333 | 333 | 333 | | | | | | |
| 0.039 µF 0.047 µF | 473 | 473 | | | | | | 473 | 393 473 | | | | | | | 473 | 393 473 | 473 | | | | | | |
| 0.056 µF | 563 | | | | | | | 563 | 563 | | | | | | | 563 | 563 | | | | | | | |
| 0.068 µF | 683 | | | | | | | 683 | | | | | | | | 683 | 683 | | | | | | | |
| 0.082 µF 0 1 µF | 823 104 | | | | | | | 823 104 | | | | | | | | 823 | 823 | | | | | | | |
| 0.12 µF | '04 | | | | | | | 124 | | | | | | | | 124 | 124 | | | | | | | |
| 0.15 μF | | | | | | | | 154 | | | | | | | | 154 | 154 | | | | | | | |
| 0.18 µF | | | | | | | | | | | | | | | | 184 | | | | | | | | |
| 0.22 μi 0.27 μF | | | | | | | | | | | | | | | | 274 | | | | | | | | |



Table 1D – Capacitance Range/Selection Waterfall SM36 Style/Size

| Style/Size | | | | | | | | | | | | | | | |
|-----------------------|--|------------|-----------|-------------------|--------------------|-----------|------|-----|---------------|--|--|--|--|--|--|
| Din | Dimensions - inches (mm) Length 1.350 ± 0.030 (33.00 ± 0.76) | | | | | | | | | | | | | | |
| Length | Length 1.350 ± 0.030 (33.00 ± 0.76) Width 0.600 ± 0.030 (15.20 ± 0.76) | | | | | | | | | | | | | | |
| Width | | | | 0.600 | ± 0.030 |) | | | | | | | | | |
| Thickness | | | | 15.20) 2 0 2 | ±0.76 20 |) | | | | | | | | | |
| Maximum | | | | (5. | 59) | | | | | | | | | | |
| Lead Width Maximum | | | | | | | | | | | | | | | |
| Lead Length | | | | 0.100 : | | | | | | | | | | | |
| Lead Length | | | | (2.54) 0.100 : | ± 0.51) ± 0.02(|) | | | | | | | | | |
| "J" | |) | -14 | (2.54 | ± 0.51) | | | | | | | | | | |
| Voltana Cada | | 10 DI | 202 | 202 | 402 | 502 | 750 | 102 | [| | | | | | |
| Voltage DC | 501 | 102 | 202 2K | 30Z | 402 | 502 5K | 75Z | 103 | Capacitance | | | | | | |
| Canacitance | 500 | IK | Can | acita | 4r. nce (| ode | 7.JK | IUK | Tolerance | | | | | | |
| 120 pF | | | oup | uontu | 121 | 121 | 121 | | | | | | | | |
| 150 pF | 151 | 151 | 151 | 151 | 151 | 151 | 151 | | | | | | | | |
| 180 pF | 181 | 181 | 181 | 181 | 181 | 181 | 181 | | | | | | | | |
| 270 pF | 271 | 271 | 271 | 271 | 271 | 271 | 271 | | | | | | | | |
| 330 pF | 331 | 331 | 331 | 331 | 331 | 331 | 331 | | | | | | | | |
| 390 pF | 391 | 391 | 391 | 391 | 391 | 391 | 391 | | | | | | | | |
| 470 pF | 471 | 471 | 471 | 471 | 471 | 471 | 471 | | | | | | | | |
| 560 pF 680 nF | 681 | 681 | 681 | 681 | 681 | 681 | 681 | | | | | | | | |
| 820 pF | 821 | 821 | 821 | 821 | 821 | 821 | 821 | | | | | | | | |
| 1,000 pF | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | | | | | | | |
| 1,200 pF | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 150 | | | | | | | |
| 1,500 pF 1,800 pF | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | | | | | | | |
| 2,200 pF | 222 | 222 | 222 | 222 | 222 | 222 | 222 | | | | | | | | |
| 2,700 pF | 272 | 272 | 272 | 272 | 272 | 272 | 272 | | | | | | | | |
| 3,300 pF | 332 | 332 | 332 | 332 | 332 | 332 | 332 | | | | | | | | |
| 3,900 pF | 392 | 392 | 392 | 392 | 392 | 392 | | | | | | | | | |
| 5,600 pF | 562 | 562 | 562 | 562 | 562 | 562 | | | | | | | | | |
| 6,800 pF | 682 | 682 | 682 | 682 | 682 | 682 | | | J, K, M, P, Z | | | | | | |
| 8,200 pF | 822 | 822 | 822 | 822 | 822 | | | | | | | | | | |
| 0.01 µF | 103 | 103 | 103 | 103 | 103 | | | | | | | | | | |
| 0.012 µF | 153 | 153 | 153 | 153 | | | | | | | | | | | |
| 0.018 µF | 183 | 183 | 183 | 183 | | | | | | | | | | | |
| 0.022 µF | 223 | 223 | 223 | 223 | | | | | | | | | | | |
| 0.027 µF | 2/3 | 2/3 | 2/3 | 2/3 | | | | | | | | | | | |
| 0.039 µF | 393 | 393 | 393 | 000 | | | | | | | | | | | |
| 0.047 µF | 473 | 473 | 473 | | | | | | | | | | | | |
| 0.056 µF | 563 | 563 | 563 | | | | | | | | | | | | |
| 0.068 µF 0.082 µF | 823 | 083 823 | | | | | | | | | | | | | |
| 0.1 µF | 104 | 104 | | | | | | | | | | | | | |
| 0.12 µF | 124 | 124 | | | | | | | | | | | | | |
| 0.15 µF | 154 | 154 | | | | | | | | | | | | | |
| 0.18 µF 0.22 µF | 224 | | | | | | | | | | | | | | |
| 0.27 μF | 274 | | | | | | | | | | | | | | |
| 0.33 µF | 334 | | | | | | | | | | | | | | |
| 0.39 µF | 394 | | | | | | | | | | | | | | |



Table 2 – Chip Thickness/Packaging Quantities

| Series | Style/Size | Tray Quantity Minimum ¹ | Tray Quantity Maximum ¹ |
|--------|------------|--|--|
| | SM20 | | |
| | SM21 | | |
| | SM22 | | |
| | SM23 | | |
| | SM24 | | 50 |
| | SM25 | | |
| SM | SM26 | 1 | |
| | SM30 | | |
| | SM31 | | |
| | SM33 | | 25 |
| | SM34 | | |
| | SM35 | | 10 |
| | SM36 | | |

¹ Minimum order value applies. Contact KEMET for details.

Soldering Process

The capacitors and assemblies outlined in this specification sheet are susceptible to thermal shock damage due to their large ceramic mass. Temperature profiles used should provide adequate temperature rise and cool-down time to prevent damage from thermal shock. In general, KEMET recommends against hand soldering for these types of large ceramic devices.

Recommended Soldering Technique:

Solder reflow only

Preheating and Reflow Profile Notes:

Due to differences in the coefficient of thermal expansion for the different materials of construction, it is critical to monitor and control the heating and cooling rates during the soldering process. During the reflow soldering process, the maximum recommended heating and cooling rate (dT/ dt) is 4°C/second. To ensure optimal component reliability, KEMET's recommended heating and cooling rate is 2°C/ second. After soldering, the capacitors should be air cooled to room temperature before further processing. Forced air cooling is not recommended.

Recommended Reflow Soldering Profile:

| Profile Feature | SnPb Assembly |
|--|-----------------|
| Preheat/Soak | |
| Temperature Minimum (T _{smin}) | 100°C |
| Temperature Maximum (T _{smax}) | 150°C |
| Time (t_s) from Tsmin to T_{max}) | 60 – 90 seconds |
| Ramp-up Rate (T _L to T _P) | 2°C/seconds |
| Liquidous Temperature (T _L) | 183°C |
| Time Above Liquidous (t _L) | 95 seconds |
| Peak Temperature (T _P) | 240°C |
| Time within 5°C of Maximum Peak Temperature (t _p) | 5 seconds |
| Ramp-down Rate $(T_{p} to T_{l})$ | 2°C/seconds |
| Time 25°C to Peak Temperature | 3.5 minutes |

Note 1: All temperatures refer to the center of the package, measured on the package body surface that is facing up during assembly reflow.





Table 3 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method |
|---------------------------------|--|--|
| Board Flex | JIS-C-6429 | Appendix 2, Note: 2 mm (minimum) for all except 3 mm for C0G. |
| | | Magnification 50 X. Conditions: |
| | | a) Method B, 4 hours at 155°C, dry heat at 235°C |
| Solderability | J-STD-002 | b) Method B at 215°C category 3 |
| | | c) Method D, category 3 at 260°C |
| | | 1,000 cycles (-55°C to +125°C). Measurement at 24 hours +/-2 hours after test conclusion. |
| | | Load Humidity: 1,000 hours 85°C/85% RH and 300 VDC Maximum Add 100 K ohm resistor. Measurement at 24 hours +/-2 hours after test conclusion. |
| Biased Humidity | MIL-STD-202 Method 103 | Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours +/-2 hours after test conclusion. |
| | | t = 24 hours/cycle. Steps 7a and 7b not required. Unpowered. Measurement at 24 hours +/-2 hours after test conclusion. |
| Thermal Shock | MIL-STD-202 Method 107 | -55°C/+125°C. Note: Number of cycles required – 300. Maximum transfer time – 20 seconds. D14 dwell time – 15 minutes. Air – Air. |
| High Temperature Life | MIL-STD-202 Method 108 /EIA -198 | 1,000 hours at 125°C (85°C for X5R, Z5U and Y5V) with rated voltage applied. |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC, for 1,000 hours. |
| Vibration | MIL-STD-202 Method 204 | 5 g for 20 minutes, 12 cycles each of 3 orientations. Note: Use 8 "X5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10–2,000 Hz. |
| Resistance to Soldering Heat | MIL-STD-202 Method 210 | Condition B. No preheat of samples. Note: single wave solder - procedure 2. |
| Terminal Strength | MIL-STD-202 Method 211 | Conditions A (2.3 kg or 5 lbs). |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Condition F. |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction



Product Marking

Product marking is an extra-cost option. These devises will be supplied unmarked unless otherwise specified and/or requested. For more detailed information regarding marked product and how to request this option, please contact KEMET.

KPS HV, Large Case, SM Series, X7R Dielectric, 500 – 10,000 VDC (Industrial Grade)



Overview

KPS HV (KEMET Power Solutions, High Voltage), Large Case (≥ 1515), SM Series capacitors in X7R dielectric are designed to meet robust performance standards required in higher reliability industrial applications. Utilizing leadframe technology, SM Series devices isolate the multilayer ceramic chip component from the printed circuit board providing advanced mechanical and thermal stress performance. Isolation of the chip component also addresses concerns for audible, microphonic noise that may occur when a bias voltage is applied. Although this technology does not eliminate the potential for mechanical damage that may propagate during extreme environmental and handling conditions, it does demonstrate superior performance over non-isolating systems. Available in both formed "L" and "J" lead configurations, SM Series devices offer up to 10 mm of board flex capability and exhibit lower ESR, ESL and higher current discharge capability when compared to other dielectric solutions.

Combined with the stability of an X7R dielectric, KEMET's High Voltage SM Series devices exhibit a predictable change in capacitance with respect to time and voltage and boast a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to $\pm 15\%$ from -55° C to $\pm 125^{\circ}$ C.

KEMET's Industrial grade products offer additional screening options for higher reliability applications. Both Group A and Group B testing/inspection options per MIL-PRF-49467 are available for the SM Series.

Benefits

- -55°C to +125°C operating temperature range
- Large Case Sizes (≥ 1515)
- Formed "L" or "J" leadframe configurations
- Group A and B screening per MIL-PRF-49467 available
- Reliable and robust leadframe termination system
- DC voltage ratings of 500 V, 1 KV, 2 KV, 3 KV, 4 KV, 5 KV, 7.5 KV, and 10 KV
- Capacitance offerings ranging from 150 pF up to 5.6 μF

Ordering Information



| SM | 120 | В | 153 | K | 501 | В | Μ |
|--|--|------------|--|--------------------------|--|------------------------------------|---|
| Style | /Size | Dielectric | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Lead Configuration ¹ | Testing/ Inspection Option ² |
| SM20 SM21 SM22 SM23 SM24 SM25 SM26 | SM30 SM31 SM33 SM34 SM35 SM36 | B = X7R | Two significant digits and number of zeros | K = ±10% M = ±20% | 501 = 500 $102 = 1,000$ $202 = 2,000$ $302 = 3,000$ $402 = 4,000$ $502 = 5,000$ $752 = 7,500$ $103 = 10,000$ | A = Formed L B = Formed J | Blank = None M = Group A per MIL-PRF-49467 |

¹ Standard lead configuration is formed "J". If the appropriate character is excluded from the ordering code, the assumed lead configuration will be formed "J".

² Group B testing/inspection option per MIL-PRF-49467 is available upon request. Please contact KEMET for ordering details.



Dimensions – Inches (Millimeters)





| Style/ Size | L Length | W Width | T Thickness Max. | A Lead Width Max. | LL Lead Length (Formed "L") | LL Lead Length (Formed "J") |
|----------------|--------------------------|--------------------------|------------------------|-------------------------|-----------------------------------|-----------------------------------|
| SM20 | 0.150±0.015 (3.81±0.38) | 0.150±0.015 (3.81±0.38) | 0.130 (3.30) | | | 0.040.0040 |
| SM21 | 0.200±0.020 (5.08±0.51) | 0.200±0.020 (5.08±0.51) | 0 100 (4 57) | 0.100 (2.54) | | 0.040±0.010 (1.02+0.25) |
| SM22 | 0.250±0.020 (6.35±0.51) | 0.200±0.020 (5.08±0.51) | 0.180 (4.57) | | | (1.0210.23) |
| SM23 | 0.350±0.030 (8.89±0.76) | 0.300±0.030 (7.62±0.76) | | 0.200 (5.08) | | |
| SM24 | 0.450±0.030 (11.43±0.76) | 0.400±0.030 (10.20±0.76) | | 0.300 (7.62) | | |
| SM25 | 0.550±0.030 (14.00±0.76) | 0.500±0.030 (12.70±0.76) | 0.220 (5.59) | 0.400 (10.20) | | |
| SM26 | 0.650±0.030 (16.50±0.76) | 0.600±0.030 (15.20±0.76) | | 0.500 (12.70) | 0.100 ± 0.020 | |
| SM30 | 0.300±0.030 (7.62±0.76) | 0.150±0.015 (3.81±0.38) | 0.140 (3.55) | 0.100 (0.54) | (2.3410.31) | 0.100±0.020 |
| SM31 | 0.400±0.030 (10.20±0.76) | 0.200±0.020 (5.08±0.51) | 0.130 (3.30) | 0.100 (2.54) | | (2.54±0.51) |
| SM33 | 0.700±0.030 (17.08±0.76) | 0.300±0.030 (7.62±0.76) | 0.180 (4.57) | 0.200 (5.08) | - | |
| SM34 | 0.900±0.030 (22.90±0.76) | 0.400±0.030 (10.20±0.76) | | 0.300 (7.62) | - | |
| SM35 | 1.100±0.030 (27.90±0.76) | 0.500±0.030 (12.70±0.76) | 0.220 (5.59) | 0.400 (10.2) | 1 | |
| SM36 | 1.350±0.030 (33.00±0.76) | 0.600±0.030 (15.20±0.76) | | 0.500 (12.7) | | |

Benefits cont.

- Advanced protection against thermal and mechanical stress
- · Provides up to 10 mm of board flex capability
- Reduces audible, microphonic noise

- Low ESR and ESL
- · Non-polar device, minimizing installation concerns
- Silver plated copper alloy leadframe termination system

Applications

Typical applications include switch mode power supplies (input filters, resonators, tank circuits, snubber circuits, output filters), high voltage coupling and DC blocking, voltage multiplier circuits, DC/DC converters and coupling capacitors in Ćuk converters, noise reduction (piezoelectric/mechanical), circuits with a direct battery or power source connection, critical and safety relevant circuits without (integrated) current limitation and any application that is subject to high levels of board flexure or temperature cycling. Markets include power supply, LCD fluorescent backlight ballasts, HID lighting, telecom equipment, industrial and medical equipment/control and Military.



Qualification/Certification

Industrial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 3, Performance & Reliability.

Environmental Compliance

RoHS Compliant with Exemption(s).

Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±15% |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| Dielectric Withstanding Voltage (DWV) | 150% of rated voltage for voltage rating of ≤ 1,250 VDC 120% of rated voltage for voltage rating of > 1,250 VDC (5±1 seconds and charge/discharge not exceeding 50 mA) |
| Dissipation Factor (DF) Maximum Limit at 25°C | 2.5% |
| Insulation Resistance (IR) Limit at 25°C | 1,000 megohm microfarads or 100 GΩ (Rated voltage DC applied for 120±5 seconds at 25°C for voltage rating of ≤ 500 VDC) (500 VDC applied for 120±5 seconds at 25°C for voltage rating of > 500 VDC) |

Regarding aging rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours. To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits. Capacitance and dissipation factor (DF) measured under the following conditions:

1 kHz ±50 Hz and 1.0 Vrms ±0.2 V if capacitance > 100 pF

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

Post Environmental Limits

| Higl | High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | | | | | | | |
|------------|---|-------------------|-----------------------------------|----------------------|--|--|--|--|--|--|--|--|--|--|--|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | | | | | | | | | | | |
| X7R | All | All | 3.0 | ±20% | | | | | | | | | | | |



Table 1A – Capacitance Range/Selection Waterfall SM20 – SM24 Style/Size

| Style/Size | SM20 SM21 | | | | | SM22 | | | SM23 | | | | SM24 | | | | | | | | | | |
|----------------------|-----------|-----------------------------|-------------|----------|---------|--------------------|-----|-------|---------|----------------------------|-------|-------|------|-------------|------|-----|------------|-----|---------|--------------------|--------|-----|--------------------------|
| | | | | <u>^</u> | | | Din | nensi | ons - | · inch | es (n | nm) | | | | | | | | | | | |
| l enath | 0.1 | 50 ± 0. | 015 | | 0.200 | ± 0.020 |) | | 0.250 | ± 0.020 |) | | 0.3 | 50 ± 0. | 030 | | | | 0.450 : | ± 0.030 |) | | |
| Length | (3. | $\frac{81 \pm 0}{50 \pm 0}$ | 38) 015 | | (5.08 | ± 0.51) + 0.020 | 1 | | (6.35 | ± 0.51) + 0.020 | 1 | | (8. | $89 \pm 0.$ | .76) | | | | (11.43 | ± 0.76 |)) | | |
| Width | (3. | 81 ± 0. | 38) | | (5.08 | ± 0.020 ± 0.51) | J | | (5.08 | ± 0.020 ± 0.51) | J | | (7. | 62 ± 0. | .76) | | | | (10.20 | ± 0.030 |) | | |
| Thickness | | 0.130 | | | 0.1 | 80 | | | 0.1 | 180 | | | | 0.220 | | | | | 0.2 | 220 | | | |
| Maximum | _ | (3.30) | | | (4. | 57) | | | (4. | 57) 100 | | | | (5.59) | | | | | (5. | 59) 200 | | | |
| Maximum | | (2.54) | | | (2. | 54) | | | (2. | 54) | | | | (5.08) | | | | | (7. | 62) | | | |
| Lead Length | 0.1 | 00 ± 0. | 020 | | 0.100 : | ± 0.020 |) | | 0.100 : | ± 0.020 |) | | 0.1 | 00 ± 0. | 020 | | | | 0.100 ± | ± 0.020 |) | | |
| "L" | (2. | 54 ± 0 | .51) 010 | | (2.54 | ± 0.51) + 0.010 | 1 | | (2.54 | ± 0.51) + 0.010 |) | | (2. | $54 \pm 0.$ | .51) | | | | (2.54) | ± 0.51) |) | | |
| "J" | (1. | 40 ± 0. 02 ± 0. | 25) | | (1.02 : | ± 0.010 ± 0.25) | | | (1.02 : | ± 0.010 $\pm 0.25)$ | , | | (2. | 54 ± 0. | .51) | | | | (2.54) | ± 0.020 ± 0.51) | , | | |
| | | | | • | | | | X | 7R Di | electi | ric | • | | | | | | | | | | | |
| Voltage Code | 501 | 102 | 202 | 501 | 102 | 202 | 302 | 501 | 102 | 202 | 302 | 501 | 102 | 202 | 302 | 402 | 501 | 102 | 202 | 302 | 402 | 502 | |
| Voltage DC | 500 | 1 K | 2 K | 500 | 1 K | 2 K | 3 K | 500 | 1 K | 2 K | 3 K | 500 | 1 K | 2 K | 3 K | 4 K | 500 | 1 K | 2 K | 3 K | 4 K | 5 K | Capacitance Tolerance |
| Capacitance | 1 | | | | | | | • | | Сар | acita | nce C | ode | | | | | | | | | | loiciunee |
| 330 pF | 331 | 331 | 331 | | | | | | | | | | | | | | | | | | | | |
| 390 pF | 391 | 391 | 391 | | | | | | | | | | | | | | | | | | | | |
| 4/0 pF | 4/1 | 4/1 | 4/1 | | | | | | | | | | | | | | | | | | | | |
| 680 pF | 681 | 681 | 681 | | | | | 681 | 681 | 681 | 681 | | | | | | | | | | | | |
| 820 pF | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | | | | | | | | | | | | |
| 1,000 pF | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | |
| 1,200 pF | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | |
| 1,500 pF | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | |
| 1,800 pF | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | 182 | |
| 2,200 pF | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | |
| 2,700 pF 3,300 nF | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | |
| 3.900 pF | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | |
| 4,700 pF | 472 | 472 | | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | |
| 5,600 pF | 562 | 562 | | 562 | 562 | 562 | | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | |
| 6,800 pF | 682 | 682 | | 682 | 682 | 682 | | 682 | 682 | 682 | | 682 | 682 | 682 | 682 | 682 | 682 | 682 | 682 | 682 | 682 | 682 | |
| 8,200 pF | 822 | 822 | | 822 | 822 | 822 | | 822 | 822 | 822 | | 822 | 822 | 822 | 822 | | 822 | 822 | 822 | 822 | 822 | | |
| 0.01 µF | 103 | 103 | | 103 | 103 | 103 | | 103 | 103 | 103 | | 103 | 103 | 103 | 103 | | 103 | 103 | 103 | 103 | 103 | | |
| 0.012 µF | 123 | 123 | | 123 | 123 | 123 | | 123 | 123 | 123 | | 123 | 123 | 123 | 123 | | 123 | 123 | 123 | 123 | 123 | | |
| 0.018 µF | 183 | 183 | | 183 | 183 | | | 183 | 183 | 155 | | 183 | 183 | 183 | 100 | | 183 | 183 | 183 | 183 | | | |
| 0.022 µF | 223 | 223 | | 223 | 223 | | | 223 | 223 | | | 223 | 223 | 223 | | | 223 | 223 | 223 | 223 | | | К, М |
| 0.027 µF | 273 | | | 273 | 273 | | | 273 | 273 | | | 273 | 273 | 273 | | | 273 | 273 | 273 | 273 | | | |
| 0.033 µF | 333 | | | 333 | 333 | | | 333 | 333 | | | 333 | 333 | 333 | | | 333 | 333 | 333 | 333 | | | |
| 0.039 µF | 393 | | | 393 | 393 | | | 393 | 393 | | | 393 | 393 | | | | 393 | 393 | 393 | | | | |
| 0.047 µF | 4/3 | | | 4/3 | 4/3 | | | 4/3 | 4/3 | | | 4/3 | 4/3 | | | | 4/3 | 4/3 | 4/3 | | | | |
| 0.050 µF | 683 | | | 683 | 683 | | | 683 | 683 | | | 683 | 683 | | | | 683 | 683 | 683 | | | | |
| 0.082 µF | 823 | | | 823 | 000 | | | 823 | 823 | | | 823 | 823 | | | | 823 | 823 | 823 | | | | |
| 0.1 µF | | | | 104 | | | | 104 | 104 | | | 104 | 104 | | | | 104 | 104 | 104 | | | | |
| 0.12 μF | | | | 124 | | | | 124 | | | | 124 | 124 | | | | 124 | 124 | | | | | |
| 0.15 µF | | | | 154 | | | | 154 | | | | 154 | 154 | | | | 154 | 154 | | | | | |
| 0.18 µF | | | | 184 | | | | 184 | | | | 184 | 184 | | | | 184 | 184 | | | | | |
| 0.22 µF | | | | | | | | 274 | | | | 224 | 224 | | | | 274 | 274 | | | | | 1 |
| 0.33 µF | | | | | | | | 2/4 | | | | 334 | 2/4 | | | | 334 | 334 | | | | | |
| 0.39 µF | | | | | | | | | | | | 394 | | | | | 394 | 394 | | | | | |
| 0.47 µF | | | | | | | | | | | | 474 | | | | | 474 | 474 | | | | | |
| 0.56 µF | | | | | | | | | | | | 564 | | | | | 564 | | | | | | |
| 0.68 µF | 1 | | | | | | | | | | | | | | | | 684 | | | | | | |
| U.82 µF | 1 | | | | | | | | | | | | | | | | δ24 105 | | | | | | |
| 1.2 μF | L | | | | | | | | | | | | | | | | 125 | | | | | | |



Table 1B – Capacitance Range/Selection Waterfall SM25 – SM31 Style/Size

| Style/Size | | SM25 SM26 | | | | | | | SM30 | | | | | SM31 | | | | | | | | | | |
|----------------------|----------------|-----------------------|--------------------|--------------------|--------|-----|-----|-------|------------------|--------------------|--------|-------|-------|------|-----------------------------|---------------|-----|-----|-----|--------|--------------------|---------|-----|-------------|
| | | | | | | | . [| Dimei | nsion | s – ir | nches | s (mm | 1) | | | | | | | | | | | |
| l enath | Τ | | 0.550 : | ± 0.030 |) | | | | 0.650 | ± 0.03 | 0 | | Í | 0.3 | 00 ± 0 | .030 | | | | 0.400 | ± 0.03 | 0 | | |
| Length | _ | | (14.00 | ± 0.76 |)) | | | | (16.50 0.600 | ± 0.76 |) 0 | | | (7. | 62 ± 0 | .76) | | | | (10.20 | ± 0.76 | 6) 0 | | |
| Width | | | (12.70 | ± 0.030 |) | | | | (15.20 | ± 0.03 |) | | | (3. | 81 ± 0 | .38) | | | | (5.08 | ± 0.02) ± 0.51) |) | | |
| Thickness | | | 0.2 | 220 | | | | | 0.2 | 220 | | | | | 0.140 |) | | | | 0.1 | 130 | | | |
| l ead Width | | | (5. | 59) 100 | | | | | (5. | 59) 500 | | | | | 0 100 |) I | | | | (3. | .30) 100 | | | |
| Maximum | | | (10 | .20) | | | | | (12 | .70) | | | | | (2.54) |) | | | | (2. | .54) | | | |
| Lead Length | | | $0.100 \pm (2.54)$ | ± 0.020 |) | | | | 0.100 | ± 0.020 | 0 | | | 0.1 | 00 ± 0 | .020 | | | | 0.100 | ± 0.02 | 0 | | |
| Lead Length | | | 0.100 ± | ± 0.01) ± 0.020 |) | | | | (2.34 0.100 : | ± 0.01) ± 0.020 | , D | | | 0.1 | $\frac{34 \pm 0}{00 \pm 0}$ | .020 | | | | 0.100 | ± 0.01 | , 0 | | |
| "J" | | (2.54 ± 0.51) (2.54 ± | | | | | | | | (2.54 ± 0.51) | | | | | | (2.54 ± 0.51) | | | | | ± 0.51) |) | | |
| | X7R Dielectric | | | | | | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | | | |
| Voltage Code | 501 | 102 | 202 | 302 | 402 | 502 | 501 | 102 | 202 | 302 | 402 | 502 | 501 | 102 | 202 | 302 | 402 | 501 | 102 | 202 | 302 | 402 | 502 | Canacitance |
| Voltage DC | 500 | 1 K | 2 K | 3 K | 4 K | 5 K | 500 | 1 K | 2 K | 3 K | 4 K | 5 K | 500 | 1 K | 2 K | 3 K | 4 K | 500 | 1 K | 2 K | 3 K | 4 K | 5 K | Tolerance |
| Capacitance | | 1 | 1 | | | 1 | 1 | | | C | apac | itanc | e Coo | le | 454 | 454 | | 1 | | 1 | 1 | 1 | | |
| 150 pF 180 pF | | | | | | | | | | | | | 151 | 151 | 151 | 151 | 151 | | | | | | | |
| 220 pF | | | | | | | | | | | | | 221 | 221 | 221 | 221 | 221 | | | | | | | |
| 270 pF | | | | | | | | | | | | | 271 | 271 | 271 | 271 | 271 | | | | | | | |
| 330 pF | | | | | | | | | | | | | 331 | 331 | 331 | 331 | 331 | | | | | | | |
| 390 pF 470 pF | | | | | | | | | | | | | 391 | 391 | 391 | 391 | 391 | | | | | | | |
| 560 pF | | | | | | | | | | | | | 561 | 561 | 561 | 561 | 561 | | | | | | | |
| 680 pF | | | | | | | | | | | | | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | 681 | |
| 820 pF | | | | | | | | | | | | | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | 821 | |
| 1,000 pF | | | | | | | | | | | | | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | |
| 1,200 pF 1,500 pF | | | | | | | | | | | | | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | |
| 1,800 pF | | | | | | | | | | | | | 182 | 182 | 182 | 182 | 152 | 182 | 182 | 182 | 182 | 182 | 152 | |
| 2,200 pF | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | | | 222 | 222 | 222 | 222 | | 222 | 222 | 222 | 222 | 222 | | |
| 2,700 pF | 272 | 272 | 272 | 272 | 272 | 272 | 272 | 272 | 272 | 272 | | | 272 | 272 | 272 | 272 | | 272 | 272 | 272 | 272 | 272 | | |
| 3,300 pF | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 200 | 200 | 332 | 332 | 332 | 332 | | 332 | 332 | 332 | 332 | 332 | | |
| 3,900 pF 4 700 pF | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | | | 392 | 392 | 392 | 392 | 392 | | |
| 5.600 pF | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | | | 562 | 562 | 562 | 562 | | | |
| 6,800 pF | 682 | 682 | 682 | 682 | 682 | 682 | 682 | 682 | 682 | 682 | 682 | 682 | 682 | 682 | 682 | | | 682 | 682 | 682 | 682 | | | |
| 8,200 pF | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | | | 822 | 822 | 822 | 822 | | | |
| 0.01 µF | 103 | 103 | 103 | 103 | 103 | 103 | 103 | 103 | 103 | 103 | 103 | 103 | 103 | 103 | 103 | | | 103 | 103 | 103 | | | | К, М |
| 0.012 µF | 123 | 123 | 123 | 123 | 123 | | 123 | 123 | 123 | 123 | 123 | 123 | 123 | 123 | | | | 123 | 123 | 123 | | | | |
| 0.018 µF | 183 | 183 | 183 | 183 | 100 | | 183 | 183 | 183 | 183 | 183 | 100 | 183 | 183 | | | | 183 | 183 | 183 | | | | |
| 0.022 µF | 223 | 223 | 223 | 223 | | | 223 | 223 | 223 | 223 | 223 | | 223 | 223 | | | | 223 | 223 | 223 | | | | |
| 0.027 µF | 273 | 273 | 273 | 273 | | | 273 | 273 | 273 | 273 | 273 | | 273 | 273 | | | | 273 | 273 | | | | | |
| 0.033 µF | 333 | 333 | 333 | 333 | | | 333 | 333 | 333 | 333 | 333 | | 333 | 333 | | | | 333 | 333 | | | | | |
| 0.039 µF | 473 | 473 | 473 | 473 | | | 473 | 473 | 473 | 473 | | | 473 | 473 | | | | 473 | 473 | | | | | |
| 0.056 µF | 563 | 563 | 563 | | | | 563 | 563 | 563 | 563 | | | 563 | 563 | | | | 563 | 563 | | | | | |
| 0.068 µF | 683 | 683 | 683 | | | | 683 | 683 | 683 | 683 | | | 683 | | | | | 683 | 683 | | | | | |
| 0.082 µF | 823 | 823 | 823 | | | | 823 | 823 | 823 | 823 | | | 823 | | | | | 823 | 823 | | | | | |
| 0.1 µF | 104 | 104 | 104 | | | | 104 | 104 | 104 | 104 | | | 104 | | | | | 104 | 104 | | | | | |
| 0.15 µF | 154 | 154 | 124 | | | | 154 | 154 | 154 | | | | 154 | | | | | 154 | | | | | | |
| 0.18 µF | 184 | 184 | | | | | 184 | 184 | 184 | | | | 184 | | | | | 184 | | | | | | |
| 0.22 µF | 224 | 224 | | | | | 224 | 224 | | | | | | | | | | 224 | | | | | | |
| 0.27 µF | 274 | 2/4 | | | | | 274 | 2/4 | | | | | | | | | | 2/4 | | | | | | |
| 0.33 µF 0.39 µF | 394 | 394 | | | | | 394 | 394 | | | | | | | | | | 394 | | | | | | |
| 0.47 µF | 474 | 474 | | | | | 474 | 474 | | | | | | | | | | | | | | | | |
| 0.56 µF | 564 | | | | | | 564 | 564 | | | | | | | | | | | | | | | | |
| 0.68 µF | 684 | | | | | | 684 | 684 | | | | | | | | | | | | | | | | |
| 0.82 µF | 824 | | | | | | 824 | 824 | | | | | | | | | | | | | | | | |



Table 1B - Capacitance Range/Selection Waterfall SM25 - SM31 Style/Size cont.

| Style/Size | | | SN | 25 | | | | | SN | 126 | | | | 9 | SM3 | 0 | | | | SN | 131 | | | |
|--------------------|-----|-----|--------------------|--------------------|-----|-----|-----|------|--------------------|-------------------|--------|-------|--------------------------------|------------|--------------------|--------------|-----|---------------|-----|-------------|------------------|---------|-----|--------------------------|
| | | | | | | | [| Dime | nsion | s – iı | nches | : (mn | 1) | | | | | | | | | | | |
| l enath | | (| 0.550 : | ± 0.030 | 0 | | | | 0.650 | ± 0.03 | 0 | | | 0.3 | 00 ± 0 | .030 | | | | 0.400 | ± 0.03 | 0 | | |
| 2011911 | | | (14.00 | ± 0.76 |) | | | | (16.50 | ± 0.76 |) | | (7.62 ± 0.76) | | | | | | | (10.20 | ± 0.7 | 6) | | |
| Width | | | 0.500 : (12.70 | ± 0.030 ± 0.76 |) | | | | 0.600 : (15.20 | ± 0.03 ± 0.76 | 0) | | | 0.1 (3. | 50 ± 0. 81 ± 0. | .015 .38) | | | | 0.200 (5.08 | ± 0.02 ± 0.51 | 20) | | |
| Thickness | | | 0.2 | 220 | | | | | 0.2 | 220 | , | | | | 0.140 | | | | | 0. | 130 | / | | |
| Maximum | | | (5. | 59) | | | | | (5. | 59) | | | (3.55) | | | | | | | (3. | 30) | | | |
| Lead Width | | | 0.4 | 100 | | | | | 0.5 | 500 | | | 0.100 | | | | | 0.100 | | | | | | |
| Maximum | | | (10 | .20) | | | | | (12 | .70) | | | (2.54) | | | | | (2.54) | | | | | | |
| Lead Length | | | 0.100 ± | £ 0.020 |) | | | | 0.100 : | ± 0.02 | D | | | 0.10 | 00 ± 0. | 020 | | 0.100 ± 0.020 | | | | | | |
| "L" | | | (2.54 : | ± 0.51) | | | | | (2.54) | ± 0.51 |) | | (2.54 ± 0.51) | | | | | (2.54 ± 0.51) | | | | | | |
| Lead Length "J" | | | 0.100 ± (2.54 : | ± 0.02(± 0.51) |) | | | | 0.100 : (2.54 : | ± 0.02 ± 0.51) | D) | | 0.100 ± 0.020 (2.54 ± 0.51) | | | | | (2.54 ± 0.51) | | | | | | |
| | | | | | | | | | X7R | Diele | ectric | | | | | | | | | | | | | |
| Voltage Code | 501 | 102 | 202 | 302 | 402 | 502 | 501 | 102 | 202 | 302 | 402 | 502 | 501 | 102 | 202 | 302 | 402 | 501 | 102 | 202 | 302 | 402 | 502 | |
| Voltage DC | 500 | 1 K | 2 K | 3 K | 4 K | 5 K | 500 | 1 K | 2 K | 3 K | 4 K | 5 K | 500 | 1 K | 2 K | 3 K | 4 K | 500 | 1 K | 2 K | 3 K | 4 K | 5 K | Capacitance Tolerance |
| Capacitance | | | | | | | | | | С | арас | itanc | e Coo | de | | | | | | | | | | |
| 1.0 µF | 105 | | | | | | 105 | 105 | | | | | | | | | | | | | | | | |
| 1.2 μF | 125 | | | | | | 125 | | | | | | | | | | | | | | | | | |
| 1.5 μF | 155 | | | | | | 155 | | | | | | | | | | | | | | | | | |
| 1.8 µF | 185 | | | | | | 185 | | | | | | | | | | | | | | | | | К, М |
| 2.2 µF | | | | | 225 | | | | | | | | | | | | | | | | | | | |
| 2.7 µF | | | | | | 275 | | | | | | | | | | | | | | | | | | |
| 2.9 µF | 1 | | | | | | 295 | | | | | | | | | | | | | | | | | 1 |



Table 1C – Capacitance Range/Selection Waterfall SM33 – SM35 Style/Size

| Style/Size | Τ | | | SM3 | 3 | | | | | | SN | /34 | | | | | | | SN | /35 | | | | |
|--------------------|-----|-----|-----------|--------------------|----------------|-----|-------|----------|------|--------|-------------|--------------------|----------|-------|------|----------|------------|-----|-------------|------------------|----------|-------|------|-------------|
| | | | | | | | | Dime | nsio | ıs – i | nche | s (m | m) | | | | | | | | | | | |
| Length | | | 0.7 | 700 ± (| 0.030 | | | | | | 0.900 | ± 0.03 | 0 | | | | | | 1.100 | ±0.03 | 0 | | | |
| | | | (1) | 7.08 ± 200 + 0 | 0.76) | | | | | | (22.90 |) ± 0.7 | 6) 10 | | | | | | (27.90 | $) \pm 0.76$ | 5) 10 | | | |
| Width | | | (7 | .62 ± (|).76) | | | | | | (10.20 |) ± 0.00 | 6) | | | | | | (12.70 | ± 0.03 | 6) | | | |
| Thickness | | | | 0.18 | 0 | | | | | | 0. (5 | 220 | | | | | | | 0. (5 | 220 | | | | |
| Lead Width | | | _ | 0.20 |) 0 | | | | | | 0. | 300 | | | | | | | 0. | 400 | | | | |
| Maximum | | | | (5.08 | 3) | | | | | | (7 | .62) | | | _ | | | | (1 | 0.2) | | | | |
| Lead Length "L" | | | 0.1 (2 | 100 ± 0 .54 ± (|).020).51) | | | | | | 0.100 (2.54 | ± 0.02 ± 0.51 | :0) | | | | | | 0.100 (2.54 | ± 0.02 ± 0.51 | :0) | | | |
| Lead Length | | | 0.1 | 100 ± 0 | 0.020 | | | | | | 0.100 | ± 0.02 | 0 | | | | | | 0.100 | ± 0.02 | 0 | | | |
| J | | | (2 | .54 ± (| J.5T) | | | <u> </u> | X7F | Diel | ectri | <u>± 0.51</u> C |) | | | <u> </u> | | | (2.54 | ± 0.51 |) | | | |
| Voltage Code | 501 | 102 | 202 | 302 | 402 | 502 | 752 | 501 | 102 | 202 | 302 | 402 | 502 | 752 | 103 | 501 | 102 | 202 | 302 | 402 | 502 | 752 | 103 | |
| Voltage DC | 500 | 1 K | 2 K | 3 K | 4 K | 5 K | 7.5 K | 500 | 1 K | 2 K | 3 K | 4 K | 5 K | 7.5 K | 10 K | 500 | 1 K | 2 K | 3 K | 4 K | 5 K | 7.5 K | 10 K | Capacitance |
| Capacitance | | | | | | | | | | C | Capad | citan | ce Co | de | | | | | | | | | | Toterance |
| 820 pF | 821 | 821 | 821 | 821 | 821 | 821 | 821 | | | | | | | | | <u> </u> | | | | | | | | |
| 1,000 pF | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | 102 | | | | | | | | 102 | |
| 1,200 pF | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | | | | | | | | 122 | |
| 1,500 pF | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | 152 | | | | | | | | 152 | |
| 2 200 pF | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | 222 | | | | | | | | 222 | |
| 2,200 pF | 272 | 272 | 272 | 272 | 272 | 272 | 272 | 272 | 272 | 272 | 272 | 272 | 272 | 272 | 272 | | | | | | | | 272 | |
| 3,300 pF | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | 332 | |
| 3,900 pF | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | 392 | |
| 4,700 pF | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 472 | |
| 5,600 pF | 562 | 562 | 562 | 562 | 562 | 562 | | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | |
| 6,800 pF | 682 | 682 | 682 | 682 | 682 | 682 | | 682 | 682 | 682 | 682 | 682 | 682 | 682 | | 682 | 682 | 682 | 682 | 682 | 682 | 682 | 682 | |
| 8,200 µF | 103 | 103 | 103 | 103 | 103 | | | 103 | 103 | 103 | 103 | 103 | 103 | | | 103 | 103 | 103 | 103 | 103 | 103 | 103 | | |
| 0.012 µF | 123 | 123 | 123 | 123 | 123 | | | 123 | 123 | 123 | 123 | 123 | 123 | | | 123 | 123 | 123 | 123 | 123 | 123 | 105 | | |
| 0.015 µF | 153 | 153 | 153 | 153 | 120 | | | 153 | 153 | 153 | 153 | 153 | 153 | | | 153 | 153 | 153 | 153 | 153 | 153 | | | |
| 0.018 µF | 183 | 183 | 183 | 183 | | | | 183 | 183 | 183 | 183 | 183 | 183 | | | 183 | 183 | 183 | 183 | 183 | 183 | | | |
| 0.022 µF | 223 | 223 | 223 | 223 | | | | 223 | 223 | 223 | 223 | 223 | 223 | | | 223 | 223 | 223 | 223 | 223 | 223 | | | |
| 0.027 µF | 273 | 273 | 273 | 273 | | | | 273 | 273 | 273 | 273 | 273 | | | | 273 | 273 | 273 | 273 | 273 | 273 | | | |
| 0.033 µF | 333 | 333 | 333 | 333 | | | | 333 | 333 | 333 | 333 | 333 | | | | 333 | 333 | 333 | 333 | 333 | | | | |
| 0.039 µF | 393 | 393 | 393 | 393 | | | | 393 | 393 | 393 | 393 | | | | | 393 | 393 | 393 | 393 | 393 | | | | |
| 0.047 µF | 563 | 563 | 563 | | | | | 563 | 563 | 563 | 473 563 | | | | | 563 | 473 563 | 563 | 563 | 4/3 | | | | |
| 0.068 µF | 683 | 683 | 683 | | | | | 683 | 683 | 683 | 683 | | | | | 683 | 683 | 683 | 683 | | | | | К, М |
| 0.082 µF | 823 | 823 | 823 | | | | | 823 | 823 | 823 | 823 | | | | | 823 | 823 | 823 | 823 | | | | | |
| 0.1 µF | 104 | 104 | | | | | | 104 | 104 | 104 | | | | | | 104 | 104 | 104 | 104 | | | | | |
| 0.12 µF | 124 | 124 | | | | | | 124 | 124 | 124 | | | | | | 124 | 124 | 124 | | | | | | |
| 0.15 µF | 154 | 154 | | | | | | 154 | 154 | 154 | | | | | | 154 | 154 | 154 | | | | | | |
| 0.18 µF | 224 | 224 | | | | | | 224 | 224 | 224 | | | | | | 224 | 224 | 224 | | | | | | |
| 0.27 µF | 274 | 274 | | | | | | 274 | 274 | 274 | | | | | | 274 | 274 | 274 | | | | | | |
| 0.33 µF | 334 | 334 | | | | | | 334 | 334 | | | | | | | 334 | 334 | | | | | | | |
| 0.39 µF | 394 | 394 | | | | | | 394 | 394 | | | | | | | 394 | 394 | | | | | | | |
| 0.47 µF | 474 | 474 | | | | | | 474 | 474 | | | | | | | 474 | 474 | | | | | | | |
| 0.56 µF | 564 | 564 | | | | | | 564 | 564 | | | | | | | 564 | 564 | | | | | | | |
| 0.68 µF | 684 | 684 | | | | | | 084 | 084 | | | | | | | 084 | 084 | | | | | | | |
| 1.0 μF | 105 | | | | | | | 105 | 105 | | | | | | | 105 | 105 | | | | | | | |
| 1.2 µF | 125 | | | | | | | 125 | | | | | | | | 125 | 125 | | | | | | | |
| 1.5 µF | 155 | | | | | | | 155 | | | | | | | | 155 | | | | | | | | |
| 1.8 µF | | | | | | | | 185 | | | | | | | | 185 | | | | | | | | |
| 2.2 µF | | | | | | | | 225 | | | | | | | | 225 | | | | | | | | |
| 2./µF | | | | | | | | | | | | | | | | 2/5 | | | | | | | | |
| 2.9 µr 3 3 µF | | | | | | | | | | | | | | | | 335 | | | | | | | | |
| 3.9 µF | | | | | | | | | | | | | | | | 395 | | | | | | | | |



Table 1D – Capacitance Range/Selection Waterfall SM36 Style/Size

| Style/Size | | | | SN | /36 | | | | |
|----------------------|------------|-----------------------|-------|-------------|------------------|----------|-------|------------|--------------------------|
| Dir | nens | ensions – inches (mm) | | | | | | | |
| Length | | 1.350 ± 0.030 | | | | | | | |
| Width | | | | 0.600 | ± 0.03 | 80 | | | |
| Thiskness | | | | (15.20 |) ± 0.7 | 6) | | | |
| Maximum | | | | 0. (5 | 220 .59) | | | | |
| Lead Width | | | | 0. | 500 | | | | |
| Lead Length | | | | 0.100 | 2.7) ±0.02 | 20 | | | |
| "L" | | | | (2.54 | ± 0.51 |) | | | |
| Lead Length "J" | | | | 0.100 (2.54 | ± 0.02 ± 0.51 | 20) | | | |
| | X | 7R D | ielec | tric | | | | | • |
| Voltage Code | 501 | 102 | 202 | 302 | 402 | 502 | 752 | 103 | |
| Voltage DC | 500 | 1 K | 2 K | 3 K | 4 K | 5 K | 7.5 K | 10 K | Capacitance Tolerance |
| Capacitance | | | Cap | pacita | ance | Code | | | |
| 1,500 pF | | | | | | | | 152 | |
| 1,800 pF 2,200 pF | | | | | | | | 182 | |
| 2,700 pF | | | | | | | | 272 | |
| 3,300 pF | | | | | | | | 332 | |
| 3,900 pF 4,700 pF | 472 | 472 | 472 | 472 | 472 | 472 | 472 | 392 472 | |
| 5,600 pF | 562 | 562 | 562 | 562 | 562 | 562 | 562 | 562 | |
| 6,800 pF | 682 | 682 | 682 | 682 | 682 | 682 | 682 | 682 | |
| 8,200 pF | 822 | 822 | 822 | 822 | 822 | 822 | 822 | 822 | |
| 0.012 µF | 123 | 123 | 123 | 123 | 123 | 123 | 123 | 103 | |
| 0.015 μF | 153 | 153 | 153 | 153 | 153 | 153 | 153 | | |
| 0.018 µF | 183 | 183 | 183 | 183 | 183 | 183 | 183 | | |
| 0.022 µF | 273 | 273 | 273 | 273 | 273 | 273 | 223 | | |
| 0.033 µF | 333 | 333 | 333 | 333 | 333 | 333 | | | |
| 0.039 µF | 393 | 393 | 393 | 393 | 393 | | | | |
| 0.047 µF 0.056 µF | 4/3 | 4/3 | 4/3 | 4/3 | 4/3 | | | | |
| 0.068 µF | 683 | 683 | 683 | 683 | 683 | | | | |
| 0.082 µF | 823 | 823 | 823 | 823 | | | | | K M D 7 |
| 0.1 μF 0.12 μF | 104 | 104 | 104 | 104 | | | | | к, м, р, 2 |
| 0.15 µF | 154 | 154 | 154 | 154 | | | | | |
| 0.18 µF | 184 | 184 | 184 | | | | | | |
| 0.22 µF | 224 | 224 | 224 | | | | | | |
| 0.33 μF | 334 | 334 | 334 | | | | | | |
| 0.39 µF | 394 | 394 | | | | | | | |
| 0.47 µF | 474 | 474 | | | | | | | |
| 0.50 µF | 684 | 684 | | | | | | | |
| 0.82 µF | 824 | 824 | | | | | | | |
| 1.0 µF | 105 | 105 | | | | | | | |
| 1.5 μF | 125 | 125 | | | | | | | |
| 1.8 μF | 185 | 185 | | | | | | | |
| 2.2 μF | 225 | 225 | | | | | | | |
| 2.7 µF 2.9 µF | 275 | | | | | | | | |
| 3.3 µF | 335 | | | | | | | | |
| 3.9 μF | 395 | | | | | | | | |
| 4.7 μF 5.6 μF | 475 565 | | | | | | | | |



Table 2 – Chip Thickness/Packaging Quantities

| Series | Style/Size | Tray Quantity Minimum ¹ | Tray Quantity Maximum ¹ |
|--------|------------|--|--|
| | SM20 | | |
| | SM21 | | |
| | SM22 | | |
| | SM23 | | |
| | SM24 | | 50 |
| | SM25 | | |
| SM | SM26 | 1 | |
| | SM30 | | |
| | SM31 |] | |
| | SM33 | | 25 |
| | SM34 | | |
| | SM35 | | 10 |
| | SM36 | | |

¹ Minimum order value applies. Contact KEMET for details.

Soldering Process

The capacitors and assemblies outlined in this specification sheet are susceptible to thermal shock damage due to their large ceramic mass. Temperature profiles used should provide adequate temperature rise and cool-down time to prevent damage from thermal shock. In general, KEMET recommends against hand soldering for these types of large ceramic devices.

Recommended Soldering Technique:

Solder reflow only

Preheating and Reflow Profile Notes:

Due to differences in the coefficient of thermal expansion for the different materials of construction, it is critical to monitor and control the heating and cooling rates during the soldering process. During the reflow soldering process, the maximum recommended heating and cooling rate (dT/ dt) is 4°C/second. To ensure optimal component reliability, KEMET's recommended heating and cooling rate is 2°C/ second. After soldering, the capacitors should be air cooled to room temperature before further processing. Forced air cooling is not recommended.

Recommended Reflow Soldering Profile:

| Profile Feature | SnPb Assembly | | | |
|--|-----------------|--|--|--|
| Preheat/Soak | | | | |
| Temperature Minimum (T _{Smin}) | 100°C | | | |
| Temperature Maximum (T _{Smax}) | 150°C | | | |
| Time (t_s) from Tsmin to T_{smax}) | 60 – 90 seconds | | | |
| Ramp-up Rate (T_L to T_P) | 2°C/seconds | | | |
| Liquidous Temperature (T_L) | 183°C | | | |
| Time Above Liquidous (t_L) | 95 seconds | | | |
| Peak Temperature (T _P) | 240°C | | | |
| Time within 5°C of Maximum Peak Temperature $(t_{\mbox{\tiny p}})$ | 5 seconds | | | |
| Ramp-down Rate (T_P to T_L) | 2°C/seconds | | | |
| Time 25°C to Peak Temperature | 3.5 minutes | | | |

Note 1: All temperatures refer to the center of the package, measured on the package body surface that is facing up during assembly reflow.





Table 3 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method |
|---------------------------------|--|--|
| Board Flex | JIS-C-6429 | Appendix 2, Note: 2 mm (minimum) for all except 3 mm for C0G. |
| | | Magnification 50 X. Conditions: |
| | | a) Method B, 4 hours at 155°C, dry heat at 235°C |
| Solderability | J-STD-002 | b) Method B at 215°C category 3 |
| | | c) Method D, category 3 at 260°C |
| | | 1,000 cycles (-55°C to +125°C). Measurement at 24 hours +/-2 hours after test conclusion. |
| Biased Humidity | | Load Humidity: 1,000 hours 85°C/85% RH and 300 VDC Maximum Add 100 K ohm resistor. Measurement at 24 hours +/-2 hours after test conclusion. |
| | MIL-STD-202 Method 103 | Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours +/-2 hours after test conclusion. |
| | | t = 24 hours/cycle. Steps 7a and 7b not required. Unpowered. Measurement at 24 hours +/-2 hours after test conclusion. |
| Thermal Shock | MIL-STD-202 Method 107 | -55°C/+125°C. Note: Number of cycles required – 300. Maximum transfer time – 20 seconds. D14 dwell time – 15 minutes. Air – Air. |
| High Temperature Life | MIL-STD-202 Method 108 /EIA -198 | 1,000 hours at 125°C (85°C for X5R, Z5U and Y5V) with rated voltage applied. |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC, for 1,000 hours. |
| Vibration | MIL-STD-202 Method 204 | 5 g for 20 minutes, 12 cycles each of 3 orientations. Note: Use 8 "X5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10–2,000 Hz. |
| Resistance to Soldering Heat | MIL-STD-202 Method 210 | Condition B. No preheat of samples. Note: single wave solder – procedure 2. |
| Terminal Strength | MIL-STD-202 Method 211 | Conditions A (2.3 kg or 5 lbs). |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Condition F. |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction



Product Marking

Product marking is an extra-cost option. These devises will be supplied unmarked unless otherwise specified and/or requested. For more detailed information regarding marked product and how to request this option, please contact KEMET.



Overview

The KEMET ArcShield high voltage surface mount capacitors in X7R dielectric are designed for use in high voltage applications susceptible to surface arcing (arc-over discharge).

The phenomenon of surface arcing is caused by a high voltage gradient between the two termination surfaces or between one of the termination surfaces and the counter internal electrode structure within the ceramic body. It occurs most frequently at application voltages that meet or exceed 300 V, in high humidity environments, and in chip sizes with minimal bandwidth separation (creepage distance). This phenomenon can either damage surrounding components or lead to a breakdown of the dielectric material, ultimately resulting in a short circuit condition (catastrophic failure mode).

Patented ArcShield technology features KEMET's highly reliable base metal dielectric system, combined with a unique internal shield electrode structure that is designed to suppress an arcover event while increasing available capacitance. Developed on the principle of a partial Faraday cage, this internal system offers unrivaled performance and reliability when compared to external surface coating technologies.

For added reliability, KEMET's flexible termination technology is an available option that provides superior flex performance over standard termination systems. This technology was developed to address flex cracks, which are the primary failure mode of MLCCs and typically the result of excessive tensile and shear stresses produced during board flexure and thermal cycling. Flexible termination technology inhibits the transfer of board stress to the rigid body of the MLCC, therefore mitigating flex cracks which can result in low IR or short circuit failures.

The KEMET ArcShield high voltage surface mount MLCCs are available in automotive grade, which undergo stricter testing protocol and inspection criteria. Whether underhood or in-cabin, these devices are designed for mission and safety-critical automotive circuits or applications requiring proven, reliable performance in harsh environments. Automotive grade devices meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.



Ordering Information

| С | 0603 | W | 392 | K | С | R | Α | C | TU |
|---------|--|--|--|---------------------------------|---------------------------------|------------|----------------------------|---|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ¹ | Packaging/ Grade (C-Spec)² |
| | 0603 0805 1206 1210 1808 1812 1825 2220 2225 | V = ArcShield W = ArcShield with flexible termination | Two significant digits and number of zeros. | J = ±5% K = ±10% M = ±20% | C = 500 B = 630 D = 1,000 | R = X7R | A = N/A | C = 100% Matte Sn L = SnPb (5% PB minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ Additional termination finish options may be available. Contact KEMET for details.

^{1, 2} SnPb termination finish option is not available on automotive grade product.

² Additional reeling or packaging options may be available. Contact KEMET for details.

Built Into Tomorrow



Packaging C-Spec Ordering Options Table

| Packaging Type | Packaging/Grade Ordering Code (C-Spec) | | | | | | |
|---|---|--|--|--|--|--|--|
| Commercial Grade ¹ | | | | | | | |
| Bulk Bag | Not Required (Blank) | | | | | | |
| 7" Reel/Unmarked | TU | | | | | | |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) | | | | | | |
| 7" Reel/Marked | ТМ | | | | | | |
| 13" Reel/Marked | 7040 (EIA 0603) 7215 (EIA 0805 and larger case sizes) | | | | | | |
| 7" Reel/Unmarked/2 mm pitch₂ | 7081 | | | | | | |
| 13" Reel/Unmarked/2 mm pitch ² | 7082 | | | | | | |
| Automoti | ve Grade ³ | | | | | | |
| 7" Reel | AUTO | | | | | | |
| 13" Reel/Unmarked | AUT07411 (EIA 0603 and smaller case sizes) AUT07210 (EIA 0805 and larger case sizes) | | | | | | |
| 7" Reel/Unmarked/2 mm pitch ² | 3190 | | | | | | |
| 13" Reel/Unmarked/2 mm pitch ² | 3191 | | | | | | |

¹ Default packaging is "Bulk Bag." An ordering code C-Spec is not required for "Bulk Bag" packaging.

- ¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked.
- ² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information."
- ³ Reeling tape options (paper or plastic) are dependent on capacitor case size (L x W) and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information."
- ³ For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information."
- ³ All Automotive packaging C-Specs listed exclude the option to laser mark components. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking."

Benefits

- · Patented technology
- Permanent internal arc protection
- · Protective surface coating not required
- · Base metal electrode (BME) dielectric system
- Industry leading CV values
- -55°C to +125°C operating temperature range
- Exceptional performance at high frequencies
- · Lead (Pb)-free, RoHS and REACH compliant
- EIA 0603, 0805, 1206, 1210, 1808, 1812, 1825, 2220, and 2225 case sizes
- DC voltage ratings of 500 V, 630 V and 1 KV

- · Capacitance offerings ranging from 1,000 pF to 560 nF
- Available capacitance tolerances of ±5%, ±10% and ±20%
- Low ESR and ESL
- · Non-polar device, minimizing installation concerns
- Commercial and Automotive (AEC-Q200) grades available
- 100% pure matte tin-plated termination finish allowing for excellent solderability
- SnPb plated termination finish option available upon request (5% Pb minimum)
- · Flexible termination option available upon request



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | Days Prior To | | | |
|-----------------------------|----------------------------------|---------------|------------------|--|--|
| C-Spec | Process/Product change | Obsolescence* | Implementation | | |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum | | |
| AUTO | AUTO Yes (without approval) | | 90 days minimum | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | PPAP (Product Part Approval Process) Level | | | | | | | | | |
|-----------------------------|--|---|---|---|---|--|--|--|--|--|
| C-Spec | 1 | 2 | 3 | 4 | 5 | | | | | |
| KEMET assigned ¹ | • | • | • | • | • | | | | | |
| AUTO | | | 0 | | | | | | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Applications

Typical applications include switch mode power supplies (input filters, resonators, tank circuits, snubber circuits, output filters), high voltage coupling and DC blocking, lighting ballasts, voltage multiplier circuits, DC/DC converters and coupling capacitors in Ćuk converters. Markets include power supply, LCD fluorescent backlight ballasts, HID lighting, telecom equipment, industrial and medical equipment/control, LAN/WAN interface, analog and digital modems, and automotive (electric and hybrid vehicles, charging stations and lighting) applications.

Application Notes

X7R dielectric is not recommended for AC line filtering or pulse applications.



Dimensions - Millimeters (Inches) - Standard Termination



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique | |
|------------------|---------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|----------------------------|---------------------------------|--|
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | | |
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave or Solder Reflow | |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | | | |
| 1210 | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | | Solder Reflow Only | |
| 1808 | 4520 | 4.70 (0.185) ±0.50 (0.020) | 2.00 (0.079) ±0.20 (0.008) | See Table 2 for Thickness | 0.60 (0.024) ±0.35 (0.014) | | | |
| 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | | 0.60 (0.024) ±0.35 (0.014) | N/A | | |
| 1825 | 4564 | 4.50 (0.177) ±0.30 (0.012) | 6.40 (0.252) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | | |
| 2220 | 5650 | 5.70 (0.224) ±0.40 (0.016) | 5.00 (0.197) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | | |
| 2225 | 5664 | 5.60 (0.220) ±0.40 (0.016) | 6.40 (0.248) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | | |

Dimensions – Millimeters (Inches) – Flexible Termination

| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique | |
|------------------|---------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|----------------------------|---------------------------------|--|
| 0603 | 1608 | 1.60 (0.064) ±0.17 (0.007) | 0.80 (0.032) ±0.15 (0.006) | | 0.45 (0.018) ±0.15 (0.006) | 0.58 (0.023) | | |
| 0805 | 2012 | 2.00 (0.079) ±0.30 (0.012) | 1.25 (0.049) ±0.30 (0.012) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave or Solder Reflow | |
| 1206 | 3216 | 3.30 (0.130) ±0.40 (0.016) | 1.60 (0.063) ±0.35 (0.013) | | 0.60 (0.024) ±0.25 (0.010) | | | |
| 1210 | 3225 | 3.30 (0.130) ±0.40 (0.016) | 2.60 (0.102) ±0.30 (0.012) | | 0.60 (0.024) ±0.25 (0.010) | | Solder Reflow Only | |
| 1808 | 4520 | 4.70 (0.185) ±0.50 (0.020) | 2.00 (0.079) ±0.20 (0.008) | See Table 2 for Thickness | 0.70 (0.028) ±0.35 (0.014) | | | |
| 1812 | 4532 | 4.50 (0.178) ±0.40 (0.016) | 3.20 (0.126) ±0.30 (0.012) | | 0.70 (0.028) ±0.35 (0.014) | N/A | | |
| 1825 | 4564 | 4.60 (0.181) ±0.40 (0.016) | 6.40 (0.252) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | - | | |
| 2220 | 5650 | 5.90 (0.232) ±0.75 (0.030) | 5.00 (0.197) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | | |
| 2225 | 5664 | 5.90 (0.232) ±0.75 (0.030) | 6.40 (0.248) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | | |



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 Vdc Applied (TCC) | ±15% |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| ² Dielectric Withstanding Voltage (DWV) | 150% of rated voltage for voltage rating of < 1000V 120% of rated voltage for voltage rating of ≥ 1000V (5±1 seconds and charge/discharge not exceeding 50mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | 2.5% |
| ⁴ Insulation Resistance (IR) Minimum Limit at 25°C | 100 megohm microfarads or 10GΩ (500VDC applied for 120±5 seconds at 25°C) |

¹ Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours.

² DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

³ Capacitance and dissipation factor (DF) measured under the following conditions:

1kHz ± 50Hz and 1.0 ± 0.2 Vrms if capacitance ≤10 μ F

120Hz \pm 10Hz and 0.5 \pm 0.1 Vrms if capacitance >10 μF

⁴ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 & Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON".

Post Environmental Limits

| High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | | | | |
|---|---------------------|----------------------|-----------------------------------|----------------------|--------------------------|--|--|--|--|--|--|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | | | | | | |
| X7R | > 25 | | 3.0 | | | | | | | | |
| | 16/25 | All | 5.0 | ±20% | 10% of Initial Limit | | | | | | |
| | < 16 | | 7.5 | | | | | | | | |



Table 1 – Capacitance Range/Selection Waterfall (0603 – 1812 Case Sizes)

| | Case Seri | | se S Serie | ize/ es | C0603W/V | | N/V | C0805W/V | | | C1206W/V | | C1210W/V | | C1808W/V | | C1812W/V | | C1825W/V | | C2220W/V | | C2225W/V | | | | | |
|-----------|----------------------|-------------|-----------------|------------|----------|---|------|----------|-----|-------------------|----------|----------------|----------|-----|-------------------|------|----------|----------|----------|---------------|----------|-------|----------|-----|----------|-----|-----|-----|
| Can | Cap | Vol | tage C | Code | C | В | D | С | В | D | C | В | D | C | В | D | C | В | D | С | В | D | C | В | С | В | С | В |
| Oap | Code | Rate | ed Vol | tage | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 500 | 630 | 500 | 630 |
| | | | (VDC) |) | | | | | | | | | | | | | | | 01.1 | T 1.1. | | | | | | | | |
| | | Capacitance | | | | See Table 2 for Chip Thickness Dimensions | | | | | | | | | | | | | | | | | | | | | | |
| 1 000 pE | 102 | | K | M | 00 | 00 | 00 | | | | | | | | Tubi | | | | | | | 51011 | , | | | | | |
| 1,000 pr | 122 | J | ĸ | M | CG | CG | | | | | | | | | | | | | | | | | | | | | | |
| 1,500 pF | 152 | Ĵ | ĸ | M | CG | CG | | | | | | | | | | | | | | | | | | | | | | |
| 1,800 pF | 182 | J | K | M | CG | | | | | | | | | | | | | | | | | | | | | | | |
| 2,200 pF | 222 | J | к | М | CG | | | DG | DG | DG | | | | | | | | | | | | | | | | | | |
| 2,700 pF | 272 | J | К | М | CG | | | DG | DG | DG | | | | | | | | | | | | | | | | | | |
| 3,300 pF | 332 | J | К | M | CG | | | DG | DG | DG | | | | | | | | | | | | | | | | | | |
| 3,900 pF | 392 | J | К | M | CG | | | DG | DG | DG | | | | | | | | | | | | | | | | | | |
| 4,700 pF | 472 | J | К | M | | | | DG | DG | DG | | | | | | | | | | | | | | | | | | |
| 5,600 pF | 562 | J | K | M | | | | DG | DG | | | | | | | | | | | | | | | | | | | |
| 6,800 pF | 682 | J | K | M | | | | DG | DG | | | | | | | | | | | | | | | | | | | |
| 8,200 pF | 822 | J | K | M | | | | DG | DG | | | | | | | | | | | | | | | | | | | |
| 10,000 pF | 103 | J | K | M | | | | DG | DG | | | | | | | | | | | | | | | | | | | |
| 12,000 pF | 123 | J | K | M | | | | DG | DG | | EJ | EJ | EJ | | | | | | | | | | | | | | | |
| 15,000 pF | 153 | J | K | M | | | | DG | | | EJ | EJ | EJ | | | | | | | | | | | | | | | |
| 18,000 pF | 183 | J | K | M | | | | DG | | | EJ | EJ | EJ | | | | LE | LE | LE | | | | | | | | | |
| 22,000 pF | 223 | J | K | M | | | | DG | | | EJ | EJ | EJ | FZ | FZ | FZ | LE | LE | LE | | | | | | | | | |
| 27,000 pF | 273 | J | K | M | | | | | | | EJ | EJ | | FZ | FZ | FZ | LA | LA | LA | GB | GB | GB | | | | | | |
| 33,000 pF | 333 | J | K | M | | | | | | | EJ | EJ | | FZ | FZ | FU | LA | LA | LA | GB | GB | GB | | | | | | |
| 39,000 pF | 393 | J | K | M | | | | | | | EJ | | | +2 | FZ | FU | LA | LA | LA | GB | GB | GB | | | | | | |
| 47,000 pF | 4/3 | J | K | M | | | | | | | EJ | | | | FU | FK | LA | LA | LB | GB | GB | GC | | | | | | |
| 50,000 pF | 503 | J | ĸ | | | | | | | | EJ | | | | FU | FK | | | LB | GB | GB | GE | | | | | | |
| 62,000 pF | 623 | J | ĸ | | | | | | | | EJ | | | | FK | F5 | | | | GB | GB | GE | | | | | | |
| 08,000 pF | 003 | J | r v | IVI | | | | | | | EJ | | | | | гэ | | | LC | GE | GE | GE | | | | | | |
| 0 10 uF | 104 | 1 | K | M | | | | | | | | | | FK | FS | | | | | GB | GH | GL | | | | | | |
| 0.10 µF | 124 | .1 | ĸ | M | | | | | | | | | | FK | 15 | | | | | GF | GK | 00 | HF | HF | | | | |
| 0.12 µF | 154 | .1 | ĸ | M | | | | | | | | | | FK | | | IR | | | GF | GN | | HF | HE | JE | JE | | |
| 0.18 µF | 184 | J | ĸ | M | | | | | | | | | | | | | | | | GF | | | HF | HG | JE | JE | KF | KF |
| 0.22 uF | 224 | J | ĸ | M | | | | | | | | | | | | | | | | GJ | | | HG | HJ | JK | JK | KE | KF |
| 0.27 µF | 274 | J | K | M | | | | | | | | | | | | | | | | GL | | | HJ | HJ | JK | JL | KF | KH |
| 0.33 µF | 334 | J | K | M | | | | | | | | | | | | | | | | GS | | | HJ | | JL | JN | KF | KH |
| 0.39 µF | 394 | J | К | М | | | | | | | | | | | | | | | | | | | НК | | JN | | КН | KJ |
| 0.47 µF | 474 | J | К | М | | | | | | | | | | | | | | | | | | | | | JN | | КН | KJ |
| 0.56 µF | 564 | J | K | M | | | | | | | | | | | | | | | | | | | | | | | KJ | |
| | | Rate | ed Vol | tage | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 500 | 630 | 500 | 630 |
| Can | Cap | Vol | (VDC) tage (|) Code | с | в | D | с | в | D | с | В | D | с | В | D | с | в | D | с | в | D | c | В | c | В | c | В |
| Joup | Code | | co Ci | 70/ | ۴, | | | ۴, | 5 | | L. | | | Ļ | - | | ۴, | - | <u> </u> | ĻŤ | | | ⊢ Ŭ | | <u> </u> | - | L _ | - |
| | Case Size/ Series | | 2e/ S | C0603W/V | | C0805W/V | | | C1 | C1206W/V C1210W/V | | C1808W/V C1812 | | | C1812W/V C1825W/V | | 5W/V | C2220W/V | | C2225W/V | | | | | | | | |

These products are protected under US Patents 8,885,319 B2 and 9,490,072 B2, other patents pending, and any foreign counterparts. KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).



Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic Quantity | | | | |
|-----------|-------------------|--------------|---------|----------------------|------------------|----------|--|--|--|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | | |
| CG | 603 | 0.80 ± 0.10* | 4000 | 15000 | 0 | 0 | | | |
| DG | 805 | 1.25 ± 0.15 | 0 | 0 | 2500 | 10000 | | | |
| EJ | 1206 | 1.70 ± 0.20 | 0 | 0 | 2000 | 8000 | | | |
| FZ | 1210 | 1.25 ± 0.20 | 0 | 0 | 2500 | 10000 | | | |
| FU | 1210 | 1.55 ± 0.20 | 0 | 0 | 2000 | 8000 | | | |
| FK | 1210 | 2.10 ± 0.20 | 0 | 0 | 2000 | 8000 | | | |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1000 | 4000 | | | |
| LE | 1808 | 1.00 ± 0.10 | 0 | 0 | 2500 | 10000 | | | |
| LA | 1808 | 1.40 ± 0.15 | 0 | 0 | 1000 | 4000 | | | |
| LB | 1808 | 1.60 ± 0.15 | 0 | 0 | 1000 | 4000 | | | |
| LC | 1808 | 2.00 ± 0.15 | 0 | 0 | 1000 | 4000 | | | |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1000 | 4000 | | | |
| GE | 1812 | 1.30 ± 0.10 | 0 | 0 | 1000 | 4000 | | | |
| GF | 1812 | 1.50 ± 0.10 | 0 | 0 | 1000 | 4000 | | | |
| GJ | 1812 | 1.70 ± 0.15 | 0 | 0 | 1000 | 4000 | | | |
| GL | 1812 | 1.90 ± 0.20 | 0 | 0 | 500 | 2000 | | | |
| GS | 1812 | 2.10 ± 0.20 | 0 | 0 | 500 | 2000 | | | |
| GC | 1812 | 1.10 ± 0.10 | 0 | 0 | 1,000 | 4,000 | | | |
| GH | 1812 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | | | |
| GK | 1812 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 | | | |
| GN | 1812 | 1.70 ± 0.20 | 0 | 0 | 1,000 | 4,000 | | | |
| HE | 1825 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | | | |
| HG | 1825 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 | | | |
| HJ | 1825 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 | | | |
| HK | 1825 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 | | | |
| JE | 2220 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | | | |
| JK | 2220 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 | | | |
| JL | 2220 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 | | | |
| JN | 2220 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 | | | |
| KE | 2225 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | | | |
| KF | 2225 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 | | | |
| KH | 2225 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 | | | |
| KJ | 2225 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 | | | |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | | |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic Quantity | | | | |

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information."


Table 2B – Bulk Packaging Quantities

| Deeke | ving Type | Loose Pa | ackaging | | | | |
|----------|------------------------|------------------------|--|--|--|--|--|
| Раска | Jing Type | Bulk Bag (default) | | | | | |
| Packagi | ng C-Spec ¹ | N, | N/A ² | | | | |
| Cas | e Size | Packaging Quantities (| Packaging Quantities (pieces/unit packaging) | | | | |
| EIA (in) | Metric (mm) | Minimum | Maximum | | | | |
| 0402 | 1005 | | | | | | |
| 0603 | 1608 | | | | | | |
| 0805 | 2012 | | 50,000 | | | | |
| 1206 | 3216 | | | | | | |
| 1210 | 3225 | 1 | | | | | |
| 1808 | 4520 | | | | | | |
| 1812 | 4532 | | | | | | |
| 1825 | 4564 | | 20,000 | | | | |
| 2220 | 5650 | | | | | | |
| 2225 | 5664 | | | | | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial Grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive Grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3A – Land Pattern Design Recommendations per IPC-7351 – Standard Termination

| EIA Size | Metric Size | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | | |
|-------------|----------------|--|------|------|------|--|------|------|---|------|------|------|------|------|------|------|
| Coue | Coue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 1.50 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 |
| 1825 | 4564 | 2.15 | 1.60 | 6.90 | 6.90 | 7.90 | 2.05 | 1.40 | 6.80 | 6.00 | 7.30 | 1.95 | 1.20 | 6.70 | 5.30 | 7.00 |
| 2220 | 5650 | 2.75 | 1.70 | 5.50 | 8.20 | 6.50 | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | 2.55 | 1.30 | 5.30 | 6.60 | 5.60 |
| 2225 | 5664 | 2.70 | 1.70 | 6.90 | 8.10 | 7.90 | 2.60 | 1.50 | 6.80 | 7.20 | 7.30 | 2.50 | 1.30 | 6.70 | 6.50 | 7.00 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1210 case size.





Table 3B - Land Pattern Design Recommendations per IPC-7351 - Flexible Termination

| EIA Size | Metric Size | | Density Level A: Maximum (Most) Land Protrusion (mm) | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | | |
|-------------|----------------|------|--|------|------|--|------|------|---|------|------|------|------|------|------|------|
| Coue | Coue | С | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0603 | 1608 | 0.85 | 1.25 | 1.10 | 4.00 | 2.10 | 0.75 | 1.05 | 1.00 | 3.10 | 1.50 | 0.65 | 0.85 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 0.99 | 1.44 | 1.66 | 4.47 | 2.71 | 0.89 | 1.24 | 1.56 | 3.57 | 2.11 | 0.79 | 1.04 | 1.46 | 2.42 | 1.81 |
| 1206 | 3216 | 1.59 | 1.62 | 2.06 | 5.85 | 3.06 | 1.49 | 1.42 | 1.96 | 4.95 | 2.46 | 1.39 | 1.22 | 1.86 | 4.25 | 2.16 |
| 1210 | 3225 | 1.59 | 1.62 | 3.01 | 5.90 | 4.01 | 1.49 | 1.42 | 2.91 | 4.95 | 3.41 | 1.39 | 1.22 | 2.81 | 4.25 | 3.11 |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 |
| 1812 | 4532 | 2.10 | 1.80 | 3.60 | 7.00 | 4.60 | 2.00 | 1.60 | 3.50 | 6.10 | 4.00 | 1.90 | 1.40 | 3.40 | 5.40 | 3.70 |
| 1825 | 4564 | 2.15 | 1.80 | 6.90 | 7.10 | 7.90 | 2.05 | 1.60 | 6.80 | 6.20 | 7.30 | 1.95 | 1.40 | 6.70 | 5.50 | 7.00 |
| 2220 | 5650 | 2.85 | 2.10 | 5.50 | 8.80 | 6.50 | 2.75 | 1.90 | 5.40 | 7.90 | 5.90 | 2.65 | 1.70 | 5.30 | 7.20 | 5.60 |
| 2225 | 5664 | 2.85 | 2.10 | 6.90 | 8.80 | 7.90 | 2.75 | 1.90 | 6.80 | 7.90 | 7.30 | 2.65 | 1.70 | 6.70 | 7.20 | 7.00 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

The KEMET families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Terminat | ion Finish |
|--|-----------------------|-----------------------|
| Fromereature | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate (T_L to T_p) | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T _L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T^{P} to T_{L})$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |

Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method |
|------------------------|---------------------------|--|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds. |
| Board Flex | JIS-C-6429 | Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm for COG. Flexible termination system – 3.0 mm (minimum). |
| | | Magnification 50 X. Conditions: |
| Soldorobility | 1-570-002 | a) Method B, 4 hours at 155°C, dry heat at 235°C |
| Solderability | J-31D-002 | b) Method B, category 3, at 215°C |
| | | c) Method D, category 3, at 260°C |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to +125°C). Measurement at 24 hours ± 4 hours after test conclusion. |
| Discod Llumidity | MIL-STD-202 | Load humidity: 1,000 hours 85°C/85% RH and 200 VDC maximum. Add 100 K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. |
| Blased Hullilulty | Method 103 | Low volt humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Unpowered. Measurement at 24 hours ± 4 hours after test conclusion. |
| Thermal Shock | MIL-STD-202 Method 107 | -55°C/+125°C. Note: Number of cycles required – 300. Maximum transfer time – 20 seconds. Dwell time – 15 minutes. Air – air. |
| High Temperature Life | MIL-STD-202 Method 108 | 1,000 hours at 125°C (85°C for X5R, Z5U and Y5V) with 1.2 X rated voltage applied. |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC for 1,000 hours. |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Condition F. |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. |

Storage & Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction – Standard Termination



Construction – Flexible Termination





Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a "K" to identify KEMET, followed by two characters (per EIA–198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the "K" character only.

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.
- X7R dielectric products in capacitance values outlined below.

| EIA Case Size | Metric Size Code | Capacitance |
|---------------|------------------|-------------|
| 0603 | 1608 | ≤ 170 pF |
| 0805 | 2012 | ≤ 150 pF |
| 1206 | 3216 | ≤ 910 pF |
| 1210 | 3225 | ≤ 2,000 pF |
| 1808 | 4520 | ≤ 3,900 pF |
| 1812 | 4532 | ≤ 6,700 pF |
| 1825 | 4564 | ≤ 0.018 µF |
| 2220 | 5650 | ≤ 0.027 µF |
| 2225 | 5664 | ≤ 0.033 µF |

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 μ F. Orientation of marking is vendor optional.





Capacitor Marking (Optional) cont.

| | Capacitance (pF) For Various Alpha/Numeral Identifiers | | | | | | | | | |
|-----------|--|-----|----|-----|-------|----------|---------|-----------|------------|-------------|
| Alaba | | | | | | Numera | d I | | | |
| Alpila | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Character | | | | | Capa | acitance | e (pF) | | | |
| A | 0.10 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 |
| Н | 0.20 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 |
| М | 0.30 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 |
| d | 0.40 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 |
| f | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 |
| у | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punche | d Paper | |
|----------------------|------|--------------------------|------------|--------------------------|----------|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | (W)* | Pitch (P ₁)* | | Pitch (P ₁)* | | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 | |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | |
| Array 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P₁ carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 16 mm | | (0.059) | | (1.181) | (1.181) | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | Note 5 | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions — Millimeters (Inches) | | | | | | | | |
|-----------|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant | Dimensions — Millimete | rs (Inches) | | | | | | | | | |
|-----------|--|---------------------------------------|--|--|--|--|--|--|--|--|--|--|
| Tape Size | А | B Minimum | C | D Minimum | | | | | | | | |
| 8 mm | 178 ±0.20 | | | | | | | | | | | |
| 12 mm | Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | | | | | | |
| 16 mm | (13.000 ±0.008) | | X | | | | | | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | | | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | | | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | | | | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber



Pulse Discharge, High Voltage, High Temperature 200°C COG Dielectric, 1,000 VDC – 3,500 VDC (Industrial Grade)



Overview

KEMET's Industrial Grade Pulse Discharge Series surface mount capacitors in COG Dielectric deliver reliable high voltage and high temperature performance required for operation in harsh environments, specifically discharge circuitry. Constructed of a robust and proprietary base metal electrode (BME) dielectric system, these devices offer industry-leading performance relative to capacitance and case size. KEMET Pulse Discharge capacitors average greater than 30% higher breakdown voltage than competitive precious metal electrode (PME) devices with similar capacitance & voltage ratings.

Designed for down-hole oil exploration and perforation, these devices feature a 200°C maximum operating temperature. The Electronics Industries Alliance (EIA) characterizes COG dielectric as a Class I material. Components of this classification are temperature compensating and are suited for resonant circuit applications or those where Q and stability of capacitance characteristics are required. Pulse Discharge series capacitors in COG dielectric exhibit no change in capacitance with respect to time and voltage and boast a negligible change in capacitance with reference to ambient temperature. These devices retain high insulation resistance with low dissipation factor at elevated temperatures up 200°C.

KEMET's Pulse Discharge surface mount MLCCs are manufactured in state-of-the-art ISO/TS 16949:2009 certified facilities and are proven to function reliably in harsh, high temperature and high humidity, down-hole environments.



Ordering Information

| С | 2824 | Н | 393 | K | U | G | W | C | TU |
|---------|------------------------------|------------------------------------|--|---------------------------------|---|------------|----------------------------|---|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Dielectric Withstanding Voltage (VDC) ¹ | Dielectric | Failure Rate/ Design | Termination Finish ² | Packaging/ Grade (C-Spec)³ |
| | 2824 3040 3640 4540 | H = High temperature (200°C) | Two significant digits and number of zeros | J = ±5% K = ±10% M = ±20% | D = 1,000 U = 1,250 G = 2,000 H = 3,000 V = 3,500 | G = COG | W = Pulse discharge | C = 100% Matte Sn L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor. See waterfall table for working voltage.

² Additional termination finish options may be available. Contact KEMET for details.

³ Additional reeling or packaging options may be available. Contact KEMET for details.

1



Packaging C-Spec Ordering Options Table

| Packaging Type/Options ¹ | Packaging Ordering Code (C-Spec) ² |
|--|--|
| 7" Reel (Embossed Plastic Tape)/Unmarked | TU |
| 13" Reel (Embossed Plastic Tape)/Unmarked | 7210 |
| Reel (Embossed Plastic Tape)/Unmarked – 50 pieces | Т050 |
| Reel (Embossed Plastic Tape)/Unmarked – 100 pieces | T100 |
| Reel (Embossed Plastic Tape)/Unmarked – 250 pieces | T250 |
| Reel (Embossed Plastic Tape)/Unmarked – 500 pieces | Т500 |
| Reel (Embossed Plastic Tape)/Unmarked – 1,000 pieces | T1K0 |

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of components. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices.

² Reeling quantities are dependent upon chip size and thickness dimension. When ordering using the "Txxx" packaging ordering codes (C-Specs) outlined above, product may be shipped on multiple 7" reels or a single 13" reel. Additional reeling or packaging options may be available. Contact KEMET for details.

Benefits

- Operating temperature range of -55°C to +200°C
- Lead (Pb)-free, RoHS and REACH compliant
- Base metal technology
- Higher UVBD capability than competitive dielectric technologies
- · Capacitance offerings ranging from 2.2 nF up to 150 nF
- Available capacitance tolerances of ±5%, ±10% or ±20%
- Extremely low ESR and ESL
- High thermal stability

- · High ripple current capability
- No capacitance change with respect to applied rated DC voltage
- Negligible capacitance change with respect to temperature from -55°C to +200°C
- · No capacitance decay with time
- · Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish allowing for excellent solderability

Applications

Typical applications include high temperature discharge circuits for munitions and down-hole oil exploration/perforation.



Dimensions – Millimeters (Inches)



| Size Code | L Length | W T Width Maximum | | B Bandwidth | S Separation Minimum | Mounting Technique |
|--------------|-----------------------------|-----------------------------|-------------|----------------|----------------------------|-----------------------|
| 2824 | 7.10±0.40 (0.280±0.016) | 6.10±0.40 (0.240±0.016) | | | | |
| 3040 3640 | 7.60±0.40 (0.300±0.016) | 10.20±0.40 (0.402±0.016) | Coo Toblo 2 | 1.27±0.40 | N/A | Solder |
| | 9.10±0.40 (0.358±0.016) | 10.20±0.40 (0.402±0.016) | See Table 2 | (0.050±0.016) | N/A | Reflow Only |
| 4540 | 11.40±0.40 (0.449±0.016) | 10.20±0.40 (0.402±0.016) | | | | |

Qualification/Certification

Industrial grade pulse discharge products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance and Reliability.

Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions (excluding SnPb termination finish option).



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +200°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±30 ppm/°C |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 0% |
| ¹ Dielectric Withstanding Voltage (DWV) | See product selection table (product waterfall) for available ratings |
| ² Dissipation Factor (DF) Maximum Limit at 25°C | 0.1% |
| ³ Insulation Resistance (IR) Minimum Limit at 25°C | 1,000 megohm microfarads or 100 GΩ (500 VDC applied for 120±5 seconds at 25°C) |

¹ DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

² Capacitance and dissipation factor (DF) measured under the following conditions:

1 MHz ±100 kHz and 1.0 Vrms ±0.2 V if capacitance ≤ 1,000 pF

1 kHz ± 50 Hz and 1.0 Vrms ±0.2 V if capacitance > 1,000 pF

³ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

Post Environmental Limits

| I | High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | | | | | |
|------------|---|----------------------|-----------------------------------|----------------------|--------------------------|--|--|--|--|--|--|--|--|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | | | | | | | | |
| COG | All | All | 0.5 | 0.3% or ±0.25 pF | 10% of Initial Limit | | | | | | | | |

Electrical Characteristics



Energy Density vs. Applied Voltage

Discharge Current vs. Applied Voltage



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Table 1 – Pulse Discharge Series, Capacitance Range Waterfall

| | | Ca | ase Siz Series | ze/ s | | C | 2824 | 4H | | | C | 3040 | ЭН | | | C | 3640 | ЭН | | | C4 | 454(|)H | |
|--------------|------|---------|-------------------|----------|---------------------------------------|---------|------|------|------|-----|----------------|---------------|--------------------|------------------|------------------|------------------|----------------|-----------------|------|---|--------|------|------|------|
| | _ | V | oltage Co | de | D | U | G | Н | v | D | U | G | н | v | D | U | G | н | v | D | U | G | н | v |
| Canacitance | Сар | Dielect | ric Withs | tanding | 8 | 20 | 8 | 8 | 8 | 8 | 20 | 8 | 8 | 8 | 8 | 20 | 8 | 8 | 8 | 8 | 20 | 8 | 8 | 8 |
| oapacitance | Code | Vo | ltage (DV | NV) | Ę | 12 | 20 | 30 | 35 | Ę. | 12 | 20 | 30 | 35 | Ę | 12 | 20 | 30 | 35 | <u>1</u> | 12 | 20 | 30 | 35 |
| | | Wo | rking Vol | tage | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 |
| | | Capaci | itance To | lerance | | | | | | Р | roduc See 1 | t Ava able | ilabili 2 for (| ty and Chip 1 | d Chip Thickı |) Thic less [| kness)imen | s Code sions | es | | | | | |
| 1,800 pF | 182 | J | K | M | | | | | | | | | | | | | | | | | | | | |
| 2,000 pF | 202 | J | K | M | | | | | | | | | | | | | | | | | | | | |
| 2,200 pF | 222 | J | K | M | TA | TA | TA | TA | TA | | | | | | | | | | | | | | | |
| 2,700 pF | 272 | J | K | M | TA | TA | TA | TA | TA | | | | | | | | | | | | | | | |
| 3,300 pF | 332 | J | К | М | TA | TA | TA | TA | TA | QB | QB | QB | QB | QB | | | | | | | | | | |
| 3,900 pF | 392 | J | K | M | TA | TA | TA | TA | TB | QB | QB | QB | QB | QB | MA | MA | MA | MA | MA | | | | | |
| 4,700 pF | 472 | J | K | М | TA | TA | TA | TB | TB | QB | QB | QB | QB | QB | MA | MA | MA | MA | MA | SA | SA | SA | SA | SA |
| 5,600 pF | 562 | J | K | M | TA | TA | TA | TB | TC | QB | QB | QB | QB | QB | MA | MA | MA | MA | MA | SA | SA | SA | SA | SA |
| 6,800 pF | 682 | J | К | М | TA | TA | TA | TB | | QB | QB | QB | QB | QC | MA | MA | MA | MA | MA | SA | SA | SA | SA | SA |
| 8,200 pF | 822 | J | К | М | TA | TA | TA | TC | | QB | QB | QB | QC | QC | MA | MA | MA | MA | MB | SA | SA | SA | SA | SA |
| 10,000 pF | 103 | J | К | М | TA | TA | TA | | | QB | QB | QB | QC | QD | MA | MA | MA | MA | MB | SA | SA | SA | SA | SB |
| 12,000 pF | 123 | J | K | М | TA | TA | TA | | | QB | QB | QB | QD | | MA | MA | MA | MB | MB | SA | SA | SA | SA | SB |
| 15,000 pF | 153 | J | K | M | TA | TA | TB | | | QB | QB | QB | QD | | MA | MA | MA | MB | MC | SA | SA | SA | SB | SB |
| 18,000 pF | 183 | J | К | М | TA | TA | TB | | | QB | QB | QB | | | MA | MA | MA | MC | | SA | SA | SA | SB | SC |
| 22,000 pF | 223 | J | К | М | TA | TB | TC | | | QB | QB | QC | | | MA | MA | MA | | | SA | SA | SA | SB | |
| 27,000 pF | 273 | J | К | М | TA | TB | | | | QB | QB | QC | | | MA | MA | MA | | | SA | SA | SA | SC | |
| 33,000 pF | 333 | J | K | М | ТВ | TB | | | | QB | QC | QC | | | MA | MA | MB | | | SA | SA | SA | | |
| 39,000 pF | 393 | J | К | М | ТВ | TC | | | | QB | QC | QD | | | MA | MA | MB | | | SA | SA | SB | | |
| 47,000 pF | 473 | J | К | М | ТВ | | | | | QB | QC | | | | MA | MB | мс | | | SA | SA | SB | | |
| 56,000 pF | 563 | J | К | М | тс | | | | | QC | QD | | | | MA | MB | | | | SA | SA | SB | | |
| 68,000 pF | 683 | J | К | М | | | | | | QC | QD | | | | MB | мс | | | | SA | SB | SC | | |
| 82,000 pF | 823 | J | K | М | | | | | | QC | | | | | MB | | | | | SA | SB | | | |
| 0.10 µF | 104 | J | К | М | | | | | | QD | | | | | мс | | | | | SB | SC | | | |
| 0.12 µF | 124 | J | К | М | | | | | | | | | | | мс | | | | | SB | | | | |
| 0.15 µF | 154 | J | К | М | | | | | | 1 | | | | | | | | | | SC | | | | |
| | | Wo | rking Vol | tage | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 |
| Ormeriterret | Сар | Dielect | ric Withs | tanding | 80 | 1250 | 5000 | 3000 | 3500 | 80 | 1250 | 5000 | 3000 | 3500 | 00 | 1250 | 5000 | 3000 | 3500 | 000 | 1250 | 5000 | 3000 | 3500 |
| Capacitance | Code | | nitane Co | nde | | , II | G | н | v | | , II | G | н | v | | , U | G | н | v | D D | , U | G | н | v |
| | | | inage ou | | ـــــــــــــــــــــــــــــــــــــ | v | Ŭ | | • | Ľ | v | | | • | <u>ب</u> | | | | • | <u>ــــــــــــــــــــــــــــــــــــ</u> | | | | • |
| | | Case | e Size/S | eries | | C | 2824 | Н | | | C | 3040 | н | | | C | 3640 | н | | | С | 4540 | н | |

These products are protected under US Patents 7,172,985 and 7,670,981, other patents pending, and any foreign counterparts.

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| Thickness | Case | Thickness ± | Paper C |)uantity | Plastic (| Quantity | | |
|-----------|------|-------------|---------|----------|------------------|----------|--|--|
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | |
| TA | 2824 | 1.40 ± 0.15 | 0 | 0 | 750 | 2,500 | | |
| TB | 2824 | 2.00 ± 0.20 | 0 | 0 | 300 | 2,000 | | |
| TC | 2824 | 2.50 ± 0.20 | 0 | 0 | 300 | 2,000 | | |
| QB | 3040 | 1.40 ± 0.15 | 0 | 0 | 500 | 1,650 | | |
| QC | 3040 | 2.00 ± 0.20 | 0 | 0 | 500 | 1,650 | | |
| QD | 3040 | 2.50 ± 0.20 | 0 | 0 | 350 | 1,400 | | |
| MA | 3640 | 1.40 ± 0.15 | 0 | 0 | 250 | 1,550 | | |
| MB | 3640 | 2.00 ± 0.20 | 0 | 0 | 250 | 1,550 | | |
| MC | 3640 | 2.50 ± 0.20 | 0 | 0 | 250 | 1,000 | | |
| SA | 4540 | 1.40 ± 0.15 | 0 | 0 | 200 | 1,500 | | |
| SB | 4540 | 2.00 ± 0.20 | 0 | 0 | 200 | 1,500 | | |
| SC | 4540 | 2.50 ± 0.20 | 0 | 0 | 200 | 1,500 | | |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | |
| Code | Size | Range (mm) | Paper C | Juantity | Plastic Quantity | | | |

Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

Package quantity based on finished chip thickness specifications.

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Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| Size Code (In.) | Metric Size Code | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | | 1 | Dens Media Land Pi | sity Lev an (Nor rotrusio | vel B: ninal) on (mm |) | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | |
|-----------------------|------------------------|--|------|-------|-------|-------|------|--------------------------|---------------------------------|----------------------------|-------|---|------|-------|-------|-------|
| () | | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 2824 | 7260 | 3.45 | 1.70 | 6.60 | 9.60 | 7.60 | 3.35 | 1.50 | 6.50 | 8.70 | 7.00 | 3.25 | 1.30 | 6.40 | 8.00 | 6.70 |
| 3040 | 7610 | 3.70 | 1.70 | 10.70 | 10.10 | 11.70 | 3.60 | 1.50 | 10.60 | 9.20 | 11.10 | 3.50 | 1.30 | 10.50 | 8.50 | 10.80 |
| 3640 | 9210 | 4.45 | 1.70 | 10.70 | 11.60 | 11.70 | 4.35 | 1.50 | 10.60 | 10.70 | 11.10 | 4.25 | 1.30 | 10.50 | 10.00 | 10.80 |
| 4540 | - | 5.60 | 1.70 | 10.70 | 13.90 | 11.70 | 5.50 | 1.50 | 10.60 | 13.00 | 11.10 | 5.40 | 1.30 | 10.50 | 12.30 | 10.80 |

Density Level A: For low-density product applications. Provides a wider process window for reflow solder processes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations, the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for a 3640 case size.





Soldering Process

Recommended Soldering Technique:

Solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Terminat | ion Finish |
|--|-----------------------|-----------------------|
| Trome reduire | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate $(T_L to T_p)$ | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T _L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T_p to T_L)$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| F | Product Qualification Test Plan |
|--------------------------------|--|
| Reliability/F | Environmental Tests per MIL-STD-202//JESD22 |
| Load Humidity | 85°C/85%RH and 200 VDC maximum, 1,000 Hours |
| Low Voltage Humidity | 85°C/85%RH, 1.5V, 1,000 Hours |
| Temperature Cycling | -55°C to +200°C, 50 Cycles |
| Thermal Shock | -55°C to +150°C, 20 seconds transfer, 15 minute dwell, 300 Cycles |
| Moisture Resistance | Cycled Temp/RH 0 V, 10 cycles at 24 hours each |
| Physical, Mecha | nical & Process Tests per MIL-STD 202/JIS-C-6429 |
| Resistance to Solvents | Include Aqueous wash chemical – OKEM Clean or equivalent |
| Mechanical Shock and Vibration | Method 213: Figure 1, Condition F Method 204: 5 gs for 20 minutes, 12 cycles |
| Resistance to Soldering Heat | Condition B, no per-heat of samples, Single Wave Solder |
| Terminal Strength | Force of 1.8 kg for 60 seconds |
| Board Flex | Appendix 2, Note: 3.0 mm (minimum) |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.

9



Construction



Capacitor Marking (Optional):

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- · EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.

Packaging

Please contact kemet for details regarding available packaging options.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12, 16 and 24 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punche | | |
|-------------------|------|---------|--------------------|---------|----------|---|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | (W)* | Pitch | (P ₁)* | Pitch | | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 - | - |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| 2824 | 16 | 12 | 12 | | | |
| 3040 - 4540 | 24 | 16 | 16 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 & 2220 | 16 | 12 | 12 | | | |
| Array 0508 & 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs
- Double the parts on each reel results in fewer reel changes and increased efficiency
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|--|-------------------------------------|----------------------------|----------------------------|----------------------------|---------------------------|----------------------------------|--------------------------------|------------------|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T1 Maximum | |
| 8 mm | | | | | 25.0 (0.984) | | | | |
| 12 mm | 1.5+0.10/-0.0 (0.059+0.004/-0.0) | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.05 (0.079±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | |
| 16 mm | | | | | (1.181) | | | | |
| 24 mm | 1.5+0.10/-0.0 (0.059+0.004/-0.0) | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.10 (0.078±0.003) | 30 (1.181) | 5 (0.196) | 0.250 (0.009) | 0.350 (0.013) | |
| | | Varial | ble Dimensions | s – Millimeters | (Inches) | | | | |
| Tape Size | Pitch | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B ₀ | & K ₀ | |
| 8 mm | Single (4 mm) | 6.25 (0.246) | 3.5±0.05 (0.138±0.002) | 4.0±0.10 (0.157±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | |
| 12 mm | Single (4 mm) & Double (8 mm) | 10.25 (0.404) | 5.5±0.05 (0.217±0.002) | 8.0±0.10 (0.315±0.004) | 4.6 (0.181) | 12.3 (0.484) | Not | o F | |
| 16 mm | Triple (12 mm) | 14.25 (0.561) | 7.5±0.05 (0.138±0.002) | 12.0±0.10 (0.157±0.004) | 4.6 (0.181) | 16.3 (0.642) | NOL | сJ | |
| 24 mm | 16 mm | 22.25 (0.875) | 11.5±0.10 (0.452±0.003) | 16.0±0.10 (0.629±0.004) | 3 (0.118) | 24.3 (0.956) | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6).

3. If S₁ < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Standard 481 paragraph 4.3 section b).

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3).

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4).

(e) for KPS Series product, A_0 and B_0 are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.

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Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | | | |
|--|-------------------------------------|----------------------------|---------------------------|---------------------------|----------------------------|-----------------|-------------------------------|--|--|
| Tape Size | D ₀ | E ₁ | Po | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | |
| 8 mm | 1.5+0.10/-0.0 (0.059+0.004/-0.0) | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.05 (0.079±0.002) | 0.10 (0.004) Maximum | 0.75 (0.030) | 2 (0.984) | | |
| Variable Dimensions – Millimeters (Inches) | | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5±0.05 | 2.0±0.05 (0.079±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138±0.002) | 4.0±0.10 (0.157±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3).

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4).

e) see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6).



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 Kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |
| 24 mm | 0.1 to 1.6 newton (10 to 160 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ±10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | | | |
|--|-------------------|-------------------------------------|---------------------------------------|----------------------------|--|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | | | |
| 8 mm | 170:0.00 | | | | | | | | |
| 12 mm | (7.008 ± 0.008) | 1.5 (0.059) | 13.0+0.5/-0.2 (0.521+0.02/-0.008) | 20.2 (0.795) | | | | | |
| 16 mm | or 330±0.20 | | | | | | | | |
| 24 mm | (13.000±0.008) | 1.2 (0.047) | 13.0 + -0.2 (0.521 + -0.008) | 21 (0.826) | | | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | | |
| 8 mm | | 8.4+1.5/-0.0 (0.331+0.059/-0.0) | 14.4 (0.567) | | | | | | |
| 12 mm | 50 | 12.4+2.0/-0.0 (0.488+0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape | | | | | |
| 16 mm | (1.969) | 16.4+2.0/-0.0 (0.646+0.078/-0.0) | 22.4 (0.882) | width without interference | | | | | |
| 24 mm | | 25+1.0/-0.0 (0.984+0.039/-0.0) | 27.4+1.0/-1.0 (1.078+0.039/-0.039) | | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Overview

KEMET Power Solutions (KPS) High Voltage stacked capacitors utilize a proprietary lead-frame technology to vertically stack one or two multilayer ceramic chip capacitors into a single compact surface mount package. The attached lead-frame mechanically isolates the capacitor(s) from the printed circuit board, thereby offering advanced mechanical and thermal stress performance. Isolation also addresses concerns for audible microphonic noise that may occur when a bias voltage is applied. A two-chip stack offers up to double the capacitance in the same or smaller design footprint when compared to traditional surface mount MLCC devices. Providing up to 10 mm of board flex capability, KPS Series High Voltage capacitors are environmentally friendly and in compliance with RoHS legislation. KEMET's KPS Series devices in X7R dielectric exhibit a predictable change in capacitance with respect to time and voltage, and boast a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to $\pm 15\%$ from -55° C to $\pm 125^{\circ}$ C. These devices are capable of Pb-Free reflow profiles and provide lower ESR, ESL and higher ripple current capability when compared to other dielectric solutions.

Conventional uses include both snubbers and filters in applications such as switching power supplies and lighting ballasts. Their exceptional performance at high frequencies has made high voltage ceramic capacitors the preferred dielectric choice of design engineers worldwide. In addition to their use in power supplies, these capacitors are widely used in industries related to automotive (hybrid), telecommunications, medical, military, aerospace, semiconductors, and test/diagnostic equipment.

Benefits

- -55°C to +125°C operating temperature range
- Reliable and robust termination system
- EIA 2220 case size
- DC voltage ratings of 500 V and 630 V
- Capacitance offerings ranging from 0.047 μF up to 1.0 μF
- Available capacitance tolerances of ±10% and ±20%
- · Higher capacitance in the same footprint
- · Potential board space savings

Ordering Information



¹ Double chip stacks ("2" in the 13th character position of the ordering code) are only available in M (±20%) capacitance tolerance. Single chip stacks ("1" in the 13th character position of the ordering code) are available in K (±10%) or M (±20%) tolerances.

² Additional leadframe finish options may be available. Contact KEMET for details.

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Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) ² | | |
|---|--|--|--|
| 7" Reel (Embossed Plastic Tape)/Unmarked | 7186 | | |
| 13" Reel (Embossed Plastic Tape)/Unmarked | 7289 | | |

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices. For more information see "Capacitor Marking".

Benefits cont.

- Advanced protection against thermal and mechanical stress
- · Provides up to 10 mm of board flex capability
- Reduces audible microphonic noise
- Extremely low ESR and ESL

- · Lead (Pb)-free, RoHS and REACH compliant
- · Capable of Pb-free reflow profiles
- · Non-polar device, minimizing installation concerns
- · Film alternative

Applications

Typical applications include switch mode power supplies (input filters, resonators, tank circuits, snubber circuits, output filters), high voltage coupling and DC blocking, lighting ballasts, voltage multiplier circuits, DC/DC converters and coupling capacitors in Ćuk converters. Markets include power supply, LCD fluorescent backlight ballasts, HID lighting, telecom equipment, industrial and medical equipment/control, LAN/WAN interface, analog and digital modems, and automotive (electric and hybrid vehicles, charging stations and lighting applications).

Application Note

X7R dielectric is not recommended for AC line filtering or pulse applications.



Qualification/Certification

Commercial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance and Reliability.

Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions.

Dimensions – Millimeters (Inches)







| Number of Chips | EIA Size Code | Metric Size Code | L Length | W Width | H Height | LW Lead Width | Mounting Technique |
|--------------------|------------------|---------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-----------------------|
| Single | 2220 | 5650 | 6.00 (0.236) ±0.50 (0.020) | 5.00 (0.197) ±0.50 (0.020) | 3.50 (0.138) ±0.30 (0.012) | 1.60 (0.063) ±0.30 (0.012) | Solder Reflow |
| Double | 2220 | 5650 | 6.00 (0.236) ±0.50 (0.020) | 5.00 (0.197) ±0.50 (0.020) | 5.00 (0.197) ±0.50 (0.020) | 1.60 (0.063) ±0.30 (0.012) | Only |



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 Vdc Applied (TCC) | ±15% |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| ² Dielectric Withstanding Voltage (DWV) | 150% of rated voltage for voltage rating of < 1000V 120% of rated voltage for voltage rating of ≥ 1000V (5±1 seconds and charge/discharge not exceeding 50mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | 2.5% |
| ⁴ Insulation Resistance (IR) Minimum Limit at 25°C | 1,000 megohm microfarads or 100GΩ (500 VDC applied for 120±5 seconds at 25°C) |

¹ Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours.

²DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

³ Capacitance and dissipation factor (DF) measured under the following conditions:

1kHz ± 50Hz and 1.0 ± 0.2 Vrms if capacitance \leq 10 μ F

120Hz \pm 10Hz and 0.5 \pm 0.1 Vrms if capacitance > 10 μ F

⁴ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON".

Post Environmental Limits

| High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | |
|---|---------------------|----------------------|-----------------------------------|----------------------|--------------------------|--|--|--|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | | | |
| | > 25 | 3.0 | 3.0 | | 10% of Initial | | | |
| X7R | 16/25 | All | 5.0 | ±20% | | | | |
| | < 16 | | 7.5 | | LIIIII | | | |



Table 1 – Capacitance Range/Selection Waterfall (2220 Case Sizes)

| | | Case Siz | e/Series | C2220C | | | |
|-------------------|-------------|--------------------------|------------------|---|-----|------|--|
| | | Voltag | Voltage Code | | В | D | |
| Capacitance | Capacitance | Rated Volt | age (VDC) | 500 | 630 | 1000 | |
| Code | | Capacitance Tolerance | | Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions | | | |
| Single Chip Stack | | | | | | | |
| 0.047 µF | 473 | К | М | JP | JP | | |
| 0.10 µF | 104 | К | М | JP | JP | | |
| 0.15 μF | 154 | К | M | JP | JP | | |
| 0.22 µF | 224 | К | М | JP | JP | | |
| 0.33 µF | 334 | К | М | JP | | | |
| 0.47 µF | 474 | K M | | JP | | | |
| | | Double | Chip Stac | k | | | |
| 0.10 µF | 104 | | M | JR | JR | | |
| 0.22 µF | 224 | | M | JR | JR | | |
| 0.33 µF | 334 | | M | JR | JR | | |
| 0.47 µF | 474 | | M | JR | JR | | |
| 0.68 µF | 684 | | M | JR | | | |
| 1.0 µF | 105 | | M | JR | | | |
| | | Rated Volt | age (VDC) | 500 | 630 | 1000 | |
| Capacitance | Capacitance | Voltag | e Code | С | В | D | |
| | Code | Case Siz | e/Series | C2220C | | | |

These products are protected under US Patent 8,331,078 other patents pending, and any foreign counterparts. SnPb termination options available. "C"(100% Sn) & "L"(SnPb) Terminations.



Table 2 - Chip Thickness/Tape & Reel Packaging Quantities

| Thickness Case Thic | Thickness ± | Paper C |)uantity | Plastic Quantity | | |
|---------------------|-------------|-------------|----------|------------------|---------|----------|
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| JP | 2220 | 3.50 ± 0.30 | 0 | 0 | 300 | 1,300 |
| JR | 2220 | 5.00 ± 0.50 | 0 | 0 | 200 | 800 |

Package quantity based on finished chip thickness specifications.

Table 3 - KPS Land Pattern Design Recommendations (mm)

| EIA SIZE | METRIC SIZE | Median (Nominal) Land Protrusion | | | | | |
|----------|----------------|-------------------------------------|------|------|------|------|--|
| CODE | CODE | C | Y | X | V1 | V2 | |
| 2220 | 5650 | 2.69 | 2.08 | 4.78 | 7.70 | 6.00 | |



KEMET's KPS Series land pattern design recommendations have been evaluated through extensive internal testing and validation. KPS lead frames are used to mechanically isolate the MLCC from the PCB and provide stress relief for increased mechanical robustness. The land pattern dimensions for each EIA size code are designed to be encompassed within the end terminations thus regulating solder wicking and maintaining lead frame flexibility. This design is optimized to enable durable solder joint fillets which improve the mechanical integrity and reliability upon placement.


Soldering Process

KEMET's KPS Series devices are compatible with IR reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for IR reflow reflect the profile conditions of the IPC/J-STD-020D standard for moisture sensitivity testing.

To prevent degradation of temperature cycling capability, care must be taken to prevent solder from flowing into the inner side of the lead frames (inner side of "J" lead in contact with the circuit board).

After soldering, the capacitors should be air cooled to room temperature before further processing. Forced air cooling is not recommended.

Hand soldering should be performed with care due to the difficulty in process control. If performed, care should be taken to avoid contact of the soldering iron to the capacitor body. The iron should be used to heat the solder pad, applying solder between the pad and the lead, until reflow occurs. Once reflow occurs, the iron should be removed immediately. (Preheating is required when hand soldering to avoid thermal shock.)

| Profile Feature | SnPb Assembly | Pb-Free Assembly | |
|--|---------------------|---------------------|--|
| Preheat/Soak | | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | |
| Time (t_s) from T_{min} to T_{max}) | 60 – 120 seconds | 60 – 120 seconds | |
| Ramp-up Rate (T_L to T_P) | 3°C/seconds maximum | 3°C/seconds maximum | |
| Liquidous Temperature (T _L) | 183°C | 217°C | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | |
| Peak Temperature (T _P) | 235°C | 250°C | |
| Time within 5°C of Maximum Peak Temperature (t _n) | 20 seconds maximum | 10 seconds maximum | |
| Ramp-down Rate $(T_{p} to T_{L})$ | 6°C/seconds maximum | 6°C/seconds maximum | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | |

Note: All temperatures refer to the center of the package, measured on the package body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method |
|------------------------|---------------------------|--|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds. |
| Board Flex | JIS-C-6429 | Appendix 2, Note: 5.0 mm minimum |
| | | Magnification 50 X. Conditions: |
| 0 - I de me hillitere | | a) Method B, 4 hours at 155°C, dry heat at 235°C |
| Solderability | J-81D-002 | b) Method B at 215°C category 3 |
| | | c) Method D, category 3 at 250°C |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to +125°C). Measurement at 24 hours +/-4 hours after test conclusion. |
| Discolution | MIL-STD-202 | Load Humidity: 1,000 hours 85°C/85% RH and 200 VDC maximum. Add 100 K ohm resistor. Measurement at 24 hours +/-4 hours after test conclusion. |
| Blased Humidity | Method 103 | Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours +/-4 hours after test conclusion. |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours +/-4 hours after test conclusion. |
| Thermal Shock | MIL-STD-202 Method 107 | -55°C/+125°C. Note: Number of cycles required – 300. Maximum transfer time – 20 seconds. Dwell time – 15 minutes. Air-Air. |
| High Temperature Life | MIL-STD-202 Method 108 | 1,000 hours at 125°C with rated voltage applied. |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC for 1,000 hours. |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick, 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz. |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Condition F. |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. |

Storage & Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature-reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction



Product Marking

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration – Embossed Plastic (mm)

| EIA Case Size | Tape Size (W)* | Pitch (P ₁)* |
|-------------------|----------------|--------------------------|
| 01005 - 0402 | 8 | 2 |
| 0603 - 1210 | 8 | 4 |
| 1805 - 1808 | 12 | 4 |
| ≥ 1812 | 12 | 8 |
| KPS 1210 | 12 | 8 |
| KPS 1812 and 2220 | 16 | 12 |
| Array 0612 | 8 | 4 |

*Refer to Figure 1 for W and P, carrier tape reference locations. *Refer to Table 5 for tolerance specifications.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions — Millimeters (Inches) | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|---------------------------------|---------------------------|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximim |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | |
| 12 mm | 1.5 +0.10/0.0-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 16 mm | | (0.059) | | | | (1.181) | | | |
| | | | Variable D | imensions — | Millimeters (| Inches) | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ , B ₀ | , & K ₀ |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | |
| 12 mm | Single (4 mm) and Double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | Not | ie 5 |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.

2. The tape with or without components shall pass around R without damage (see Figure 5).

3. If S₁ < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Standard 481 paragraph 4.3 section b).

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{α} , B_{α} and K_{α} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 2).

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 3).

(e) for KPS Series product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 2 – Maximum Component Rotation



Figure 3 – Maximum Lateral Movement



Figure 4 – Bending Radius





Figure 5 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 7 – Reel Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | |
|--|-----------------|---------------------------------------|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | |
| 8 mm | 178 ±0.20 | | | | |
| 12 mm | Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | |
| 16 mm | (13.000 ±0.008) | | , , , , , , , , , , , , , , , , , , , | | |
| | Variable | Dimensions — Millimete | rs (Inches) | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | |



Figure 6 – Tape Leader & Trailer Dimensions



Figure 7 – Maximum Camber





Overview

KEMET Power Solutions (KPS) High Voltage stacked capacitors utilize a proprietary lead-frame technology to vertically stack one or two multilayer ceramic chip capacitors into a single compact surface mount package. The attached lead-frame mechanically isolates the capacitor(s) from the printed circuit board, thereby offering advanced mechanical and thermal stress performance. Isolation also addresses concerns for audible microphonic noise that may occur when a bias voltage is applied. A twochip stack offers up to double the capacitance in the same or smaller design footprint when compared to traditional surface mount MLCC devices. Providing up to 10 mm of board flex capability, KPS Series High Voltage capacitors are environmentally friendly and in compliance with RoHS legislation. KEMET's KPS Series devices in X7R dielectric exhibit a predictable change in capacitance with respect to time and voltage, and boast a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to ±15% from -55°C to +125°C. These devices are capable of Pb-Free reflow profiles and provide lower ESR, ESL and higher ripple current capability when compared to other dielectric solutions.

KPS Series Automotive Grade capacitors meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.

Benefits

- · AEC Q200 automotive qualified
- -55°C to +125°C operating temperature range
- Reliable and robust termination system
- EIA 2220 case size
- DC voltage ratings of 500 V and 630 V
- Capacitance offerings ranging from 0.047 μF up to 0.47 μF
- Available capacitance tolerances of ±10% and ±20%
- · Higher capacitance in the same footprint
- Potential board space savings
- · Advanced protection against thermal and mechanical stress



Ordering Information

| С | 2220 | C | 474 | Μ | C | R | 2 | C | AUTO |
|---------|-----------------------|--------------------------|--|---------------------------------------|---------------------------|------------|--|-------------------------------|---|
| Ceramic | Case Size (L"x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance ¹ | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Leadframe Finish ² | Packaging/Grade (C-Spec) |
| | 2220 | C = Standard | Two significant digits and number of zeros. | K = ±10% M = ±20% | C = 500 B = 630 | R = X7R | 1 = KPS Single Chip Stack 2 = KPS Double Chip Stack | C = 100% Matte Sn | See "Packaging C-Spec Ordering Options Table" |

¹ Double chip stacks ("2" in the 13th character position of the ordering code) are only available in M (\pm 20%) capacitance tolerance. Single chip stacks ("1" in the 13th character position of the ordering code) are available in K (\pm 10%) or M (\pm 20%) tolerances.

² Additional leadframe finish options may be available. Contact KEMET for details.

Built Into Tomorrow



Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) ² |
|---|--|
| 7" Reel (Embossed Plastic Tape)/Unmarked | AUTO |
| 13" Reel (Embossed Plastic Tape)/Unmarked | AUTO 7289 |

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices. For more information see "Capacitor Marking".

² For additional information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information".

Benefits cont.

- · Provides up to 10 mm of board flex capability
- · Reduces audible microphonic noise
- Extremely low ESR and ESL
- Lead (Pb)-free, RoHS, and REACH compliant.
- Capable of Pb-free reflow profiles
- · Non-polar device, minimizing installation concerns
- · Film alternative

Applications

Typical applications include switch mode power supplies (input filters, resonators, tank circuits, snubber circuits, output filters), high voltage coupling and DC blocking, lighting ballasts, voltage multiplier circuits, DC/DC converters and coupling capacitors in Ćuk converters. Markets include power supply, LCD fluorescent backlight ballasts, HID lighting, telecom equipment, industrial and medical equipment/control, LAN/WAN interface, analog and digital modems, and automotive (electric and hybrid vehicles, charging stations and lighting applications).

Application Note

X7R dielectric is not recommended for AC line filtering or pulse applications.



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | Days Prior To | |
|-----------------------------|----------------------------------|---------------|------------------|
| C-Spec | Process/Product change | Obsolescence* | Implementation |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum |
| AUTO | Yes (without approval) | Yes | 90 days minimum |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | PPAP (Product Part Approval Process) Level | | | | | |
|-----------------------------|--|---|---|---|---|--|
| C-Spec | 1 | 2 | 3 | 4 | 5 | |
| KEMET assigned ¹ | • | • | • | • | • | |
| AUTO | | | 0 | | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions.

Dimensions – Millimeters (Inches)







| Number of Chips | EIA Size Code | Metric Size Code | L Length | W Width | H Height | LW Lead Width | Mounting Technique |
|--------------------|------------------|---------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-----------------------|
| Single | 2220 | 5650 | 6.00 (0.236) ±0.50 (0.020) | 5.00 (0.197) ±0.50 (0.020) | 3.50 (0.138) ±0.30 (0.012) | 1.60 (0.063) ±0.30 (0.012) | Solder Reflow |
| Double | 2220 | 5650 | 6.00 (0.236) ±0.50 (0.020) | 5.00 (0.197) ±0.50 (0.020) | 5.00 (0.197) ±0.50 (0.020) | 1.60 (0.063) ±0.30 (0.012) | Only |



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 Vdc Applied (TCC) | ±15% |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| ² Dielectric Withstanding Voltage (DWV) | 150% of rated voltage for voltage rating of < 1000V 120% of rated voltage for voltage rating of ≥ 1000V (5±1 seconds and charge/discharge not exceeding 50mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | 2.5% |
| ⁴ Insulation Resistance (IR) Minimum Limit at 25°C | 1,000 megohm microfarads or 100GΩ (500 VDC applied for 120±5 seconds at 25°C) |

¹ Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours.

² DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

³ Capacitance and dissipation factor (DF) measured under the following conditions:

1kHz ± 50Hz and 1.0 ± 0.2 Vrms if capacitance \leq 10 μ F

120Hz \pm 10Hz and 0.5 \pm 0.1 Vrms if capacitance > 10 μF

⁴ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON".

Post Environmental Limits

| High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | |
|---|---------------------|--|-----|------|----------------|--|--|
| Dielectric | Rated DC Voltage | C Capacitance Dissipation Factor Capacitance Insulati Value (Maximum %) Shift Resista | | | | | |
| | > 25 | | 3.0 | | 10% of Initial | | |
| X7R | 16/25 | All | 5.0 | ±20% | | | |
| | < 16 | | 7.5 | | LIIIII | | |



Table 1 – Capacitance Range/Selection Waterfall (2220 Case Sizes)

| | | Case Siz | Case Size/Series | | C2220C | | |
|-------------------|-------------|--------------------------|------------------|---|--------|------|--|
| | | Voltag | Voltage Code | | В | D | |
| Capacitance | Capacitance | Rated Volt | age (VDC) | 500 | 630 | 1000 | |
| | Code | Capacitance Tolerance | | Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions | | | |
| Single Chip Stack | | | | | | | |
| 0.047 µF | 473 | К | М | JP | JP | | |
| 0.10 µF | 104 | К | М | JP | JP | | |
| 0.15 µF | 154 | К | М | JP | JP | | |
| 0.22 µF | 224 | K | М | JP | JP | | |
| | | Double | Chip Stac | k | | | |
| 0.10 µF | 104 | | M | JR | JR | | |
| 0.22 µF | 224 | | M | JR | JR | | |
| 0.33 µF | 334 | | М | JR | JR | | |
| 0.47 µF | 474 | | М | JR | JR | | |
| | | Rated Voltage (VDC) | | 500 | 630 | 1000 | |
| Capacitance | Capacitance | Voltag | e Code | С | В | D | |
| | Code | Case Size/Series | | C2220C | | | |

These products are protected under US Patent 8,331,078 other patents pending, and any foreign counterparts.



Table 2 - Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | ckness Case Thickness ± | | Paper C |)uantity | Plastic Quantity | | |
|-----------|-------------------------|-------------|---------|----------|------------------|----------|--|
| Code Size | | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| JP | 2220 | 3.50 ± 0.30 | 0 | 0 | 300 | 1,300 | |
| JR | 2220 | 5.00 ± 0.50 | 0 | 0 | 200 | 800 | |

Package quantity based on finished chip thickness specifications.

Table 3 – KPS Land Pattern Design Recommendations (mm)

| EIA SIZE | METRIC SIZE | Median (Nominal) Land Protrusion | | | | | |
|----------|----------------|-------------------------------------|------|------|------|------|--|
| CODL | CODE | C | Y | X | V1 | V2 | |
| 2220 | 5650 | 2.69 | 2.08 | 4.78 | 7.70 | 6.00 | |



KEMET's KPS Series land pattern design recommendations have been evaluated through extensive internal testing and validation. KPS lead frames are used to mechanically isolate the MLCC from the PCB and provide stress relief for increased mechanical robustness. The land pattern dimensions for each EIA size code are designed to be encompassed within the end terminations thus regulating solder wicking and maintaining lead frame flexibility. This design is optimized to enable durable solder joint fillets which improve the mechanical integrity and reliability upon placement.



Soldering Process

KEMET's KPS Series devices are compatible with IR reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for IR reflow reflect the profile conditions of the IPC/J-STD-020D standard for moisture sensitivity testing.

To prevent degradation of temperature cycling capability, care must be taken to prevent solder from flowing into the inner side of the lead frames (inner side of "J" lead in contact with the circuit board).

After soldering, the capacitors should be air cooled to room temperature before further processing. Forced air cooling is not recommended.

Hand soldering should be performed with care due to the difficulty in process control. If performed, care should be taken to avoid contact of the soldering iron to the capacitor body. The iron should be used to heat the solder pad, applying solder between the pad and the lead, until reflow occurs. Once reflow occurs, the iron should be removed immediately. (Preheating is required when hand soldering to avoid thermal shock.)

| Profile Feature | SnPb Assembly | Pb-Free Assembly |
|--|---------------------|---------------------|
| Preheat/Soak | | |
| Temperature Minimum (T _{smin}) | 100°C | 150°C |
| Temperature Maximum (T _{smax}) | 150°C | 200°C |
| Time (t_s) from T_{min} to T_{max}) | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-up Rate (T_L to T_P) | 3°C/seconds maximum | 3°C/seconds maximum |
| Liquidous Temperature (T _L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 250°C |
| Time within 5°C of Maximum Peak Temperature (t _n) | 20 seconds maximum | 10 seconds maximum |
| Ramp-down Rate $(T_{p} to T_{L})$ | 6°C/seconds maximum | 6°C/seconds maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |

Note: All temperatures refer to the center of the package, measured on the package body surface that is facing up during assembly reflow.





Construction



Product Marking

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



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Table 4 – Carrier Tape Configuration – Embossed Plastic (mm)

| EIA Case Size | Tape Size (W)* | Pitch (P ₁)* |
|-------------------|----------------|--------------------------|
| 01005 - 0402 | 8 | 2 |
| 0603 - 1210 | 8 | 4 |
| 1805 - 1808 | 12 | 4 |
| ≥ 1812 | 12 | 8 |
| KPS 1210 | 12 | 8 |
| KPS 1812 & 2220 | 16 | 12 |
| Array 0508 & 0612 | 8 | 4 |

*Refer to Figure 1 for W and P, carrier tape reference locations. *Refer to Table 5 for tolerance specifications.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 5 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|--|--|----------------------------------|----------------------------|---------------------------|----------------------------|---------------------------|----------------------------------|---------------------------------|---------------------------|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximim |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | |
| 12 mm | 1.5+0.10/0.0-0.0 (0.059+0.004/-0.0) | 1.5 | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.05 (0.079±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 16 mm | | (0.059) | | | | (1.181) | | | |
| | | | Variable D | imensions — | Millimeters (| Inches) | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ , B ₀ | , & K ₀ |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5±0.05 (0.138±0.002) | 4.0±0.10 (0.157±0.004) | 2.5 (0.098) | 8.3 (0.327) | | |
| 12 mm | Single (4 mm) & Double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5±0.05 (0.217±0.002) | 8.0±0.10 (0.315±0.004) | 4.6 (0.181) | 12.3 (0.484) | Not | e 5 |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5±0.05 (0.138±0.002) | 12.0±0.10 (0.157±0.004) | 4.6 (0.181) | 16.3 (0.642) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.

2. The tape with or without components shall pass around R without damage (see Figure 5).

3. If S₁ < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Standard 481 paragraph 4.3 section b).

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 2).

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 3).

(e) for KPS Series product, A_0 and B_0 are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 Kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 2 – Maximum Component Rotation



Figure 3 – Maximum Lateral Movement



Figure 4 – Bending Radius





Figure 5 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 6 – Reel Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | | |
|--|--|-------------------------------------|--------------------------------------|--|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | | |
| 8 mm | 178±0.20 | | | | | | | |
| 12 mm | (7.00810.008) Or 2200.0 20 | 1.5 (0.059) | 13.0+0.5/-0.2 (0.521+0.02/-0.008) | 20.2 (0.795) | | | | |
| 16 mm | (13.000±0.008) | | | | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | |
| 8 mm | | 8.4+1.5/-0.0 (0.331+0.059/-0.0) | 14.4 (0.567) | | | | | |
| 12 mm | 50 (1.969) | 12.4+2.0/-0.0 (0.488+0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | | |
| 16 mm | | 16.4+2.0/-0.0 (0.646+0.078/-0.0) | 22.4 (0.882) | | | | | |



Figure 6 – Tape Leader & Trailer Dimensions



Figure 7 – Maximum Camber





Overview

KEMET Power Solutions High Temperature (KPS HT) stacked capacitors utilize a proprietary lead-frame technology to vertically stack one or two multilayer ceramic chip capacitors into a single compact surface mount package. The attached lead-frame mechanically isolates the capacitor(s) from the printed circuit board, thereby offering advanced mechanical and thermal stress performance. Isolation also addresses concerns for audible, microphonic noise that may occur when a bias voltage is applied. A two-chip stack offers up to double the capacitance in the same or smaller design footprint when compared to traditional surface mount MLCC devices. Providing up to 10 mm of board flex capability, KPS Series capacitors are environmentally friendly and in compliance with RoHS legislation. Combined with X8L dielectric, these devices are capable of reliable operation up to 150°C and are well suited for high temperature filtering, bypass and decoupling applications.

X8L exhibits a predictable change in capacitance with respect to time and voltage, and boasts a minimal change in capacitance with reference to ambient temperature up to 125°C. Beyond 125°C, X8L displays a wider variation in capacitance. Capacitance change is limited to $\pm 15\%$ from -55°C to $\pm 125°C$ and ± 15 , -40% from 125°C to 150°C.

In addition to Commercial grade, Automotive grade devices are available and meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.

Benefits

- -55°C to +150°C operating temperature range
- · Reliable and robust termination system
- · EIA 1210 and 2220 case sizes
- DC voltage ratings of 10 V, 16 V, 25 V, and 50 V
- Capacitance offerings ranging from 0.47 μF up to 47 μF
- Available capacitance tolerances of $\pm 10\%$ and $\pm 20\%$
- Higher capacitance in the same footprint
- Potential board space savings
- · Advanced protection against thermal and mechanical stress
- · Provides up to 10 mm of board flex capability

Ordering Information

| С | 2220 | C | 476 | М | 8 | N | 2 | C | 7186 |
|---------|-----------------------|--------------------------|--|---------------------------------------|--------------------------------------|------------|--|-------------------------------|---|
| Ceramic | Case Size (L"x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance ¹ | Rated Voltage (VDC) | Dielectric | FailureRate/ Design | Leadframe Finish ² | Packaging/Grade (C-Spec) |
| | 1210 1812 2220 | C = Standard | Two significant digits and number of zeros. | K = ±10% M = ±20% | 8 = 10 4 = 16 3 = 25 5 = 50 | N = X8L | 1 = KPS single chip stack 2 = KPS double chip stack | C = 100% Matte Sn | See "Packaging C-Spec Ordering Options Table" |

¹ Double chip stacks ("2" in the 13th character position of the ordering code) are only available in M (±20%) capacitance tolerance. Single chip stacks ("1" in the 13th character position of the ordering code) are available in K (±10%) or M (±20%) tolerances.

² Additional leadframe finish options may be available. Contact KEMET for details.

Built Into Tomorrow



Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) ² | | | | |
|---|--|--|--|--|--|
| Commercial Grade | | | | | |
| 7" Reel (Embossed Plastic Tape)/Unmarked | 7186 | | | | |
| 13" Reel (Embossed Plastic Tape)/Unmarked | 7289 | | | | |
| Automotive Grade | | | | | |
| 7" Reel (Embossed Plastic Tape)/Unmarked | AUTO | | | | |
| 13" Reel (Embossed Plastic Tape)/Unmarked | AUT07289 | | | | |

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices. For more information see "Capacitor Marking". ² For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information".

Benefits cont.

- · Reduces audible, microphonic noise
- Extremely low ESR and ESL
- · Lead (Pb)-free, RoHS and REACH compliant
- Capable of Pb-free reflow profiles

- · Non-polar device, minimizing installation concerns
- · Tantalum and electrolytic alternative
- · Commercial and Automotive (AEC-Q200) grades available

Applications

Typical applications include smoothing circuits, DC/DC converters, power supplies (input/output filters), noise reduction (piezoelectric/mechanical), circuits with a direct battery or power source connection, critical and safety relevant circuits without (integrated) current limitation and any application that is subject to extreme environments such as high temperature, high levels of board flexure and/or temperature cycling. Markets include industrial, aerospace, automotive, and telecom.



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | Days Prior To | | |
|-----------------------------|----------------------------------|---------------|------------------|--|
| C-Spec | Process/Product change | Obsolescence* | Implementation | |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum | |
| AUTO | Yes (without approval) | Yes | 90 days minimum | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | PPAP (Product Part Approval Process) Level | | | | | | | | |
|-----------------------------|--|---|---|---|---|--|--|--|--|
| C-Spec | 1 | 2 | 3 | 4 | 5 | | | | |
| KEMET assigned ¹ | • | • | • | • | • | | | | |
| AUTO | | | 0 | | | | | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions - Millimeters (Inches)







Single Chip Stack

| Number of Chips | EIA Size Code | Metric Size Code | L Length | W Width | H Height | LW Lead Width | Mounting Technique |
|--------------------|------------------|---------------------|-------------------------------|-------------------------------|--|-------------------------------|-----------------------|
| | 1210 | 3225 | 3.50 (0.138) | 2.60 (0.102) | 3.35 (0.132) | 0.80 (0.032) | |
| | | | ±0.30 (0.012) | ±0.30 (0.012) | ±0.10 (0.004) | ±0.15 (0.006) | |
| Single | 1912 | 1532 | 5.00 (0.197) | 3.50 (0.138) | 2.65 (0.104) | 1.10 (0.043) | |
| Siligle | 1012 | 4332 | ±0.50 (0.020) | ±0.50 (0.020) | ±0.35 (0.014) | ±0.30 (0.012) | |
| | 2220 | 5650 | 6.00 (0.236) | 5.00 (0.197) | 3.50 (0.138) | 1.60 (0.063) | |
| | 2220 | 3030 | ±0.50 (0.020) | ±0.50 (0.020) | ±0.30 (0.012) | ±0.30 (0.012) | |
| | 1210 | 2225 | 3.50 (0.138) | 2.60 (0.102) | 6.15 (0.242) | 0.80 (0.031) | Solder Reflow Only |
| | 1210 | 3223 | ±0.30 (0.012) | ±0.30 (0.012) | ±0.15 (0.006) | ±0.15 (0.006) | |
| Double | 1812 | 4532 | 5.00 (0.197) ±0.50 (0.020) | 3.50 (0.138) ±0.50 (0.020) | 5.00 (0.197) -1.00/+0.50 (-0.040/+0.020) | 1.10 (0.043) ±0.30 (0.012) | |
| | | | 6 00 (0 236) | 5 00 (0 197) | 5.00 (0.197) | 1.60 (0.063) | |
| | 2220 | 5650 | ±0.50 (0.020) | ±0.50 (0.020) | ±0.50 (0.020) | ±0.30 (0.012) | |

Н

Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|--|
| Operating Temperature Range | -55°C to +150°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±15% (-55°C to 125°C), +15, -40% (125°C to 150°C) |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| ² Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5±1 seconds and charge/discharge not exceeding 50 mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | 3.5% (≤ 16V) and 2.5% (≥ 25V) |
| ⁴ Insulation Resistance (IR) Minimum Limit at 25°C | 500 megohm microfarads or 10 GΩ (Rated voltage applied for 120±5 seconds at 25°C) |

¹ Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours.

²DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

³ Capacitance and dissipation factor (DF) measured under the following conditions:

 $1kHz \pm 50Hz$ and 1.0 ± 0.2 Vrms if capacitance $\leq 10\mu F$

120Hz ± 10Hz and 0.5 ± 0.1 Vrms if capacitance > 10μF

⁴ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 & Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON".

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Post Environmental Limits

| High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | |
|---|---------------------|----------------------|-----------------------------------|----------------------|--------------------------|--|--|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | | |
| VOL | ≥ 25 | A 11 | 3.0 | 120% | 10% of | | |
| , XOL | ×8L ≤ 16 | | 5.0 | ±20% | Initial Limit | | |

Table 1 – Capacitance Range/Selection Waterfall (1210 – 2220 Case Sizes)

| | Case Size/ Series | | | | C12 | 10C | | | | C | :1812 | С | | | | C22 | 20C | | | | |
|-------------|----------------------|---------|--------------------|----------|-----|--------|-----|---------|-----------|----------|----------|---------|----------|---------------|-----------|----------|--------|---------|------|-----|-----|
| Canacitance | Сар | Vo | ltage Co | de | 8 | 4 | 3 | 5 | 1 | A | 4 | 3 | 5 | 1 | A | 8 | 4 | 3 | 5 | 1 | A |
| oupuontanee | Code | Rated | Voltage | (VDC) | 10 | 16 | 25 | 50 | 100 | 250 | 16 | 25 | 50 | 100 | 250 | 10 | 16 | 25 | 50 | 100 | 250 |
| | | Ca T | pacitan oleranc | ce e | | | Pro | duct Av | ailabilit | y and Ch | ip Thicl | kness C | odes – S | i See Tabl | e 2 for C | Chip Thi | ckness | Dimensi | ions | | |
| | Single Chip Stack | | | | | | | | | | | | | | | | | | | | |
| 0.47 µF | 474 | | К | М | FV | FV | FV | FV | | | | | | | | | | | | | |
| 1.0 µF | 105 | | K | М | FV | FV | FV | FV | | | | | | | | | | | | | |
| 2.2 µF | 225 | | К | М | FV | FV | FV | | | | | | | | | JP | JP | JP | | | |
| 3.3 µF | 335 | | К | М | FV | FV | FV | | | | | | | | | JP | JP | JP | | | |
| 4.7 μF | 475 | | К | М | FV | FV | FV | | | | | | | | | JP | JP | JP | | | |
| 10 µF | 106 | | K | М | | | | | | | | | | | | JP | JP | JP | | | |
| 15 µF | 156 | | К | М | | | | | | | | | | | | JP | | | | | |
| 22 µF | 226 | | K | М | | | | | | | | | | | | JP | | | | | |
| | | | | | | | | Dou | ble C | hip St | tack | | | | | | | | | | |
| 1.0 µF | 105 | | | М | FW | FW | FW | FW | | | | | | | | | | | | | |
| 2.2 µF | 225 | | | М | FW | FW | FW | FW | | | | | | | | | | | | | |
| 3.3 µF | 335 | | | М | FW | FW | FW | | | | | | | | | | | | | | |
| 4.7 μF | 475 | | | М | FW | FW | FW | | | | GR | GR | GR | | | JR | JR | JR | | | |
| 10 µF | 106 | | | М | FW | FW | FW | | | | | | | | | JR | JR | JR | | | |
| 22 µF | 226 | | | М | | | | | | | | | | | | JR | JR | JR | | | |
| 33 µF | 336 | | | М | | | | | | | | | | | | JR | | | | | |
| 47 μF | 476 | | | М | | | | | | | | | | | | JR | | | | | |
| | | Rated | Voltage | (VDC) | 10 | 16 | 25 | 50 | 100 | 250 | 4 | 3 | 5 | 1 | A | 10 | 16 | 25 | 50 | 100 | 250 |
| Canacitance | Сар | Vo | ltage Co | de | 8 | 4 | 3 | 5 | 1 | A | 16 | 25 | 50 | 100 | 250 | 8 | 4 | 3 | 5 | 1 | A |
| Capacitance | Code | Ca | se Si: Series | ze/ S | | C1210C | | | C1812C | | | | C2220C | | | | | | | | |

These products are protected under US Patent 8,331,078 other patents pending, and any foreign counterparts.



Table 2 - Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper C |)uantity | Plastic Quantity | | |
|-----------|------|-------------|---------|----------|------------------|----------|--|
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| FV | 1210 | 3.35 ± 0.10 | 0 | 0 | 600 | 2,000 | |
| FW | 1210 | 6.15 ± 0.15 | 0 | 0 | 300 | 1,000 | |
| GR | 1812 | 5.00 ± 0.50 | 0 | 0 | 400 | 1,700 | |
| JP | 2220 | 3.50 ± 0.30 | 0 | 0 | 300 | 1,300 | |
| JR | 2220 | 5.00 ± 0.50 | 0 | 0 | 200 | 800 | |

Package quantity based on finished chip thickness specifications.

Table 3 – KPS Land Pattern Design Recommendations (mm)

| EIA SIZE | METRIC SIZE | IETRIC Median (Nominal) Land SIZE Protrusion | | | | | | | |
|----------|----------------|---|------|------|------|------|--|--|--|
| OODL | CODE | C | Y | Х | V1 | V2 | | | |
| 1210 | 3225 | 1.50 | 1.14 | 1.75 | 5.05 | 3.40 | | | |
| 2220 | 5650 | 2.69 | 2.08 | 4.78 | 7.70 | 6.00 | | | |

Image at right based on an EIA 1210 case size.



KEMET's KPS Series land pattern design recommendations have been evaluated through extensive internal testing and validation. KPS lead frames are used to mechanically isolate the MLCC from the PCB and provide stress relief for increased mechanical robustness. The land pattern dimensions for each EIA size code are designed to be encompassed within the end terminations thus regulating solder wicking and maintaining lead frame flexibility. This design is optimized to enable durable solder joint fillets which improve the mechanical integrity and reliability upon placement.



Soldering Process

KEMET's KPS Series devices are compatible with IR reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for IR reflow reflect the profile conditions of the IPC/J-STD-020D standard for moisture sensitivity testing.

To prevent degradation of temperature cycling capability, care must be taken to prevent solder from flowing into the inner side of the lead frames (inner side of "J" lead in contact with the circuit board).

After soldering, the capacitors should be air cooled to room temperature before further processing. Forced air cooling is not recommended.

Hand soldering should be performed with care due to the difficulty in process control. If performed, care should be taken to avoid contact of the soldering iron to the capacitor body. The iron should be used to heat the solder pad, applying solder between the pad and the lead, until reflow occurs. Once reflow occurs, the iron should be removed immediately. (Preheating is required when hand soldering to avoid thermal shock.)

| Profile Feature | SnPb Assembly | Pb-Free Assembly | | |
|--|---------------------|---------------------|--|--|
| Preheat/Soak | | | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C | | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | | |
| Time (t $_{\rm s})$ from T $_{\rm smin}$ to T $_{\rm smax})$ | 60 – 120 seconds | 60 – 120 seconds | | |
| Ramp-up Rate (T_L to T_P) | 3°C/seconds maximum | 3°C/seconds maximum | | |
| Liquidous Temperature (T _L) | 183°C | 217°C | | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | | |
| Peak Temperature (T _P) | 235°C | 250°C | | |
| Time within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 10 seconds maximum | | |
| Ramp-down Rate $(T_p to T_L)$ | 6°C/seconds maximum | 6°C/seconds maximum | | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | | |

Note: All temperatures refer to the center of the package, measured on the package body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method |
|------------------------|---------------------------|---|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds. |
| Board Flex | JIS-C-6429 | Appendix 2, Note: 5.0 mm minimum |
| | | Magnification 50 X. Conditions: |
| | | a) Method B, 4 hours at 155°C, dry heat at 235°C |
| Solderability | J-SID-002 | b) Method B at 215°C category 3 |
| | | c) Method D, category 3 at 250°C |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to +150°C). Measurement at 24 hours ±4 hours after test conclusion. |
| Discond Humaidian | MIL-STD-202 | Load Humidity: 1,000 hours 85°C/85% RH and rated voltage. Add 100 K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. |
| Blased Humidity | Method 103 | Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours ±4 hours after test conclusion. |
| Thermal Shock | MIL-STD-202 Method 107 | -55°C/+150°C. Note: Number of cycles required – 300, Maximum transfer time – 20 seconds, Dwell time – 15 minutes. Air – Air. |
| High Temperature Life | MIL-STD-202 Method 108 | 1,000 hours at 150°C with rated voltage applied. |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC for 1,000 hours. |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB .031" thick, 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz. |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Condition F. |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. |

Storage & Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction



Product Marking

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 4 – Carrier Tape Configuration – Embossed Plastic (mm)

| EIA Case Size | Tape Size (W)* | Pitch (P ₁)* |
|-------------------|----------------|--------------------------|
| 01005 - 0402 | 8 | 2 |
| 0603 - 1210 | 8 | 4 |
| 1805 - 1808 | 12 | 4 |
| ≥ 1812 | 12 | 8 |
| KPS 1210 | 12 | 8 |
| KPS 1812 & 2220 | 16 | 12 |
| Array 0508 & 0612 | 8 | 4 |

*Refer to Figure 1 for W and P, carrier tape reference locations. *Refer to Table 5 for tolerance specifications.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 5 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | |
|-----------|--|----------------------------------|----------------------------|---------------------------|----------------------------|---------------------------|----------------------------------|---------------------------------|---------------------------|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximim |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | |
| 12 mm | 1.5+0.10/0.0-0.0 (0.059+0.004/-0.0) | 1.5 | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.05 (0.079±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 16 mm | | (0.059) | | | | (1.181) | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ , B ₀ | , & K ₀ |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5±0.05 (0.138±0.002) | 4.0±0.10 (0.157±0.004) | 2.5 (0.098) | 8.3 (0.327) | | |
| 12 mm | Single (4 mm) & Double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5±0.05 (0.217±0.002) | 8.0±0.10 (0.315±0.004) | 4.6 (0.181) | 12.3 (0.484) | Not | e 5 |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5±0.05 (0.138±0.002) | 12.0±0.10 (0.157±0.004) | 4.6 (0.181) | 16.3 (0.642) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.

2. The tape with or without components shall pass around R without damage (see Figure 5).

3. If S, < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Standard 481 paragraph 4.3 section b).

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 2).

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 3).

(e) for KPS Series product, A_a and B_a are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 Kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 2 – Maximum Component Rotation



Figure 3 – Maximum Lateral Movement



Figure 4 – Bending Radius





Figure 5 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 6 – Reel Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | |
|--|---|-------------------------------------|--------------------------------------|---|
| Tape Size | А | B Minimum | С | D Minimum |
| 8 mm | 178±0.20 (7.008±0.008) or 330±0.20 (13.000±0.008) | 1.5 (0.059) | 13.0+0.5/-0.2 (0.521+0.02/-0.008) | 20.2 (0.795) |
| 12 mm | | | | |
| 16 mm | | | | |
| Variable Dimensions – Millimeters (Inches) | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ |
| 8 mm | 50 (1.969) | 8.4+1.5/-0.0 (0.331+0.059/-0.0) | 14.4 (0.567) | Shall accommodate tape width without interference |
| 12 mm | | 12.4+2.0/-0.0 (0.488+0.078/-0.0) | 18.4 (0.724) | |
| 16 mm | | 16.4+2.0/-0.0 (0.646+0.078/-0.0) | 22.4 (0.882) | |



Figure 6 – Tape Leader & Trailer Dimensions



Figure 7 – Maximum Camber


Flexible Termination System (FT-CAP), COG Dielectric, 10 – 250 VDC (Commercial & Automotive Grade)



Overview

KEMET's Flexible Termination (FT-CAP) Multilayer Ceramic Capacitor in COG dielectric incorporates a unique, flexible termination system that is integrated with KEMET's standard termination materials. A conductive silver epoxy is utilized between the base metal and nickel barrier layers of KEMET's standard termination system in order to establish pliability while maintaining terminal strength, solderability and electrical performance. This technology was developed in order to address the primary failure mode of MLCCs- flex cracks, which are typically the result of excessive tensile and shear stresses produced during board flexure and thermal cycling. Flexible termination technology inhibits the transfer of board stress to the rigid ceramic body, therefore mitigating flex cracks which can result in low IR or short circuit failures.

Although this technology does not eliminate the potential for mechanical damage that may propagate during extreme environmental and handling conditions, it does provide superior flex performance over standard termination systems. FT-CAP complements KEMET's Open Mode, Floating Electrode (FE-CAP), Floating Electrode with Flexible Termination (FF-CAP), and KEMET Power Solutions (KPS) product lines by providing a complete portfolio of flex mitigation solutions. Combined with the stability of COG dielectric and designed to accommodate all capacitance requirements, these flex-robust devices are RoHS Compliant, offer up to 5 mm of flex-bend capability and exhibit no change in capacitance with respect to time and voltage. Capacitance change with reference to ambient temperature is limited to ± 30 ppm/°C from -55°C to ± 125 °C.

In addition to Commercial Grade, Automotive Grade devices are available which meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.



Ordering Information

| С | 1206 | X | 563 | J | 3 | G | Α | С | TU |
|---------|--|-----------------------------|--|---|---|------------|----------------------------|---|--|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance ¹ | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ² | Packaging/ Grade (C-Spec) |
| | 0603 0805 1206 1210 1812 1825 2220 2225 | X = Flexible Termination | Two significant digits and number of zeros. Use 9 for 1.0 – 9.9 pF Use 8 for 0.5 – .99 pF e.g., 2.2 pF = 229 e.g., 0.5 pF = 508 | $B = \pm 0.10 \text{ pF}$ $C = \pm 0.25 \text{ pF}$ $D = \pm 0.5 \text{ pF}$ $F = \pm 1\%$ $G = \pm 2\%$ $J = \pm 5\%$ $K = \pm 10\%$ $M = \pm 20\%$ | 8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 2 = 200 A = 250 | G = COG | A = N/A | C = 100% Matte Sn L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ Additional capacitance tolerance offerings may be available. Contact KEMET for details.

² Additional termination finish options may be available. Contact KEMET for details.

Built Into Tomorrow



Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) |
|--|---|
| Commerc | ial Grade ¹ |
| Bulk Bag | Not required (Blank) |
| 7" Reel/Unmarked | TU |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2mm pitch ² | 7081 |
| 13" Reel/Unmarked/2mm pitch ² | 7082 |
| Automoti | ve Grade ³ |
| 7" Reel | AUTO |
| 13" Reel/Unmarked | AUTO7411 (EIA 0603 and smaller case sizes) AUTO7210 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2mm pitch ² | 3190 |
| 13" Reel/Unmarked/2mm pitch ² | 3191 |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices. For more information see "Capacitor Marking".

² The 2mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2mm pitch option see "Tape & Reel Packaging Information".

³ Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information".

³ For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information".

³ All Automotive packaging C-Specs listed exclude the option to laser mark components. The option to laser mark is not available on these devices. For more information see "Capacitor Marking".

Benefits

- -55°C to +125°C operating temperature range
- Superior flex performance (up to 5 mm)
- Lead (Pb)-Free, RoHS and REACH compliant
- EIA 0603, 0805, 1206, 1210, 1812, 1825, 2220, and 2225 case sizes
- DC voltage ratings of 10 V, 16 V, 25 V, 50 V, 100 V, 200 V, and 250 V
- Capacitance offerings ranging from 0.5 pF up to 0.47 μ F
- Available capacitance tolerances of ±0.10pF, ±0.25 pF, ±0.5 pF, ±1%, ±2%, ±5%, ±10%, and ±20%
- No piezoelectric noise
- Extremely low ESR and ESL
- · High thermal stability

- · High ripple current capability
- Preferred capacitance solution at line frequencies and into the MHz range
- No capacitance change with respect to applied rated DC voltage
- Negligible capacitance change with respect to temperature from -55°C to +125°C
- · Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish allowing for excellent solderability
- Commercial & Automotive (AEC-Q200) Grades available
- SnPb termination finish option available upon request (5% Pb minimum)

Applications

Typical applications include critical timing, tuning, circuits requiring low loss, circuits with pulse, high current, decoupling, bypass, filtering, transient voltage suppression and blocking, as well as energy storage in critical and safety relevant circuits without (integrated) current limitation, including those subject to high levels of board flexure or temperature cycling.



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | tion Due To: | Days Prior To |
|-----------------------------|----------------------------------|---------------|------------------|
| C-Spec | Process/Product change | Obsolescence* | Implementation |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum |
| AUTO | Yes (without approval) | Yes | 90 days minimum |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | | PPAP (Product | Part Approval | Process) Leve | I |
|-----------------------------|---|---------------|---------------|---------------|---|
| C-Spec | 1 | 2 | 3 | 4 | 5 |
| KEMET assigned ¹ | • | • | • | • | • |
| AUTO | | | 0 | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|-------------------------------|-----------------|-------------------------------|----------------------------|-----------------------|
| 0603 | 1608 | 1.60 (0.064) ±0.17 (0.007) | 0.80 (0.032) ±0.15 (0.006) | | 0.45 (0.018) ±0.15 (0.006) | 0.58 (0.023) | Colder Ways |
| 0805 | 2012 | 2.00 (0.079) ±0.30 (0.012) | 1.25 (0.049) ±0.30 (0.012) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Or Solder Deflow |
| 1206 | 3216 | 3.30 (0.130) ±0.40 (0.016) | 1.60 (0.063) ±0.35 (0.013) | | 0.60 (0.024) ±0.25 (0.010) | | Soluel Kellow |
| 1210 | 3225 | 3.30 (0.130) ±0.40 (0.016) | 2.60 (0.102) ±0.30 (0.012) | See Table 2 for | 0.60 (0.024) ±0.25 (0.010) | | |
| 1812 | 4532 | 4.50 (0.178) ±0.40 (0.016) | 3.20 (0.126) ±0.30 (0.012) | Thickness | 0.70 (0.028) ±0.35 (0.014) | N1/A | |
| 1825 | 4564 | 4.60 (0.181) ±0.40 (0.016) | 6.40 (0.252) ±0.40 (0.016) | _ | 0.70 (0.028) ±0.35 (0.014) | N/A | Solder Reflow Only |
| 2220 | 5650 | 5.90 (0.232) ±0.75 (0.030) | 5.00 (0.197) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | |
| 2225 | 5664 | 5.90 (0.232) ±0.75 (0.030) | 6.40 (0.248) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | |



Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions (excluding SnPb termination finish option).

Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|--|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±30 ppm/°C |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 0% |
| ¹ Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5±1 seconds and charge/discharge not exceeding 50 mA) |
| ² Dissipation Factor (DF) Maximum Limit at 25°C | 0.1% |
| ³ Insulation Resistance (IR) Limit at 25°C | 1,000 megohm microfarads or 100 G Ω (Rated voltage applied for 120±5 seconds at 25°C) |

¹ DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

² Capacitance and dissipation factor (DF) measured under the following conditions:

1 MHz ±100 kHz and 1.0 Vrms ±0.2 V if capacitance \leq 1,000 pF

1 kHz ±50 Hz and 1.0 Vrms ±0.2 V if capacitance > 1,000 pF

³ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Capacitance and Dissipation Factor (DF) measured under the following conditions:

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

Post Environmental Limits

| | High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | | | | | | | |
|------------|---|----------------------|-----------------------------------|----------------------|--------------------------|--|--|--|--|--|--|--|--|--|--|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | | | | | | | | | | |
| COG | All | All | 0.5 | 0.3% or ±0.25 pF | 10% of Initial Limit | | | | | | | | | | |



Table 1A - Capacitance Range/Selection Waterfall (0603 - 1206 Case Sizes)

| | | | Ca | Case Size/Series Voltage Code | | | | | | C | 060 | 3X | | | | | C |) 80 ! | 5X | | | | | C 1 | 1200 | 5X | | | | |
|----------------------|--------------------------|---|-----------------------|-------------------------------|--------|------|-------|----|----|-----|-----|-----|------|-----|-----|------|-------|---------------|-------------|-------------|----------|----------|------|------------|------|----------|------|----------|----------|----------|
| Consoitonoo | Сар | | | ۷ | oltag | e Co | de | | | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | Α |
| Capacitance | Code | | I | Rate | d Volt | age | (VDC | C) | | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 10 | 16 | 25 | 50 | 100 | 200 | 250 |
| | | | C | apac | itanc | e To | leran | ce | | | | | | | P | rodu | ct Av | ailab | ility a | and C | hip T | hick | ness | Cod | es | | | | | |
| 0.50 & 0.75 pE | 508 & 758 | B | C | | | | | | | C L | CL | C I | C I | C I | CL | See | | 2 to | r Chi DR | p Thi DR | CKNE | SS DI | DR | sions I | 5 | | | | | _ |
| 1.0 - 9.1 pF* | 109 - 919* | В | C | D | | | | | | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 10 - 91 pF* | 100 - 910* | | | | F | G | J | К | М | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 100 pF | 101 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 110 - 180 pF* | 111 - 181* 201 - 201* | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | | | DR | | DR | | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 330 pF | 331 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EO | EO | EO | EO | EO | EO | EO |
| 360 pF | 361 | | | | F | G | J | к | М | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 390 pF | 391 | | | | F | G | J | К | М | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 430 pF | 431 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 470 pF 510 nF | 471 511 | | | | F | G | J | ĸ | M | | | CI | | CI | | CI | | | | | | חח | | EQ FO | EQ | EQ FO | EQ | EQ | EQ | EQ |
| 560 pF | 561 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 620 pF | 621 | 1 | | | F | G | J | К | М | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 680 pF | 681 | | | | F | G | J | K | М | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 750 pF | 751 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 820 pF 910 pF | 8Z1 011 | | | | | G | J | ĸ | M | | | | | CI | | | | | | | חח | חח | | | EQ | EQ | EQ | EQ | EQ | EQ |
| 1,000 pF | 102 | | | | F | G | J | ĸ | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DD | DD | DD | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 1,100 pF | 112 | | | | F | G | J | к | М | CJ | CJ | CJ | CJ | CJ | СН | СН | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 1,200 pF | 122 | | | | F | G | J | K | М | CJ | CJ | CJ | CJ | CJ | СН | СН | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 1,300 pF | 132 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | CH | CH | DD | DD | DD | DD | DD | DR | DR | EQ | EQ | EQ | EQ | ER | ER | ER |
| 1,500 pF 1,600 pF | 152 | | | | F | G | J | ĸ | M | | CI | CI | | CI | СН | СН | חח | עע חח | ם חח | עע חח | םם חם | | | EQ FO | EQ | EQ FO | EQ | ES FS | ER FS | ER FS |
| 1,800 pF | 182 | | | | F | G | J | ĸ | M | CJ | CJ | CJ | CJ | CJ | СН | CH | DD | DD | DD | DD | DD | DR | DR | EQ | EQ | EQ | EQ | ES | ES | ES |
| 2,000 pF | 202 | | | | F | G | J | К | М | CJ | CJ | CJ | CJ | CJ | СН | СН | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | ES | ES | ES |
| 2,200 pF | 222 | | | | F | G | J | K | М | CJ | CJ | CJ | CJ | CJ | СН | СН | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | ET | ET | ET |
| 2,400 pF | 242 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | | | DR | DR | DR | DR | DR | DR | | EQ | EQ | EQ | EQ | ER | ER | ER |
| 2,700 pF 3,000 pF | 302 | | | | F | G | J | K | M | | CJ | CJ | CJ | CJ | | | | | | | DR | DR | DR | FR | FR | FR | FR | FR | ER FO | ER FO |
| 3,300 pF | 332 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | | | DD | DD | DD | DD | DR | DR | DR | ER | ER | ER | ER | ET | EQ | EQ |
| 3,600 pF | 362 | | | | F | G | J | К | М | CJ | CJ | CJ | CJ | CJ | | | DD | DD | DD | DD | DR | DD | DD | ER | ER | ER | ER | ET | EQ | EQ |
| 3,900 pF | 392 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | | | DS | DS | DS | DS | DR | DD | DD | ER | ER | ER | ER | EF | EQ | EQ |
| 4,300 pF | 432 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | | | | DS | DS | DS | | עע חח | ם ס | ER | ER | ER | ER | ER | EQ | EQ |
| 5.100 pF | 512 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | 03 | | | DS | DS | DS | DS | DR | DD | DD | ES | ES | ES | ES | ES | EO | EO |
| 5,600 pF | 562 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | | | | DR | DR | DR | DR | DR | DD | DD | ES | ES | ES | ES | ES | EQ | EQ |
| 6,200 pF | 622 | | | | F | G | J | К | М | CJ | CJ | CJ | CJ | | | | DR | DR | DR | DR | DR | DG | DG | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 6,800 pF | 682 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | | | | DR | DR | DR | DR | DR | DG | DG | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 7,500 pF 8 200 nF | /52 | | | | F | G | J | K | M | C.I | C.I | CJ | | | | | | DR | DR | DR | DR | DG | DG | FR | FR | EQ | EQ | EQ | EQ | EQ |
| 9,100 pF | 912 | | | | F | G | J | K | M | CJ | CJ | CJ | | | | | DR | DR | DR | DR | DR | 00 | | ER | ER | ER | ER | EQ | ER | ER |
| 10,000 pF | 103 | | | | F | G | J | К | М | CJ | CJ | CJ | | | | | DR | DR | DR | DR | DD | | | ES | ES | ES | ES | EQ | ER | ER |
| 12,000 pF | 123 | | | | F | G | J | K | M | CJ | CJ | CJ | | | | | DR | DR | DR | DR | DS | | | EQ | EQ | EQ | EQ | EQ | ES | ES |
| 15,000 pF | 153 | | | | F | G | J | K | M | CJ | CJ | CJ | | | | | DR | DR | DR | DD | DG | | | EQ | EQ | EQ | EQ | EQ | EF | EF |
| 22 000 pF | 223 | | | | F | G | J | K | M | | | | | | | | | | | DF | | | | FO | FO | FO | FO | FR | FH | FH |
| 27,000 pF | 273 | | | | F | G | J | ĸ | M | | | | | | | | DF | DF | DF | | | | | EQ | EQ | EQ | EQ | ET | | |
| 33,000 pF | 333 | | | | F | G | J | к | М | | | | | | | | DG | DG | DG | | | | | EQ | EQ | EQ | EQ | ET | | |
| 39,000 pF | 393 | | | | F | G | J | K | М | | | | | | | | DG | DG | DG | | | | | ER | ER | ER | ET | EH | | |
| 47,000 pF | 4/3 | | | | F | G | J | K | M | | | | | | | | DG | DG | DG | | | | | ER | ER | ER | EL | EH | | |
| 68.000 pF | 683 | | | | F | G | J | K | M | | | | | | | | | | | | | | | EF | EF | EF | EH | | | |
| 82,000 pF | 823 | | | | F | G | J | K | M | | | | | | | | | | | | | | | EH | EH | EH | EH | | | |
| 0.10 µF | 104 | | | | F | G | J | K | М | | | | | | | | | | | | | - | - | EH | EH | EH | | | - | |
| | C | | Rated Voltage (VDC) 🗧 | | | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 9 | 16 | 25 | 50 | 100 | 200 | 250 | 2 | 16 | 25 | 50 | 100 | 200 | 250 | | | | |
| Capacitance | Code | | Voltage Code | | | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | | | | |
| | | | | Cas | e Siz | e/S | erie | s | | | | 0 | 0603 | 3X | | | | | C | 0805 | X | | | | | C | 1206 | X | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) These products are protected under US Patents 7,172,985 and 7,670,981, other patents pending, and any foreign counterparts.



Table 1B - Capacitance Range/Selection Waterfall (1210 - 2225 Case Sizes)

| | | | Ca | ase Size/Series Voltage Code 8 | | | | | | C | 121 | 0X | | | | C18 | 12) | (| | C18 | 25) | (| (| C22 | 20) | K | (| :22 | 25) | (| | |
|----------------------|-------------|---|------------------|-----------------------------------|--------|------|-------|-----|-----|----|-----|-----------|-----|-----|-------|-----|--------------|-------|-------|--------|--------------|------|-------|------|-------------|-----|-----|-----|-----|----------|-----|-----|
| Osmasitanaa | Сар | | | ١ | /oltag | je C | ode | | | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 5 | 1 | 2 | Α |
| Capacitance | Code | | R | Rate | d Vol | tag | e (VC | C) | | 5 | 16 | 25 | 50 | 8 | 500 | 250 | 50 | 8 | 200 | 250 | 50 | 8 | 200 | 250 | 50 | 8 | 200 | 250 | 50 | 10 | 500 | 250 |
| | | | <u> </u> | | nitan | | olora | | | | | | | | | Pro | duct | Āva | ilabi | lity a | and C | Chip | Thic | knes | s Co | des | | | | <u> </u> | | |
| | | | Ud | apa | | e i | | nce | | | | | | | | S | <u>ee Ta</u> | ble : | 2 for | Chi | <u>p Thi</u> | ckne | ess D | lime | <u>nsio</u> | ns | _ | | | | _ | |
| 1.0 - 9.1 pF* | 109 - 919* | В | C | |) | L . | | V | | FN | FN | FN | FN | FN | FN | FN | | | | | | | | | | | | | | | | |
| 100 - 430 nF* | 101 - 431* | | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | | | | | | | | | | | | | | | | |
| 470 - 910 pF* | 471 - 911* | | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | | | | | | | | | | | | |
| 1,000 pF | 102 | | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | | | | | | | | | | | | |
| 1,100 pF | 112 | | | | F | G | J | K | Μ | FN | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | | | | | | | | | | | | |
| 1,200 pF | 122 | | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | | | | | | | | | | | | |
| 1,300 pF | 132 | | | | F | G | J | K | M | FN | FN | FN | FN | FN | FQ | FQ | GB | GB | GB | GB | | | | | | | | | | | | |
| 1,500 pF | 152 | | | | F | G | J | K | M | FN | FN | FN | FN | FN | FE | FE | GB | GB | GB | GB | | | | | | | | | | | | |
| 1,600 pF | 162 | | | | F | G | J | K | M | FN | FN | FN | FN | FN | FE | FE | GB | GB | GB | GB | | | | | | | | | | | | _ |
| 1,800 pF | 182 | | | | | 6 | J | K | M | | | | | FN | FE | FE | GB | GB | GB | GB | | | | | | | | | | | | |
| 2,000 pF 2,200 nF | 202 | | | | F | G | J | K | M | FN | FN | | FN | FQ | FT F7 | FT | GB | GB | GB | GB | | | | | | | | | | | | |
| 2,200 pF | 242 | | | | F | G | J | K | M | FN | FN | FN | FN | FO | FO | FO | | 00 | 00 | | | | | | | | | | | | | |
| 2,700 pF | 272 | | | | F | G | J | K | M | FN | FN | FN | FN | FO | FO | FO | GB | GB | GB | GB | | | | | | | | | | | | |
| 3,000 pF | 302 | | | Т | F | G | J | К | Μ | FN | FN | FN | FN | FQ | FA | FA | | | | | | | | | | | | | | | | |
| 3,300 pF | 332 | | | | F | G | J | K | M | FN | FN | FN | FN | FA | FA | FA | GB | GB | GB | GB | i i | | | | | | | | | | | |
| 3,600 pF | 362 | | | | F | G | J | K | M | FN | FN | FN | FN | FA | FA | FA | | | | | | | | | | | | | | | | |
| 3,900 pF | 392 | | | | F | G | J | K | M | FN | FN | FN | FN | FA | FA | FA | GB | GB | GB | GB | HB | HB | HB | HB | | | | | | | | |
| 4,300 pF | 432 | | | | F | G | J | K | M | FN | FN | FN | FN | FA | FA | FA | | | | | | | | | | | | | | | | |
| 4,700 pF | 472 | | | | F | G | J | K | M | FA | FA | FA | FA | FZ | FZ | FZ | GB | GB | GD | GD | НВ | HB | HB | HB | | | | | KE | KE | KE | KE |
| 5,100 pF | 512 | | | | | G | J | K | M | FN | FN | FN | FN | FZ | FZ | FZ | | 0.0 | | 0.1 | | | | | | | | | KE | KE | KE | KE |
| 5,600 pF | 502 | | | | | 6 | J | K | IVI | | | | | FZ | | | GB | GB | GH | GH | нв | нв | нв | нв | | | | | KE | KE | KE | KE |
| 6,200 pF | 682 | | | | | G | J | K | M | | | | | FZ | | | GR | GB | GI | GI | нв | нв | нв | нв | IF | IE | IR | | KE | KE | KE | KE |
| 7 500 pF | 752 | | | | F | G | J | K | M | FO | FO | FO | FO | FO | FN | FN | | UD | 00 | 00 | | TID | TID | TID | JL | JL | 50 | | KE | KE | KE | KE |
| 8.200 pF | 822 | | | | F | G | J | K | M | FO | FO | FO | FO | FO | FN | FN | GB | GH | GB | GB | НВ | НВ | НВ | НВ | JE | JE | JB | | KE | KE | KE | KE |
| 9,100 pF | 912 | | | | F | G | J | K | M | FE | FE | FE | FE | FE | FN | FN | | | | | | | | | | | | | KE | KE | KE | KE |
| 10,000 pF | 103 | | | | F | G | J | K | M | FA | FA | FA | FA | FA | FN | FN | GB | GH | GB | GB | НВ | HB | HE | HE | JE | JE | JB | | KE | KE | KE | KE |
| 12,000 pF | 123 | | | | F | G | J | K | M | FZ | FZ | FZ | FZ | FN | FN | FN | GB | GG | GB | GB | HB | HB | HE | HE | JE | JE | JB | | KE | KE | KE | KE |
| 15,000 pF | 153 | | | | F | G | J | K | Μ | FZ | FZ | FZ | FZ | FN | FQ | FQ | GB | GB | GB | GB | HB | HB | | | JE | JE | JB | | KE | KE | KE | KE |
| 18,000 pF | 183 | | | | F | G | J | K | M | FN | FN | FN | FN | FN | FQ | FQ | GB | GB | GB | GB | HB | HE | | | JE | JE | JB | | KE | KE | | |
| 22,000 pF | 223 | | | | F | G | J | K | M | FN | FN | FN | FN | FN | FA | FA | GB | GB | GB | GB | HB | HE | | | JE | JB | JB | | KE | KE | | |
| 27,000 pF | 2/3 | | | | | G | J | K | M | | FN | | FN | | FZ | FL | GB | GB | GB | GB | НВ | HG | | | JE | JB | JB | | KE | KE | | |
| 33,000 pF | 333 | | | | F | G | J | N K | M | | | | EN | | FU | FU | GB | GB | GB | GB | | | | | | JB | JB | | NE. | | | |
| 47 000 pF | 473 | | | | F | G | | K | M | FN | FN | FN | FN | FE | F.I | F.I | GB | GB | GD | GD | | | | | JB | JB | JB | | | | | |
| 56.000 pF | 563 | | | | F | G | J | ĸ | м | FN | FN | FN | FN | FA | 10 | 10 | GB | GB | GD | GD | | | | | JB | JB | JB | | | | | |
| 68,000 pF | 683 | | | | F | G | J | K | M | FN | FN | FN | FQ | FZ | | | GB | GB | GK | GK | | | | | JB | JB | JB | | | | | |
| 82,000 pF | 823 | | | | F | G | J | K | M | FQ | FQ | FQ | FA | FU | | | GB | GB | GM | GM | i i | | | | JB | JB | JB | | | | | |
| 0.10 µF | 104 | | | | F | G | J | K | Μ | FE | FE | FE | FZ | FM | | | GB | GD | GM | GM | | | | | JB | JB | JD | | | | | |
| 0.12 µF | 124 | | | | F | G | J | K | Μ | FZ | FZ | FZ | FU | | | | GB | GH | | | | | | | JB | JB | JD | | | | | |
| 0.15 µF | 154 | | | | F | G | J | K | M | FU | FU | FU | FM | | | | GD | GN | | | | | | | JB | JB | JG | | | | | |
| 0.18 µF | 184 | | | | F | G | J | K | M | FJ | FJ | FJ | | | | | GH | | | | | | | | JB | JD | JG | | | | | |
| 0.22 µF | 224 | | | | F | 6 | J | K | IVI | FK | FK | FK | | | | | GK | | | | | | | | JB | JD | | | | | | |
| 0.27 µF | 274 | | | | F | 6 | J | ĸ | M | | | | | | | | | | | | | | | | | JF | | | | | | |
| 0.35 µF | 394 | | | | F | G | 1 | K | M | | | | | | | | | | | | | | | | JG | 30 | | | | | | |
| 0.47 µF | 474 | | | | F | G | J | K | M | | | | | | | | | | | | | | | | JG | | | | | | | |
| | | | R | ate | d Vol | tag | e (VD | C) | | 5 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | 50 | 100 | | 200 | 50 | 100 | 200 | 250 |
| Capacitance | Cap Code | | | ١ | /oltaç | je C | ode | | | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 5 | 1 | | 2 | 5 | 1 | 2 | A |
| | Jue | | Case Size/Series | | | C | :121(| X | | | | C18 | 12X | | | C18 | 25X | | | C22 | 20X | | | C22 | 25X | | | | | | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82 and 91) These products are protected under US Patents 7,172,985 and 7,670,981, other patents pending, and any foreign counterparts.



Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic | Quantity |
|-----------|-------------------|--------------------------------|---------|----------------------|---------|----------|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| CJ | 0603 | 0.80 ± 0.15 | 4,000 | 15,000 | 0 | 0 |
| CH | 0603 | 0.85 ± 0.07 | 4,000 | 10,000 | 0 | 0 |
| DR | 0805 | 0.78 ± 0.20 | 0 | 0 | 4,000 | 10,000 |
| DD | 0805 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| DS | 0805 | 1.00 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| DF | 0805 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EQ | 1206 | 0.78 ± 0.20 | 0 | 0 | 4,000 | 10,000 |
| ER | 1206 | 0.90 ± 0.20 | 0 | 0 | 4,000 | 10,000 |
| ES | 1206 | 1.00 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| ET | 1206 | 1.10 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EH | 1206 | 1.60 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FN | 1210 | 0.78 ± 0.20 | 0 | 0 | 4,000 | 10,000 |
| FQ | 1210 | 0.90 ± 0.20 | 0 | 0 | 4,000 | 10,000 |
| | 1210 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FA F7 | 1210 | 1.10 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| FZ | 1210 | 1.25 ± 0.20 | 0 | | 2,500 | |
| FU | 1210 | 1.33 ± 0.20 1.70 ± 0.20 | 0 | | 2,000 | |
| | 1210 | 1.70 ± 0.20 1.95 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FJ | 1210 | 1.05 ± 0.20 2.10 + 0.20 | 0 | | 2,000 | |
| GR | 1210 | 2.10 ± 0.20 1 00 + 0 10 | 0 | 0 | 2,000 | 4 000 |
| GD | 1812 | 1.00 ± 0.10 | 0 | | 1,000 | 4,000 |
| GH | 1812 | 1.25 ± 0.15 1 40 + 0 15 | 0 | 0 | 1,000 | 4,000 |
| 66 | 1812 | 1 55 + 0 10 | 0 | 0 | 1,000 | 4,000 |
| GK | 1812 | 1 60 + 0 20 | Ő | 0 | 1,000 | 4 000 |
| GJ | 1812 | 1 70 + 0 15 | 0 | 0 | 1 000 | 4 000 |
| GN | 1812 | 1.70 ± 0.20 | Ő | 0 0 | 1,000 | 4.000 |
| GM | 1812 | 2.00 ± 0.20 | 0 | 0 | 500 | 2.000 |
| HB | 1825 | 1.10 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| HE | 1825 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| HG | 1825 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| JB | 2220 | 1.00 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JD | 2220 | 1.30 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JE | 2220 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JF | 2220 | 1.50 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JG | 2220 | 1.70 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| KE | 2225 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic | Quantity |

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".



Table 2B – Bulk Packaging Quantities

| Deeke | ving Tuno | Loose Pa | ackaging |
|----------|------------------------|------------------------|------------------------|
| Раска | Jing Type | Bulk Bag | (default) |
| Packagi | ng C-Spec ¹ | N, | /A ² |
| Cas | e Size | Packaging Quantities (| pieces/unit packaging) |
| EIA (in) | Metric (mm) | Minimum | Maximum |
| 0402 | 1005 | | |
| 0603 | 1608 | | |
| 0805 | 2012 | | 50,000 |
| 1206 | 3216 | | |
| 1210 | 3225 | 1 | |
| 1808 | 4520 | | |
| 1812 | 4532 | | |
| 1825 | 4564 | | 20,000 |
| 2220 | 5650 | | |
| 2225 | 5664 | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial Grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive Grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351 (mm)

| EIA Size | Metric Size | | Dens Maxi Land P | sity Lev mum (I rotrusio | vel A: Most) on (mm |) | | Dens Media Land Pi | sity Lev an (Noi rotrusio | vel B: minal) on (mm |) | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | |
|-------------|----------------|------|------------------------|--------------------------------|---------------------------|------|------|--------------------------|---------------------------------|----------------------------|------|---|------|------|------|------|--|--|
| Coue | Coue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | | |
| 0603 | 1608 | 0.85 | 1.25 | 1.10 | 4.00 | 2.10 | 0.75 | 1.05 | 1.00 | 3.10 | 1.50 | 0.65 | 0.85 | 0.90 | 2.40 | 1.20 | | |
| 0805 | 2012 | 0.99 | 1.44 | 1.66 | 4.47 | 2.71 | 0.89 | 1.24 | 1.56 | 3.57 | 2.11 | 0.79 | 1.04 | 1.46 | 2.42 | 1.81 | | |
| 1206 | 3216 | 1.59 | 1.62 | 2.06 | 5.85 | 3.06 | 1.49 | 1.42 | 1.96 | 4.95 | 2.46 | 1.39 | 1.22 | 1.86 | 4.25 | 2.16 | | |
| 1210 | 3225 | 1.59 | 1.62 | 3.01 | 5.90 | 4.01 | 1.49 | 1.42 | 2.91 | 4.95 | 3.41 | 1.39 | 1.22 | 2.81 | 4.25 | 3.11 | | |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 | | |
| 1812 | 4532 | 2.10 | 1.80 | 3.60 | 7.00 | 4.60 | 2.00 | 1.60 | 3.50 | 6.10 | 4.00 | 1.90 | 1.40 | 3.40 | 5.40 | 3.70 | | |
| 1825 | 4564 | 2.15 | 1.80 | 6.90 | 7.10 | 7.90 | 2.05 | 1.60 | 6.80 | 6.20 | 7.30 | 1.95 | 1.40 | 6.70 | 5.50 | 7.00 | | |
| 2220 | 5650 | 2.85 | 2.10 | 5.50 | 8.80 | 6.50 | 2.75 | 1.90 | 5.40 | 7.90 | 5.90 | 2.65 | 1.70 | 5.30 | 7.20 | 5.60 | | |
| 2225 | 5664 | 2.85 | 2.10 | 6.90 | 8.80 | 7.90 | 2.75 | 1.90 | 6.80 | 7.90 | 7.30 | 2.65 | 1.70 | 6.70 | 7.20 | 7.00 | | |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805, and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Termination Finish | | | |
|--|-----------------------|-----------------------|--|--|
| Fromereature | SnPb | 100% Matte Sn | | |
| Preheat/Soak | | | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C | | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | | |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds | | |
| Ramp-Up Rate (T_L to T_p) | 3°C/second maximum | 3°C/second maximum | | |
| Liquidous Temperature (T _L) | 183°C | 217°C | | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | | |
| Peak Temperature (T _P) | 235°C | 260°C | | |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 30 seconds maximum | | |
| Ramp-Down Rate $(T_p to T_L)$ | 6°C/second maximum | 6°C/second maximum | | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | | |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method |
|------------------------|---------------------------------------|--|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds. |
| Board Flex | JIS-C-6429 | Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm for COG. Flexible termination system – 3.0 mm (minimum). |
| | | Magnification 50 X. Conditions: |
| Solderability | 1-STD-002 | a) Method B, 4 hours at 155°C, dry heat at 235°C |
| | J-31D-002 | b) Method B at 215°C category 3 |
| | | c) Method D, category 3 at 260°C |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 Cycles (-55°C to +125°C). Measurement at 24 hours +/-4 hours after test conclusion. |
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and rated voltage. Add 100 K ohm resistor. Measurement at 24 hours +/-4 hours after test conclusion. Low Volt Humidity: 1.000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. |
| | | Measurement at 24 hours +/-4 hours after test conclusion. |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours +/-4 hours after test conclusion. |
| Thermal Shock | MIL-STD-202 Method 107 | -55°C/+125°C. Note: Number of cycles required – 300, maximum transfer time – 20 seconds, dwell time – 15 minutes. Air – Air. |
| High Temperature Life | MIL-STD-202 Method 108 /EIA-198 | 1,000 hours at 125°C (85°C for X5R, Z5U and Y5V) with 2 X rated voltage applied. |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC for 1,000 hours. |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Condition F. |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction



Capacitor Marking (Optional)

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- · EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| EIA Case Size | Tape | Embosse | ed Plastic | Punched Paper | | |
|----------------------|------|---------|--------------------|---------------|--------------------|--|
| | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | (W)* | Pitch | (P ₁)* | Pitch | (P ₁)* | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 | |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | |
| Array 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | |
| 16 mm | | (0.059) | | | | (1.181) | | | | |
| | | , | Variable Dime | ensions – Mil | limeters (Incl | nes) | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | Note 5 | | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|--|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|
| Tape Size | D _o | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | |
| 8 mm Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | |
|--|----------------------|---------------------------------------|--|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | |
| 8 mm | 178 ±0.20 | | | | | | |
| 12 mm | (7.008 ±0.008) Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 | | | |
| 16 mm | (13.000 ±0.008) | | | | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber



Overview

KEMET's Flexible Termination (FT-CAP) Multilayer Ceramic Capacitor in Ultra-Stable X8R dielectric incorporates a unique, flexible termination system that is integrated with KEMET's standard termination materials. A conductive silver epoxy is utilized between the base metal and nickel barrier layers of KEMET's standard termination system in order to establish pliability, while maintaining terminal strength, solderability and electrical performance. This technology was developed in order to address the primary failure mode of MLCCs- flex cracks, which are typically the result of excessive tensile and shear stresses produced during board flexure and thermal cycling. Flexible termination technology inhibits the transfer of board stress to the rigid ceramic body, therefore mitigating flex cracks which can result in low IR or short circuit failures.

Although this technology does not eliminate the potential for mechanical damage that may propagate during extreme environmental and handling conditions, it does provide superior flex performance over standard termination systems. FT-CAP complements KEMET's Open Mode, Floating Electrode (FE-CAP), Floating Electrode with Flexible Termination (FF-CAP), and KEMET Power Solutions (KPS) product lines by providing a complete portfolio of flex mitigation solutions.

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Combined with the stability of KEMET's Ultra-Stable high temperature dielectric technology, these flex-robust devices are RoHS Compliant, offer up to 5 mm of flex-bend capability and feature a 150°C maximum operating temperature. Ultra-Stable X8R dielectric offers the same temperature capability as conventional X8R, but without the capacitance loss due to applied DC voltage. These devices exhibit no change in capacitance with respect to voltage and boast a minimal change in capacitance with reference to ambient temperature. They are also suitable replacements for higher capacitance and larger footprint devices that fail to offer capacitance stability. Capacitance change with respect to temperature is limited to \pm 15% from -55°C to +150°C.

In addition to Commercial Grade, Automotive Grade devices are available which meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.



Ordering Information

| С | 1206 | X | 104 | J | 3 | Н | Α | C | AUTO |
|---------|--------------------------------------|-----------------------------|---|---|---|--------------------------|----------------------------|---|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Reated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ¹ | Packaging/ Grade (C-Spec) |
| | 0603 0805 1206 1210 1812 | X = Flexible Termination | Two significant digits and number of zeros. | $B = \pm 0.10 \text{ pF}$ $C = \pm 0.25 \text{ pF}$ $D = \pm 0.5 \text{ pF}$ $F = \pm 1\%$ $G = \pm 2\%$ $J = \pm 5\%$ $K = \pm 10\%$ $M = \pm 20\%$ | 8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 | H = Ultra- Stable X8R | A = N/A | C = 100% Matte Sn L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ Additional termination finish options may be available. Contact KEMET for details. ¹ SnPb termination finish option is not available on Automotive Grade product.



Packaging C-Spec Ordering Options Table

| Packaging Type | Packaging/Grade Ordering Code (C-Spec) | | |
|---|---|--|--|
| Commerc | ial Grade ¹ | | |
| Bulk Bag | Not Required (Blank) | | |
| 7" Reel/Unmarked | TU | | |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) | | |
| 7" Reel/Unmarked/2 mm pitch ² | 7081 | | |
| 13" Reel/Unmarked/2 mm pitch ² | 7082 | | |
| Automoti | ve Grade ³ | | |
| 7" Reel | AUTO | | |
| 13" Reel/Unmarked | AUT07411 (EIA 0603 and smaller case sizes) AUT07210 (EIA 0805 and larger case sizes) | | |
| 7" Reel/Unmarked/2 mm pitch ² | 3190 | | |
| 13" Reel/Unmarked/2 mm pitch ² | 3191 | | |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked.

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

³ Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information".

³ For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information".

³ All Automotive packaging C-Specs listed exclude the option to laser mark components. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking".

Benefits

- -55°C to +150°C operating temperature range
- Superior flex performance (up to 5 mm)
- Lead (Pb)-free, RoHS and REACH compliant
- EIA 0603, 0805, 1206, 1210, and 1812 case sizes
- DC voltage ratings of 10 V, 16 V, 25 V, 50 V and 100 V
- Capacitance offerings ranging from 0.5 pF to 0.22 μF
- Available capacitance tolerances of ± 0.10 pf, ± 0.25 pf, ± 0.5 pf, $\pm 1\%$, $\pm 2\%$, $\pm 5\%$,
 - ±10%, and ±20%
- Extremely low ESR and ESL

- · High thermal stability
- High ripple current capability
- No capacitance change with respect to applied rated DC voltage
- Non-polar device, minimizing installation concerns
- Commercial and Automotive (AEC-Q200) grades available
- 100% pure matte tin-plated termination finish allowing for excellent solderability
- SnPb plated termination finish option available upon request (5% Pb minimum)

Applications

Typical applications include decoupling, bypass, filtering and transient voltage suppression in critical and safety relevant circuits without (integrated) current limitation, including those subject to high levels of board flexure or temperature cycling.



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | Days Prior To | | |
|-----------------------------|----------------------------------|---------------|------------------|--|
| C-Spec | Process/Product change | Obsolescence* | Implementation | |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum | |
| AUTO | Yes (without approval) | Yes | 90 days minimum | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive C-Spec | PPAP (Product Part Approval Process) Level | | | | | | |
|-----------------------------|--|---|---|---|---|--|--|
| | 1 | 2 | 3 | 4 | 5 | | |
| KEMET assigned ¹ | • | • | • | • | • | | |
| AUTO | | | 0 | | | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|----------------------------|------------------------------------|
| 0603 | 1608 | 1.60 (0.063) ±0.17 (0.007) | 0.80 (0.032) ±0.15 (0.006) | | 0.45 (0.018) ±0.15 (0.006) | 0.58 (0.023) | Colder Wave |
| 0805 | 2012 | 2.00 (0.079) ±0.30 (0.012) | 1.25 (0.049) ±0.30 (0.012) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave Or Solder Deflow |
| 1206 | 3216 | 3.30 (0.130) ±0.40 (0.016) | 1.60 (0.063) ±0.35 (0.013) | See Table 2 for Thickness | 0.60 (0.024) ±0.25 (0.010) | | Soluel Reliow |
| 1210 | 3225 | 3.30 (0.130) ±0.40 (0.016) | 2.60 (0.102) ±0.30 (0.012) | | 0.60 (0.024) ±0.25 (0.010) | N/A | Solder Reflow |
| 1812 | 4532 | 4.50 (0.178) ±0.40 (0.016) | 3.20 (0.126) ±0.30 (0.012) | | 0.70 (0.028) ±0.35 (0.014) | | Only |



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +150°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±15% |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 0% |
| ¹ Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50mA) |
| ² Dissipation Factor (DF) Maximum Limit at 25°C | 2.5% |
| ³ Insulation Resistance (IR) Minimum Limit at 25°C | 1,000 MΩ μF or 100 GΩ (Rated voltage applied for 120 ±5 seconds at 25°C) |

¹ DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

²Capacitance and dissipation factor (DF) measured under the following conditions:

1 MHz ±100 kHz and 1.0 ±0.2 V_{rms} if capacitance \leq 1,000 pF.

1 kHz ±50 Hz and 1.0 ±0.2 V_{rms} if capacitance > 1,000 pF.

³ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 & Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON".

Post Environmental Limits

| | High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | |
|------------------|---|----------------------|-----------------------------------|----------------------|--------------------------|--|--|--|--|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | | | | |
| Ultra-Stable X8R | All | All | 3.0 | 0.3% or ±0.25 pF | 10% of Initial Limit | | | | |



Table 1 – Capacitance Range/Selection Waterfall (0603 – 1812 Case Sizes)

| | | 0 | Cas | se | Siz | ze/ | Se | rie | s | | C |)60 | 3C | | | C |)80 | 5C | | | C | 120 | 6 C | | | C | 121 | 0C | | C18 | 12C |
|------------------|------------|---|-----|----------|------|------|-------|------|---|-----|-----|------|-----|-----|----|----|------|-------|---------|---------|-------|-------|------------|-------|-----|----|-------|----|-----|-----|-----|
| 0 | Сар | | | Vo | ltag | je C | ode | | | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 5 | 1 |
| Capacitance | Code | | Ra | ated | Volt | tage | e (VI | DC) | | 10 | 16 | 25 | 50 | 100 | 5 | 16 | 25 | 50 | 100 | 5 | 16 | 25 | 50 | 100 | 10 | 16 | 25 | 50 | 100 | 50 | 100 |
| | | | Cap | aci | tanc | e To | oler | ance | e | | | | | | - | P | rodu | ct Av | ailab | ility : | and C | hip 1 | Thick | ness | Cod | es | | | | | |
| 0.50 & 0.75 pF | 508 & 758 | В | С | D | | | | | | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | | | ртп | CKIIE | 55 DI | | | • | | | | |
| 0.75 pF | 758 | В | С | D | | | | | | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | | | | | | | | | | | | |
| 1.0 - 9.1 pF* | 109 - 919* | B | C | D | | | | | | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 1.1 pF 1.2 nF | 119 | B | C | | | | | | | C.I | C.I | CJ | CJ | CJ | | | | | | FO | FO | FO | FO | FO | FN | FN | FN | FN | FN | | |
| 1.3 pF | 139 | B | C | D | | | | | | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 1.5 pF | 159 | В | С | D | | | | | | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 1.6 pF | 169 | В | C | D | | | | | | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 1.8 pF | 189 | B | C | D | | | | | | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 2.0 pF | 209 | B | C | D | | | | | | C.I | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | FO | FO | EQ | FO | FO | FN | FN | FN | FN | FN | | |
| 2.4 pF | 249 | В | c | D | | | | | | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 2.7 pF | 279 | В | С | D | | | | | | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 3.0 pF | 309 | В | С | D | | | | | | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 3.3 pF | 339 | B | C | D | | | | | | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 3.0 pF 3.0 pF | 309 | B | | | | | | | | | | | CI | CI | | | | | | EQ | EQ | EQ | EQ | EQ | | | | | | | |
| 4.3 pF | 439 | В | c | D | | | | | | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EO | EO | EO | EO | EO | FN | FN | FN | FN | FN | | |
| 4.7 pF | 479 | В | С | D | | | | | | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 5.1 pF | 519 | В | С | D | | | | | | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 5.6 pF | 569 | B | C | D | | | | | | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 6.2 pF | 629 680 | B | | | | | | | | CJ | CJ | CJ | CJ | CJ | | | | DR | | EQ | EQ | EQ | EQ | EQ | | | | | | | |
| 7.5 pF | 759 | B | c | D | | | | | | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EO | EO | EO | EO | EO | FN | FN | FN | FN | FN | | |
| 8.2 pF | 829 | В | C | D | | | | | | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 9.1 pF | 919 | В | С | D | | | | | | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 10 pF | 100 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 11 pF 12 pE | 110 | | | | | G | J | K | M | CJ | CJ | CJ | CJ | CJ | | | | | | EQ | EQ | EQ | EQ | EQ | | | | | | | |
| 12 pF 13 nF | 120 | | | | F | G | J | K | M | C.J | CJ | CJ | CJ | CJ | | DR | | | DR | FO | FO | FO | FO | FO | FN | FN | FN | FN | FN | | |
| 15 pF | 150 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 16 pF | 160 | | | | F | G | J | K | М | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 18 pF | 180 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 20 pF | 200 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 22 pF 24 nF | 220 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | FO | FO | FO | FO | FO | FN | FN | FN | FN | FN | | |
| 27 pF | 270 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 30 pF | 300 | | | | F | G | J | K | М | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 33 pF | 330 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 36 pF | 360 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 43 nF | 430 | | | | F | G | 1 | K | M | C.I | C.I | C.I | C.I | C.I | | DR | DR | DR | DR | FO | FO | EQ | FO | FO | FN | FN | FN | FN | FN | | |
| 47 pF | 470 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 51 pF | 510 | | | | F | G | J | K | М | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 56 pF | 560 | | | | F | G | J | K | М | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 62 pF | 620 680 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | DR | | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | | FN | | | | | |
| 75 nF | 750 | | | | F | G | J. | K | M | C.I | C.I | C.I | C.J | C.I | | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 82 pF | 820 | | | | F | G | J | K | M | ĊJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 91 pF | 910 | | | | F | G | J | K | М | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 100 pF | 101 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 110 pF | 111 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 120 pF | 121 | | | | F | G | J | K | M | C.I | C.J | C.J | C.J | C.J | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 150 pF | 151 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 160 pF | 161 | | | | F | G | J | K | М | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 180 pF | 181 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 200 pF | 201 | | | <u> </u> | F | G | J | K | M | | CJ | CJ | | CJ | | DR | DR | DR | DR O | | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| | Can | L | Ra | ted | Vol | tage | e (V | DC) | | μ¥ | 1 | 25 | 5(| 9 | μĔ | 12 | 25 | 5(| 9 | Ĕ | 16 | 25 | 5(| 9 | Ĕ | 7 | 25 | 5(| 9 | 5(| 10 |
| Capacitance | Code | | | Vo | ltag | je C | ode | | | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 5 | 1 |
| | | | C | ase | Siz | ze/S | Seri | es | | | C | 0603 | BC | | | C | 0805 | С | | | C | 1206 | C | | | C | ;1210 | C | | C18 | 12C |



Table 1 – Capacitance Range/Selection Waterfall (0603 – 1812 Case Sizes) cont.

| | | Cas | se | Siz | e/ | Se | rie | S | | C |)60 | 3C | | | C | 080 | 5C | | | C | 120 | 6C | | | C | 121 | OC | | C18 | 12C |
|----------------------|------|-----|------|------|-------|------|---------|-----|-----|----|------|----|-----|-----|----|------|-------|-------|----------|----------|------------------|----------|------|------|----|-------|----|----------|-----|-----|
| 0 | Сар | | Vo | ltag | je Co | ode | | | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 5 | 1 |
| Capacitance | Code | Ra | ated | Volt | tage | (VD |)C) | | 10 | 16 | 25 | 50 | 100 | 1 | 16 | 25 | 50 | 100 | 5 | 16 | 25 | 50 | 100 | 10 | 16 | 25 | 50 | 100 | 50 | 100 |
| | | Cap | paci | tanc | e To | lera | ance | ; | | | | | | | P | rodu | ct Av | ailab | ility | and C | hip 1 | hick | ness | Code | es | | | | | |
| 220 pF | 221 | | | F | G | J | К | М | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | <u>pin</u> EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 240 pF | 241 | | | F | G | J | К | М | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 270 pF | 271 | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 300 pF | 301 | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 330 pF 360 nF | 361 | | | F | G | J | ĸ | M | | CI | | CI | CI | | | | | | EQ FO | EQ FO | EQ FO | EQ | EQ | FN | FN | FN | FN | FN | | |
| 390 pF | 391 | | | F | G | J | ĸ | M | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EO | EO | EO | EO | EO | FN | FN | FN | FN | FN | | |
| 430 pF | 431 | | | F | G | J | К | М | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | | |
| 470 pF | 471 | | | F | G | J | К | М | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | GB | GB |
| 510 pF | 511 | | | F | G | J | K | М | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | GB | GB |
| 560 pF | 561 | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | GB | GB |
| 620 pF | 621 | | | F | G | J | ĸ | M | CJ | CJ | CJ | CJ | CJ | | DR | | DR | | EQ | EQ | EQ | EQ | EQ | | FN | FN | FN | FN | GB | GB |
| 750 pF | 751 | | | F | G | J | ĸ | M | C.J | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | FO | FO | FO | FO | FO | FN | FN | FN | FN | FN | GB | GB |
| 820 pF | 821 | | | F | G | J | ĸ | M | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | GB | GB |
| 910 pF | 911 | | | F | G | J | К | М | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DD | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | GB | GB |
| 1,000 pF | 102 | | | F | G | J | K | Μ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DD | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | GB | GB |
| 1,100 pF | 112 | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | GB | GB |
| 1,200 pF | 122 | | | | G | J | K | M | CJ | CJ | CJ | CJ | CJ | | | | | | EQ | EQ | EQ | EQ | EQ | | | | | | GB | GB |
| 1,500 pF | 152 | | | F | G | J | ĸ | M | C.I | CJ | CJ | CJ | CJ | | םם | | םם | םם | FO | FO | FO | FO | ER | FN | FN | FN | FN | FN | GB | GB |
| 1,600 pF | 162 | | | F | G | J | ĸ | M | CJ | CJ | CJ | CJ | CJ | DD | DD | DD | DD | DD | EO | EO | EO | EO | ES | FN | FN | FN | FN | FN | GB | GB |
| 1,800 pF | 182 | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | DD | DD | DD | DD | DD | EQ | EQ | EQ | EQ | ES | FN | FN | FN | FN | FN | GB | GB |
| 2,000 pF | 202 | | | F | G | J | К | М | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | ES | FN | FN | FN | FN | FQ | GB | GB |
| 2,200 pF | 222 | | | F | G | J | K | М | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | ET | FN | FN | FN | FN | FQ | GB | GB |
| 2,400 pF | 242 | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | ER | FN | FN | FN | FN | FQ | CD. | CD. |
| 2,700 pF 3,000 pE | 302 | | | F | G | J | ĸ | M | | CI | CI | CI | CI | | | | | | FR | EQ | EQ | EQ | FR | FN | FN | FN | FN | FQ | GB | GB |
| 3.300 pF | 332 | | | F | G | J | ĸ | M | CJ | CJ | CJ | CJ | CJ | DD | DD | DR | DR | DR | ER | ER | ER | ER | ET | FN | FN | FN | FN | FA | GB | GB |
| 3,600 pF | 362 | | | F | G | J | к | м | CJ | CJ | CJ | CJ | CJ | DD | DD | DR | DR | DR | ER | ER | ER | ER | ET | FN | FN | FN | FN | FA | | |
| 3,900 pF | 392 | | | F | G | J | ĸ | М | CJ | CJ | CJ | CJ | CJ | DS | DS | DR | DR | DR | ER | ER | ER | ER | EF | FN | FN | FN | FN | FA | GB | GB |
| 4,300 pF | 432 | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | DS | DS | DR | DR | DR | ER | ER | ER | ER | ER | FN | FN | FN | FN | FA | | |
| 4,700 pF | 472 | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | DS | DS | DR | DR | DR | ER | ER | ER | ER | ER | FA | FA | FA | FA | FZ | GB | GB |
| 5,100 pF | 562 | | | F | G | J | ĸ | M | | CI | | CI | | | | | | | ES FS | ES FS | ES FS | ES FS | ES | FN | FN | FN | FN | FZ F7 | GB | GB |
| 6.200 pF | 622 | | | F | G | J | ĸ | M | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | EO | EO | EO | EO | EO | FN | FN | FN | FN | FZ | 05 | 00 |
| 6,800 pF | 682 | | | F | G | J | к | М | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FZ | GB | GB |
| 7,500 pF | 752 | | | F | G | J | К | М | CJ | CJ | CJ | | | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | FQ | FQ | FQ | FQ | FQ | | |
| 8,200 pF | 822 | | | F | G | J | K | М | CJ | CJ | CJ | | | DR | DR | DR | DR | DR | ER | ER | EQ | EQ | EQ | FQ | FQ | FQ | FQ | FQ | GB | GH |
| 9,100 pF | 912 | | | F | G | J | K | M | CJ | CJ | CJ | | | DR | DR | DR | DR | DR | ER | ER | EQ | EQ | EQ | FE | FE | FE | FE | FE | 0.0 | 011 |
| 12,000 pF | 103 | | | F | G | J | ĸ | M | UJ | UJ | UJ | | | | | | | | EQ FO | EQ FO | EQ FO | FO | FO | FA | FA | FA | FN | FN | GB | GG |
| 15.000 pF | 153 | | | F | G | J | K | M | | | | | | DR | DR | DR | DD | DG | EO | EO | EO | EO | EO | FN | FN | FN | FN | FN | GB | GB |
| 18,000 pF | 183 | | | F | G | J | K | M | | | | | | DR | DR | DR | DD | | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | GB | GB |
| 22,000 pF | 223 | | | F | G | J | К | М | | | | | | DD | DD | DD | DF | | EQ | EQ | EQ | EQ | ER | FN | FN | FN | FN | FN | GB | GB |
| 27,000 pF | 273 | | | F | G | J | K | Μ | | | | | | DF | DF | DF | | | EQ | EQ | EQ | EQ | ET | FN | FN | FN | FN | FN | GB | GB |
| 33,000 pF | 333 | | | F | G | J | K | M | | | | | | DG | DG | DG | | | EQ | EQ | EQ | EQ | ET | FN | FN | FN | FN | FN | GB | GB |
| 47,000 pF | 473 | | | | G | J | ĸ | M | | | | | | | | | | | ER | ER | ER | FF | EH | FN | | | FN | FE | GB | GB |
| 68 000 pF | 683 | | | F | G | J | ĸ | M | | | | | | | | | | | FF | FF | FF | FH | | FN | FN | FN | FO | F7 | GB | GB |
| 82,000 pF | 823 | | | F | G | J | K | M | | | | | | | | | | | EH | EH | EH | EH | | FQ | FQ | FQ | FA | FU | GB | GB |
| 100,000 pF | 104 | | | F | G | J | Κ | М | | | | | | | | | | | EH | EH | EH | | | FE | FE | FE | FZ | FM | GB | GD |
| 120,000 pF | 124 | | | F | G | J | K | М | | | | | | | | | | | | | | | | FZ | FZ | FZ | FU | | GB | GH |
| 150,000 pF | 154 | | | F | G | J | K | M | | | | | | | | | | | | | | | | FU | FU | FU | FM | | GD | GN |
| 220 000 pF | 184 | | | F | G | J | K | M | | | | | | | | | | | | | | | | FJ | FJ | FJ | | | GK | |
| 220,000 pr | 224 | R | ated | Volt | tage | (VI |) () | IVI | e | 16 | 25 | .0 | 8 | _ ⊇ | 16 | 25 | 20 | 8 | <u> </u> | 16 | 25 | 20 | 8 | 2 | 16 | 25 | 20 | 8 | 20 | 00 |
| Capacitance | Cap | | Vo | Itao | e Co | de. | -, | | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | / | 1 |
| | Code | c | ase | Siz | ze/S | eri | es | | - | C | 0603 | BC | 1 | | C | 0805 | C | | | C | 1206 | C | | | C | :1210 | C | I | C18 | 12C |



| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic Quantity | | | |
|-----------|-------------------|-------------|---------|----------------------|------------------|----------|--|--|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | |
| CJ | 0603 | 0.80 ±0.15* | 4,000 | 15,000 | 0 | 0 | | |
| DR | 0805 | 0.78 ±0.20 | 0 | 0 | 4,000 | 10,000 | | |
| DD | 0805 | 0.90 ±0.10 | 0 | 0 | 4,000 | 10,000 | | |
| DS | 0805 | 1.00 ±0.20 | 0 | 0 | 2,500 | 10,000 | | |
| DF | 0805 | 1.10 ±0.10 | 0 | 0 | 2,500 | 10,000 | | |
| DG | 0805 | 1.25 ±0.15 | 0 | 0 | 2,500 | 10,000 | | |
| EQ | 1206 | 0.78 ±0.20 | 0 | 0 | 4,000 | 10,000 | | |
| ER | 1206 | 0.90 ±0.20 | 0 | 0 | 4,000 | 10,000 | | |
| ES | 1206 | 1.00 ±0.20 | 0 | 0 | 2,500 | 10,000 | | |
| ET | 1206 | 1.10 ±0.20 | 0 | 0 | 2,500 | 10,000 | | |
| EF | 1206 | 1.20 ±0.15 | 0 | 0 | 2,500 | 10,000 | | |
| EH | 1206 | 1.60 ±0.20 | 0 | 0 | 2,000 | 8,000 | | |
| FN | 1210 | 0.78 ±0.20 | 0 | 0 | 4,000 | 10,000 | | |
| FQ | 1210 | 0.90 ±0.20 | 0 | 0 | 4,000 | 10,000 | | |
| FE | 1210 | 1.00 ±0.10 | 0 | 0 | 2,500 | 10,000 | | |
| FA | 1210 | 1.10 ±0.15 | 0 | 0 | 2,500 | 10,000 | | |
| FZ | 1210 | 1.25 ±0.20 | 0 | 0 | 2,500 | 10,000 | | |
| FU | 1210 | 1.55 ±0.20 | 0 | 0 | 2,000 | 8,000 | | |
| FM | 1210 | 1.70 ±0.20 | 0 | 0 | 2,000 | 8,000 | | |
| FJ | 1210 | 1.85 ±0.20 | 0 | 0 | 2,000 | 8,000 | | |
| GB | 1812 | 1.00 ±0.10 | 0 | 0 | 1,000 | 4,000 | | |
| GD | 1812 | 1.25 ±0.15 | 0 | 0 | 1,000 | 4,000 | | |
| GH | 1812 | 1.40 ±0.15 | 0 | 0 | 1,000 | 4,000 | | |
| GG | 1812 | 1.55 ±0.10 | 0 | 0 | 1,000 | 4,000 | | |
| GK | 1812 | 1.60 ±0.20 | 0 | 0 | 1,000 | 4,000 | | |
| GN | 1812 | 1.70 ±0.20 | 0 | 0 | 1,000 | 4,000 | | |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic | Quantity | | |

Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".



Table 2B – Bulk Packaging Quantities

| Deelver | | Loose Packaging Bulk Bag (default) | | | | | | |
|----------|------------------------|---|---------|--|--|--|--|--|
| Раскад | ing type | | | | | | | |
| Packagin | lg C-Spec ¹ | N/A ² | | | | | | |
| Case | e Size | Packaging Quantities (pieces/unit packaging | | | | | | |
| EIA (in) | Metric (mm) | Minimum | Maximum | | | | | |
| 0402 | 1005 | | | | | | | |
| 0603 | 1608 | | | | | | | |
| 0805 | 2012 | | 50,000 | | | | | |
| 1206 | 3216 | | | | | | | |
| 1210 | 3225 | 1 | | | | | | |
| 1808 | 4520 | | | | | | | |
| 1812 | 4532 | | | | | | | |
| 1825 | 4564 | | 20,000 | | | | | |
| 2220 | 5650 |] | | | | | | |
| 2225 | 5664 |] | | | | | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and automotive grade products). The 15th through 22nd character positions of the ordering code should be left blank. All products ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351 (mm)

| EIA Size | Metric Size | | Dens Maxi Land P | sity Lev mum (I rotrusio | vel A: Most) on (mm |) | | Dens Media Land Pi | sity Lev an (Nor rotrusio | vel B: ninal) on (mm |) | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | |
|-------------|----------------|------|------------------------|--------------------------------|---------------------------|------|------|--------------------------|---------------------------------|----------------------------|------|---|------|------|------|------|--|--|
| Coue | Coue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | | |
| 0603 | 1608 | 0.85 | 1.25 | 1.10 | 4.00 | 2.10 | 0.75 | 1.05 | 1.00 | 3.10 | 1.50 | 0.65 | 0.85 | 0.90 | 2.40 | 1.20 | | |
| 0805 | 2012 | 0.99 | 1.44 | 1.66 | 4.47 | 2.71 | 0.89 | 1.24 | 1.56 | 3.57 | 2.11 | 0.79 | 1.04 | 1.46 | 2.42 | 1.81 | | |
| 1206 | 3216 | 1.59 | 1.62 | 2.06 | 5.85 | 3.06 | 1.49 | 1.42 | 1.96 | 4.95 | 2.46 | 1.39 | 1.22 | 1.86 | 4.25 | 2.16 | | |
| 1210 | 3225 | 1.59 | 1.62 | 3.01 | 5.90 | 4.01 | 1.49 | 1.42 | 2.91 | 4.95 | 3.41 | 1.39 | 1.22 | 2.81 | 4.25 | 3.11 | | |
| 1812 | 4532 | 2.10 | 1.80 | 3.60 | 7.00 | 4.60 | 2.00 | 1.60 | 3.50 | 6.10 | 4.00 | 1.90 | 1.40 | 3.40 | 5.40 | 3.70 | | |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805, and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Termination Finish | | | | | | |
|--|-----------------------|-----------------------|--|--|--|--|--|
| Tomeredure | SnPb | 100% Matte Sn | | | | | |
| Preheat/Soak | | | | | | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C | | | | | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | | | | | |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds | | | | | |
| Ramp-Up Rate (T_L to T_p) | 3°C/second maximum | 3°C/second maximum | | | | | |
| Liquidous Temperature (T _L) | 183°C | 217°C | | | | | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | | | | | |
| Peak Temperature (T _P) | 235°C | 260°C | | | | | |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 30 seconds maximum | | | | | |
| Ramp-Down Rate $(T_p to T_L)$ | 6°C/second maximum | 6°C/second maximum | | | | | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | | | | | |

Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods & Conditions

| Stress | Reference | Test or Inspection Method |
|------------------------|-----------------------------------|---|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds. |
| Board Flex | JIS-C-6429 | Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm for COG. Flexible termination system – 3.0 mm (minimum). |
| | | Magnification 50 X. Conditions: |
| Soldorability | 1-510-002 | a) Method B, 4 hours at 155°C, dry heat at 235°C |
| Solderability | J-31D-002 | b) Method B at 215°C category 3 |
| | | c) Method D, category 3 at 260°C |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to +150°C). Measurement at 24 hours ±4 hours after test conclusion. |
| Dissod Humidity | MIL-STD-202 Method | Load humidity: 1,000 hours 85°C/85%RH and rated voltage. Add 100K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. |
| Blased Hullidity | 103 | Low volt humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours. \pm 4 hours after test conclusion. |
| Thermal Shock | MIL-STD-202 Method 107 | -55°C/+150. Note: Number of cycles required – 300. Maximum transfer time – 20 seconds. Dwell time – 15 minutes. Air – Air. |
| High Temperature Life | MIL-STD-202 Method 108/EIA-198 | 1,000 hours at 150°C with 2 X rated voltage applied. |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC for 1,000 hours. |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz. |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Condition F. |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. |

Storage & Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction



Capacitor Marking (Optional)

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punched Paper | | | | |
|----------------------|------|---------|--------------------|---------------|--------------------|--|--|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | | |
| | (W)* | Pitch | (P ₁)* | Pitch | (P ₁)* | | | |
| 01005 - 0402 | 8 | | | 2 | 2 | | | |
| 0603 | 8 | | | 2/4 | 2/4 | | | |
| 0805 | 8 | 4 | 4 | 4 | 4 | | | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | | | |
| 1805 - 1808 | 12 | 4 | 4 | | | | | |
| ≥ 1812 | 12 | 8 | 8 | | | | | |
| KPS 1210 | 12 | 8 | 8 | | | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | | | |
| Array 0612 | 8 | 4 | 4 | | | | | |

*Refer to Figures 1 and 2 for W and P, carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size. 2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- · Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|--|---------------------------------------|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|---|---------------------------|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum |
| 8 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.0 (0.039) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 25.0 (0.984) | 0.600 (0.024) | 0.600 (0.024) | |
| 12 mm | | 1.5 | | | | 30 (1.181) | | | 0.100 (0.004) |
| 16 mm | | (0.059) | | | | | | | |
| Variable Dimensions – Millimeters (Inches) | | | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B ₀ & K ₀ | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | Note 5 | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_a and B_a are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | |
|--|---------------------------------------|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|
| Tape Size | D _o | E ₁ | Po | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) |
| Variable Dimensions — Millimeters (Inches) | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 (0.138 ±0.002) | 2.0 ±0.05 (0.079 ±0.002) | 1.1 (0.098) | 8.3 (0.327) | Note 1 |
| 8 mm | Single (4 mm) | (0.246) | | 4.0 ±0.10 (0.157 ±0.004) | | 8.3 (0.327) | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength | | | |
|--------------|----------------------------------|--|--|--|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) | | | |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) | | | |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius




Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant | Dimensions — Millimete | rs (Inches) | |
|-----------|-----------------|---------------------------------------|--|--|
| Tape Size | А | B Minimum | С | D Minimum |
| 8 mm | 178 ±0.20 | | | |
| 12 mm | Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) |
| 16 mm | (13.000 ±0.008) | | , , , , , , , , , , , , , , , , , , , | |
| | Variable | Dimensions — Millimeter | rs (Inches) | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber



HV-HT Series, High Voltage, High Temperature 200°C, COG Dielectric, 500 – 2,000 VDC (Industrial Grade)



Overview

KEMET's High Voltage-High Temperature (HV-HT) series surface mount COG Multilayer Ceramic Capacitors (MLCCs) are constructed of a robust and proprietary base metal electrode (BME) dielectric system that offers industryleading performance at extreme temperatures. These surface mountable devices feature a 200°C maximum operating temperature and are specifically designed to withstand the demands of harsh industrial environments such as oil exploration and automotive/avionics engine compartment circuitry. They also offer higher and more uniform breakdown voltage performance than competitive products, resulting in increased yields in customer field applications. When dealing with expensive high temperature circuitry and systems, higher yields can quickly result in significant cost savings.

KEMET's HV-HT series MLCCs are temperature compensating and are suited for resonant circuit applications or those where Q and stability of capacitance characteristics are required. They exhibit no change in capacitance with respect to time and voltage and boast a negligible change in capacitance with reference to ambient temperature. Capacitance change is limited to ±30ppm/°C from -55°C to +200°C. In addition, these capacitors exhibit high insulation resistance with low dissipation factor at elevated temperatures up to 200°C. They also exhibit low ESR at high frequencies and offer superior volumetric efficiency over competitive high temperature precious metal electrode (PME) and base metal electrode (BME) dielectric system devices.

These devices are Lead (Pb)-free, RoHS and REACH compliant without the need of any exemptions.



| С | 2225 | H | 393 | J | C | G | Α | C | TU |
|---------|--|------------------------------------|---|---|---|------------|-------------------------|---|--|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance ¹ | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ² | Packaging/ Grade (C-Spec) |
| | 0805 1206 1210 1808 1812 1825 2220 2225 2824 3040 3640 4540 | H = High temperature (200°C) | Two significant digits and number of zeros. | $B = \pm 0.10 \text{ pF}$ C = ±0.25 pF D = ±0.5 pF F = ±1% G = ±2% J = ±5% K = ±10% M = ±20% | C = 500 B = 630 D = 1,000 F = 1,500 G = 2,000 | G = COG | A = N/A | C = 100% Matte Sn L = SnPb (5% Pb minimum) E = Gold (Au) 1.97 – 11.8 µin F = Gold (Au) 30 – 70 µin G = Gold (Au) 100 µin minimum | See "Packaging C-Spec Ordering Options Table" |

Ordering Information

¹ Additional capacitance tolerance offerings may be available. Contact KEMET for details.

² Gold(Au) termination finish options are not available on 2824, 3040, 3640 and 4540 case sizes.

1



Packaging C-Spec Ordering Options Table

| Termination Finish Options | Packaging Type/Options | Packaging Ordering Code (C-Spec) |
|---|--|---|
| | Standard Packaging – Unmarked ³ | |
| | Bulk Bag | Blank ¹ |
| | Waffle Tray ² | 7292 |
| | 7" Tape & Reel | TU |
| C = 100% Matte Sn | 13" Reel | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) |
| L = SnPb (5% Pb min.) | 7" Tape & Reel/2 mm pitch ⁴ | 7081 |
| $F = Gold (Au) 30 - 70 \mu in$ G = Gold (Au) 100 uin minimum | 7" Tape & Reel – 50 pcs | T050 |
| | 7" Tape & Reel – 100 pcs | T100 |
| | 7" Tape & Reel – 250 pcs | T250 |
| | 7" Tape & Reel – 500 pcs | T500 |
| | 7" Tape & Reel – 1,000 pcs | Т1К0 |
| Ν | Aoisture Sensitive Packaging⁵ – Unmarked | 3 |
| | Waffle Tray ² | 7282 |
| | 7" Tape & Reel | 7130 |
| F = Gold (Au) 1 97 - 11 8 uin | 7" Tape & Reel – 50 pcs | |
| $F = Gold (Au) 30 - 70 \mu in$ | 7" Tape & Reel – 100 pcs | |
| G = Gold (Au) 100 µin minimum | 7" Tape & Reel – 250 pcs | Contact KEMET ⁶ |
| | 7" Tape & Reel – 500 pcs | |
| | 7" Tape & Reel – 1,000 pcs | |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ "Bulk Bag" packaging option is not available for Gold (Au) termination finish options and case sizes larger than 2225 (5664 Metric).

² "Waffle Tray" packaging option is not available for case sizes larger than 2225 (5664 Metric).

³ The terms "Marked" and "Unmarked" pertain to laser marking option of components. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices.

³ Reeling quantities are dependent upon chip size and thickness dimension. When ordering using the "T1K0" packaging option, 1812 through 2225 case size devices with chip thickness of ≥ 1.9mm (nominal) may be shipped on multiple 7" reels or a single 13" reel. Additional reeling or packaging options may be available. Contact KEMET for details.

⁴ The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

⁵ Moisture sensitive packaging is required for Gold (Au) termination option "E" (1.97 μin min / 11.8 μin max.). Not available for case sizes larger than 2225 (5664 Metric).

⁶ Additional reeling or packaging options may be available. Contact KEMET for details.



Benefits

- Operating temperature range of -55°C to +200°C
- Lead (Pb)-free, RoHS, and REACH compliant
- EIA 0805, 1206, 1210, 1808, 1812, 1825, 2220, 2225, 2824, 3040, 3640, and 4540 case sizes
- DC voltage ratings of 500 V, 630 V, 1 KV, 1.5 KV, and 2 KV
- Capacitance offerings ranging from 1 pF to 0.150 μF
- Available capacitance tolerances of ±0.10 pF, ±0.25 pF, ±0.5 pF, ±1%, ±2%, ±5%, ±10%, and ±20%
- · No piezoelectric noise
- Extremely low ESR and ESL
- · High thermal stability
- High ripple current capability

- No capacitance change with respect to applied rated DC voltage
- Negligible capacitance change with respect to temperature from -55°C to +125°C
- · No capacitance decay with time
- · Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish allowing for excellent solderability
- SnPb plated termination finish option available upon request (5% Pb minimum)
- Gold (Au), Tin/Lead (Sn/Pb) and 100% pure matte Tin (Sn) termination finishes available

Applications

Typical applications include critical timing, tuning, circuits requiring low loss, circuits with pulse, high current, switch mode power supplies (input filters, resonators, tank circuits, snubbed circuits, output filters), high voltage coupling, DC blocking and voltage multiplier circuits in extreme environments such as down-hole exploration, aerospace engine compartments and geophysical probes. Markets include power supply, HID lighting, industrial equipment/control, automotive, aerospace, and munitions.



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|--------------------------------|--------------------------------|-----------------|-------------------------------|----------------------------|-----------------------|
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (.030) | Solder Wave or |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | | Solder Reflow |
| 1210 | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | | |
| 1808 | 4520 | 4.70 (0.185) ±0.50 (0.020) | 2.00 (0.079) ±0.20 (0.008) | | 0.60 (0.024) ±0.35 (0.014) | | |
| 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | | 0.60 (0.024) ±0.35 (0.014) | | |
| 1825 | 4564 | 4.50 (0.177) ±0.30 (0.012) | 6.40 (0.252) ±0.40 (0.016) | See Table 2 for | 0.60 (0.024) ±0.35 (0.014) | | |
| 2220 | 5650 | 5.70 (0.224) ±0.40 (0.016) | 5.00 (0.197) ±0.40 (0.016) | Thickness | 0.60 (0.024) ±0.35 (0.014) | N/A | Solder Reflow |
| 2225 | 5664 | 5.60 (0.220) ±0.40 (0.016) | 6.40 (0.248) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | Only |
| 2824 | 7260 | 7.10 (0.280) ±0.40 (0.016) | 6.10 (0.240) ±0.40 (0.016) | | 1.27 (0.050) ±0.40 (0.016) | | |
| 3040 | 7610 | 7.60 (0.300) ±0.40 (0.016) | 10.20 (0.402) ±0.40 (0.016) | | 1.27 (0.050) ±0.40 (0.016) | | |
| 3640 | 9210 | 9.10 (0.358) ±0.40 (0.016) | 10.20 (0.402) ±0.40 (0.016) | | 1.27 (0.050) ±0.40 (0.016) | | |
| 4540 | - | 11.40 (0.449) ±0.40 (0.016) | 10.20 (0.402) ±0.40 (0.016) | | 1.27 (0.050) ±0.40 (0.016) | | |



Table 1A - Capacitance Range/Selection Waterfall (0805 - 1808 Case Sizes)

| Capability Capabil | | | | Ca | se | Siz | e/\$ | Se | rie | s | C | 080 | 5H | | C | 1206 | ы | | | C | 1210 |)H | | | C | 1808 | H | |
|--|----------------------|------------|---|----|------|------|------|-------------------|--------|---|----------|--------|----------|-----|--------|--------|----------|---------|-------------|---------------|----------|---------------|---------|--------|--------|--------|---------------|---------|
| Code Networks Pateworks Pate | | Сар | | | Vo | ltag | e Co | de | | | C | B | D | C | В | D | F | G | C | В | D | F | G | C | В | D | F | G |
| Image: Constraints 1.0 - 3) gF* 100 - 470* <th>Capacitance</th> <th>Code</th> <th></th> <th>Ra</th> <th>ated</th> <th>Volt</th> <th>tage</th> <th>(VE</th> <th>)C)</th> <th></th> <th>500</th> <th>630</th> <th>000</th> <th>500</th> <th>630</th> <th>000</th> <th>1500</th> <th>000</th> <th>500</th> <th>630</th> <th>000</th> <th>1500</th> <th>000</th> <th>500</th> <th>630</th> <th>000</th> <th>1500</th> <th>2000</th> | Capacitance | Code | | Ra | ated | Volt | tage | (VE |)C) | | 500 | 630 | 000 | 500 | 630 | 000 | 1500 | 000 | 500 | 630 | 000 | 1500 | 000 | 500 | 630 | 000 | 1500 | 2000 |
| Image: 1 prime Image: | | | | | Ca | pac | itar | ice | | | | | - | | P | roduc | t Ava | ilabili | ity and | d Chip | Thic | kness | code | es | | - | - | 5 |
| T10 p+7p+7 T0 - 70 p+ T F G J K M OC DC ED | 10-91nF* | 109 - 919* | В | С | D | oiei | ranc | ;e | | | DG | DG | DG | | | See | able | 2 TOP | Unip i I | nickr | iess L | Jimen | sions | IB | LB | IB | IB | IB |
| StopF Stop Stop F G J K M Co Co Co D PM PM <t< td=""><td>10 pF - 47pF*</td><td>100 - 470*</td><td></td><td></td><td></td><td>F</td><td>G</td><td>J</td><td>к</td><td>м</td><td>DG</td><td>DG</td><td>DG</td><td>ED</td><td>ED</td><td>ED</td><td>ED</td><td>ED</td><td>FM</td><td>FM</td><td>FM</td><td>FM</td><td>FM</td><td>LB</td><td>LB</td><td>LB</td><td>LB</td><td>LB</td></t<> | 10 pF - 47pF* | 100 - 470* | | | | F | G | J | к | м | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB |
| Sep F Sep F G J K M DG DG DD DD F M < | 51 pF | 510 | | | | F | G | J | K | М | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB |
| c2 p F 6 20 F 6 J K M 0 G 05 | 56 pF | 560 | | | | F | G | J | K | M | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB |
| cbs pr cbs pr< | 62 pF | 620 | | | | F | G | J | K | M | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB |
| 2.2 pr | 68 pF | 680 | | | | F | G | J | K | M | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | | LB |
| scope scope <th< td=""><td>75 pF</td><td>/50</td><td></td><td></td><td></td><td>F</td><td>6</td><td>J</td><td>K</td><td></td><td></td><td></td><td></td><td>ED</td><td>ED</td><td>ED</td><td>ED</td><td></td><td>FIVI</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></th<> | 75 pF | /50 | | | | F | 6 | J | K | | | | | ED | ED | ED | ED | | FIVI | | | | | | | | | |
| 100 pr 101 | 91 nF | 910 | | | | F | G | 1 | K | M | DG | DG | DG | FD | FD | FD | FD | FF | FM | FM | FM | FM | FM | | | IB | IB | |
| 1110pf 1111 p G J M M DG DG DG DC D | 100 pF | 101 | | | | F | G | J | ĸ | M | DG | DG | DG | ED | ED | ED | ED | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB |
| 130 pF 121 121 1 K 0 05 < | 110 pF | 111 | | | | F | G | J | K | M | DG | DG | DG | ED | ED | ED | ED | EG | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB |
| 130 pF 131 1< | 120 pF | 121 | | | | F | G | J | K | М | DG | DG | DG | ED | ED | ED | ED | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LB |
| 151 F 6 J K M DC DC DC ED EP EO FC FA L <t< td=""><td>130 pF</td><td>131</td><td></td><td></td><td></td><td>F</td><td>G</td><td>J</td><td>K</td><td>М</td><td>DG</td><td>DG</td><td>DG</td><td>ED</td><td>ED</td><td>ED</td><td>ED</td><td>EG</td><td>FG</td><td>FG</td><td>FG</td><td>FM</td><td>FM</td><td>LA</td><td>LA</td><td>LA</td><td>LA</td><td>LB</td></t<> | 130 pF | 131 | | | | F | G | J | K | М | DG | DG | DG | ED | ED | ED | ED | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LB |
| 160 pF 161 F 6 J K M 06 06 06 E0 E0 E6 F6 F6< | 150 pF | 151 | | | | F | G | J | K | M | DG | DG | DG | ED | ED | ED | EF | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LB |
| $ \begin{array}{ c c c c c c c c c c c c c c c c c c c$ | 160 pF | 161 | | | | F | G | J | K | M | DG | DG | DG | ED | ED | ED | EF | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LC |
| 200 pF 201 F 6 J K M D6 D6 D6 D E0 E0 E0 F0 F0 F0 F K J K M D6 D6 <thd6< th=""> <thd6< th=""> <thd6< th=""></thd6<></thd6<></thd6<> | 180 pF | 181 | | | | F | G | J | K | M | DG | DG | DG | ED | ED | ED | EF | EG | FG | FG | FG | FM | FM | | | | LA | LC |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $ | 200 pF | 201 | | | | | 6 | J | K | | | | | ED | ED | ED | EF | EG | FG | FG | FG | | | | | | | |
| 270 pr 251 251 5 6 5 6 | 220 pF 240 nF | 221 | | | | F | G | J | ĸ | M | | | | | FD | FD | FG | EG | FG | FG | FG | FIVI | FM | | | | | |
| 300 pF 301 S F 6 J K M D6 D6 ED ED ED EF E6 F6 | 270 pF | 241 | | | | F | G | J | ĸ | M | DG | DG | DG | FD | FD | FD | FG | FG | FG | FG | FG | FK | FK | | IA | | IB | |
| 330 pF 331 S F G J K M DG DG ED EF EG F G F K K M DG DG ED EF EG F G F K M DG DG ED EF EG F G F K M DG DG ED EF EG F G K M DG DG ED EF EG F G K M DG DG ED EF EG F G K M DG DG ED EF EG F G K M DG DG ED ED <td>300 pF</td> <td>301</td> <td></td> <td></td> <td></td> <td>F</td> <td>G</td> <td>J</td> <td>K</td> <td>M</td> <td>DG</td> <td>DG</td> <td></td> <td>ED</td> <td>ED</td> <td>EF</td> <td>EG</td> <td></td> <td>FG</td> <td>FG</td> <td>FG</td> <td>FK</td> <td>FK</td> <td>LA</td> <td>LA</td> <td>LA</td> <td>LB</td> <td>LC</td> | 300 pF | 301 | | | | F | G | J | K | M | DG | DG | | ED | ED | EF | EG | | FG | FG | FG | FK | FK | LA | LA | LA | LB | LC |
| 360 pF 361 S F G J K M DG DG DG DE EP EG F G F G J K M DG DG DE EP EG F G F G J K M DG DG DE EF EG F G F G J K M DG DG DE EG EG FG FG FK FS LA LA <thla< th=""> LA <thla< th=""> <</thla<></thla<> | 330 pF | 331 | | | | F | G | J | K | М | DG | DG | | ED | ED | EF | EG | | FG | FG | FG | FK | FK | LA | LA | LA | LB | LC |
| 390 pF 391 s F G J K M DG DG DG DE EF EG F G J K M DG DG DG DE EF EG F G J K M DG DG DG DF G J K M DG DG DF G J K M DG DG DG DF G J K M DG | 360 pF | 361 | | | | F | G | J | K | М | DG | DG | | ED | ED | EF | EG | | FG | FG | FG | FK | FS | LA | LA | LA | LB | LA |
| 430 pF 431 F 6 J K M 06 06 E0 E0 E6 E6 F6 FM FM FS FS LA LB LB LC LA 470 pF 471 511 F 6 J K M 06 06 E0 E0 E6 E6 F6 FM FM FS FS LA LB LB LC LA 560 pF 561 F 6 J K M 06 C E0 E0 E6 E6 F6 FM FM FS FS LA LB LB LB LA LC LB | 390 pF | 391 | | | | F | G | J | K | M | DG | DG | | ED | ED | EF | EG | | FG | FG | FG | FK | FS | LA | LA | LA | LB | LA |
| 470 pF 471 F 6 J K M D6 D6 ED | 430 pF | 431 | | | | F | G | J | K | М | DG | DG | | ED | ED | EF | EG | | FG | FM | FM | FS | FS | LA | LB | LB | LC | LA |
| S10 pr S11 F G J K M DG DG DG DG DG | 470 pF | 471 | | | | F | G | J | K | M | DG | DG | | ED | ED | EG | EG | | FG | FM | FM | FS | FS | LA | LB | LB | LC | LA |
| 300 µF 301 µF 6 µ K N 0 µ D 0 µ D 0 µ K 0 µ D 0 µ K 0 µ D 0 µ K 0 µ D 0 | 510 pF | 511 | | | | F | G | J | K | M | DG | DG | | ED | ED | EG | EG | | FG | | FM | FS | FS | | | | | |
| 680 pr 681 6 j k m DG j <th< td=""><td>620 pF</td><td>621</td><td></td><td></td><td></td><td>F</td><td>G</td><td>J</td><td>ĸ</td><td>M</td><td></td><td>DG</td><td></td><td></td><td>FD</td><td>EG</td><td>EG</td><td></td><td>FG</td><td>FM</td><td>FM</td><td>FS</td><td>FS</td><td></td><td></td><td></td><td></td><td></td></th<> | 620 pF | 621 | | | | F | G | J | ĸ | M | | DG | | | FD | EG | EG | | FG | FM | FM | FS | FS | | | | | |
| 750 pF 751 751 751 751 75 | 680 pF | 681 | | | | F | G | | ĸ | M | DG | | | FD | FD | FG | | | FG | FM | FM | FS | FS | IB | IB | IB | IA | |
| 820 pF 821 F 6 J K M DG F ED EF EG F F G J K M DG ED EF EG F F G J K M DG ED EF EG F F M F LB | 750 pF | 751 | | | | F | G | J | K | M | DG | | | ED | EF | EG | | | FG | FM | FM | FM | | LB | LB | LB | LA | |
| 910 pF 911 100 F G J K M F C J K M F E C J K M F E F G J K M F E C J K M F G J K M F E G J K M F E G J K M F E G J K M C C C F G J K M C C F E G J K M C C C F G J K M C C C F G J K M C C C C C C C C C C C C C C C C C C C | 820 pF | 821 | | | | F | G | J | K | М | DG | | | ED | EF | EG | | | FG | FM | FM | FM | | LB | LB | LB | LA | |
| 1,000 pF 102 i F G J K M ED EF EG I FM | 910 pF | 911 | | | | F | G | J | K | М | | | | ED | EF | EG | | | FM | FM | FM | FY | | LB | LB | LB | LA | |
| 1,100 pF 112 I | 1,000 pF | 102 | | | | F | G | J | K | М | | | | ED | EF | EG | | | FM | FM | FM | FY | | LB | LB | LB | LB | |
| 1,200 pF 122 F G J K M F F F F C L F G J K M I I I F G J K M I I F G J K M I I F G J K M I I F G J K M I I I I I I I | 1,100 pF | 112 | | | | F | G | J | K | М | | | | EF | EG | | | | FM | FK | FK | FS | | LC | LC | LC | LB | |
| 1,300 pF 132 F 6 J K M F E E E E E E E E F G L | 1,200 pF | 122 | | | | F | G | J | K | M | | | | EF | EG | | | | FM | FK | FK | FS | | | | | LC | |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $ | 1,300 pF | 132 | | | | F | G | J | K | M | | | | | EG | | | | FM | FS Ee | FS ES | | | | | | | |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $ | 1,500 pr 1.600 pF | 162 | | | | F | G | J | ĸ | M | | | | FF | FG | | | | FK | FS FS | FS FS | | | | | | 10 | |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $ | 1,800 pF | 182 | | | | F | G | | K | M | | | | EF | EG | | | | FK | FS | FS | | | | LC | LC | | |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $ | 2,000 pF | 202 | | | | F | G | J | K | M | | | | EG | | | | | FK | FL | FS | | | LC | LA | LB | | |
| 2,400 pF 242 242 F G J K M L L EG L L FS FL FS FL FS LC LA LB LC LA LA <thla< th=""> LA <thla< th=""></thla<></thla<> | 2,200 pF | 222 | | | | F | G | J | K | М | | | | EG | | | | | FK | FL | FS | | | LC | LA | LB | | |
| 2,700 pF 272 302 F G J K M I F G J K M I F G I K M I F G J K M I F G J K M I F G J K M I F G J K M I F G J K M I F G J K M I I F G J K M I I F G J K M I I F G J K M I I I I F F G J K M I <t< td=""><td>2,400 pF</td><td>242</td><td></td><td></td><td></td><td>F</td><td>G</td><td>J</td><td>K</td><td>М</td><td></td><td></td><td></td><td>EG</td><td></td><td></td><td></td><td></td><td>FS</td><td>FL</td><td>FS</td><td></td><td></td><td>LC</td><td>LA</td><td>LB</td><td></td><td></td></t<> | 2,400 pF | 242 | | | | F | G | J | K | М | | | | EG | | | | | FS | FL | FS | | | LC | LA | LB | | |
| 3,000 pF 302 F G J K M I I I I F F F G J K M I I I I I F F G J K M I I I I I F G J K M I I I I F G J K M I I I I F G J K M I I I I F G J K M I | 2,700 pF | 272 | | | | F | G | J | K | М | | | | EG | | | | | FS | FL | FS | | | LC | LA | LC | | |
| 3,300 pF 332 362 362 362 5 K M | 3,000 pF | 302 | | | | F | G | J | K | М | | | | | | | | | FS | FL | | | | LA | LA | | | |
| 3,000 pr 362 392 392 392 F G J K M I | 3,300 pF | 332 | | | | F | G | J | K | M | | | | | | | | | FS | FM | | | | LA | | | | |
| 3.900 pr 3.92 4.30 pF 4.32 4.32 4.32 4.32 4.700 pF 4.32 4.700 pF 4.72 F G J K M Image: Marked voltage (VDC) % <td>3,600 pF</td> <td>362</td> <td></td> <td></td> <td></td> <td></td> <td>G</td> <td>J</td> <td>K</td> <td>M</td> <td> </td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>FM</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> | 3,600 pF | 362 | | | | | G | J | K | M | | | | | | | | | | FM | | | | | | | | |
| 4,000 pF 472 I 0 K M 4,700 pF 472 F G J K M Capacitance Cap Code Capacitance Capacitance <td>3,900 pF 4 300 pF</td> <td>39Z 122</td> <td></td> <td></td> <td></td> <td>F</td> <td>6</td> <td>J</td> <td>K K</td> <td>M</td> <td> </td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>FM</td> <td>FV</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> | 3,900 pF 4 300 pF | 39Z 122 | | | | F | 6 | J | K K | M | | | | | | | | | FM | FV | | | | | | | | |
| Capacitance Cap Code Capacitance Capacit | 4,700 pF | 472 | | | | F | G | | K | M | | | | | | | | | FM | FY | | | | | LC | | | |
| Capacitance Cap Code Capacitance | 1,700 pi | 172 | ┢ | R | ated | Voli | tane | <u>ب ،</u> ۱۷) |)C) | | 8 | 30 | 000 | 8 | 30 | 000 | 000 | 000 | 8 | 30 | 000 | 200 | 000 | 8 | 30 | 00 | 00 | 000 |
| Case Size/Series C0805H C1206H C1210H C1208H | Capacitance | Cap | | | Vo | Itan | e Co | , • • | -, | - | <u>с</u> | 9 R | <u>п</u> | 0 | ю R | Ц П | ¥ ۲ | ب 2 | 0 | ю R | Ц П | | ء 2(| n U | ю R | ц П | ¥ ۲ | ء 2(|
| | • • • • • | Code | ⊢ | C | ase | Siz | e/S | eri | es | | ۲, | 0805 | H | ŀ | ت ۱ | 1206 | ∟ ' H | | ŀ | <u>ر</u> م | | <u>'</u> Н | | Ļ | ^ | 1808 | <u>.</u> Н | 3 |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).



Table 1A – Capacitance Range/Selection Waterfall (0805 – 1808 Case Sizes) cont.

| | | Ca | ase | Siz | ze/ | Se | rie | s | C | 080 | 5H | | C | 1206 | 5H | | | C | 1210 | H | | | C | 1808 | H | |
|-------------|-------------------------|----|---------|--------------|--------------|-----------|-----|---|-----|------|------|-----|-----|----------------|-----------------|-----------------|-------------------|------------------|------------------|----------------|-----------------|-----|-----|------|------|------|
| | Cap | | Vo | oltag | je Co | ode | | | С | В | D | С | В | D | F | G | С | В | D | F | G | С | В | D | F | G |
| Capacitance | Code | I | Rated | Vol | tage | (VC |)C) | | 500 | 630 | 1000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 |
| | | | Ca 1 | apac Fole | cita: ran | ice ce | | | | | | | Р | roduc See 1 | ct Ava Table | ilabil 2 for | ity and Chip 1 | d Chip Thickr |) Thic less D | kness)imen | s Code sions | 25 | | | | |
| 5,100 pF | 512 | | | F | G | J | K | М | | | | | | | | | FY | FS | | | | LA | | | | |
| 5,600 pF | 562 | | | F | G | J | K | M | | | | | | | | | FY | FS | | | | LB | | | | |
| 6,200pF | 622 | | | F | G | J | K | M | | | | | | | | | FY | | | | | LC | | | | |
| 6,800pF | 682 | | | F | G | J | K | M | | | | | | | | | FY | | | | | LC | | | | |
| 7,500pF | 752 | | | F | G | J | K | M | | | | | | | | | FS | | | | | | | | | |
| 8,200 pF | 822 | | | F | G | J | K | M | | | | | | | | | FS | | | | | | | | | |
| | Can | I | Rated | Vol | tage | (VC |)C) | | 500 | 630 | 1000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 |
| Capacitance | Capacitance Cap Code | | | | je Co | ode | | | С | В | D | С | В | D | F | G | C | В | D | F | G | C | В | D | F | G |
| | | | Case | e Siz | ze/S | erie | es | | 0 | 0805 | H | | C | ;1206 | H | | | C | ;1210 | H | | | C | 1808 | H | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).



Table 1B - Capacitance Range/Selection Waterfall (1812 - 2225 Case Sizes)

| | | Ca | se S | Size, | /Sei | ries | | C | 1812 | 2H | | | C | 1825 | 5H | | | C2 | 2220 | DH | | | C | 222 | 5H | |
|----------------------|-------------|-----|--------|--------|-------|------|-----|----------|------|------|------|----------|-----|------|-----------------|--------|------------------|--------|--------------|------|------|----------|-----|------|------|----------|
| | Сар | | Vol | tage (| Code | | C | В | D | F | G | C | В | D | F | G | C | B | D | F | G | C | В | D | F | G |
| Capacitance | Code | Ra | ated \ | /oltag | e (VD | C) | 500 | 630 | 0001 | 1500 | 2000 | 500 | 630 | 0001 | 1500 | 2000 | 500 | 630 | 0001 | 1500 | 2000 | 500 | 630 | 0001 | 1500 | 2000 |
| | | Cap | acita | nce T | Foler | ance | | | | 1 | | Pro | | Avai | labili for (| ty and | d Chij Ghicki | o Thio | knes Dime | s Co | des | | | | | |
| 10 pF - 47pF* | 100 - 470* | F | G | J | K | М | GK | GK | GK | GK | GK | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF |
| 51 pF | 510 | F | G | J | K | M | GK | GK | GK | GK | GK | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF |
| 56 pF | 560 | | G | J | K | M | GK | GK | GK | GK | GK | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | | KF | | | KF |
| 68 nF | 680 | F | G | J | K | M | GK | GK | GK | GK | GK | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF |
| 75 pF | 750 | F | G | J | K | M | GK | GK | GK | GK | GK | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF |
| 82 pF | 820 | F | G | J | К | М | GK | GK | GK | GK | GK | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF |
| 91 pF | 910 | F | G | J | K | М | GK | GK | GK | GK | GK | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF |
| 100 pF | 101 | F | G | J | K | M | GK | GK | GK | GK | GK | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF |
| 110 pF 120 pF | 111 | F | G | J | ĸ | M | GK | GK | GK | GK | GK | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF |
| 130 pF | 131 | F | G | J | ĸ | M | GK | GK | GK | GK | GK | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF |
| 150 pF | 151 | F | G | J | K | M | GK | GK | GK | GK | GK | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF |
| 160 pF | 161 | F | G | J | К | М | GK | GK | GK | GK | GK | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF |
| 180 pF | 181 | F | G | J | K | М | GK | GK | GK | GK | GK | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF |
| 200 pF | 201 | F | G | J | K | M | GH | GH | GH | GH | GH | HE | HE | HE | HE | HE | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF |
| 220 pF 240 pF | 221 | | G | J | ĸ | M | СН | СН | СН | GH | СН | HE | HE | HE | HE | HE | JK | JK | JK | JK | JK | | KF | | KF | KF |
| 240 pr 270 nF | 241 | F | G | J | ĸ | M | GH | GH | GH | GH | GH | HF | HF | HF | HF | HE | JK | JK | JK | JK | JK | KF | KF | KE | KE | KE |
| 300 pF | 301 | F | G | J | ĸ | M | GH | GH | GH | GH | GH | HE | HE | HE | HE | HE | JK | JK | JK | JK | JK | KE | KE | KE | KE | KE |
| 330 pF | 331 | F | G | J | K | М | GH | GH | GH | GH | GH | HE | HE | HE | HE | HE | JE | JE | JE | JE | JE | KE | KE | KE | KE | KE |
| 360 pF | 361 | F | G | J | K | M | GK | GK | GK | GK | GH | HE | HE | HE | HE | HE | JE | JE | JE | JE | JE | KE | KE | KE | KE | KE |
| 390 pF | 391 | F | G | J | K | M | GK | GK | GK | GK | GK | HE | HE | HE | HE | HE | JE | JE | JE | JE | JE | KE | KE | KE | KE | KE |
| 430 pF | 431 | | G | J | K | M | GK | GK | GK | GK | GK | HE | HE | HE | HE | HE | JE | JE | JE | JE | JE | KE | KE | KE | KE | KE |
| 470 pF 510 pE | 47 I 511 | F | G | J | ĸ | M | GH | GH | GH | GK | GH | HE | HE | HE | HE | HE | JE | JE | JE | JE | JE | KF | KF | KF | KF | KE |
| 560 pF | 561 | F | G | J | ĸ | M | GH | GH | GH | GK | GH | HE | HE | HE | HE | HG | JK | JK | JK | JK | JK | KF | KF | KF | KF | KE |
| 620 pF | 621 | F | G | J | к | м | GH | GH | GH | GK | GH | HE | HE | HE | HE | HG | JK | JK | JK | JK | JK | KF | KF | KF | KF | KE |
| 680 pF | 681 | F | G | J | К | M | GH | GH | GH | GK | GH | HE | HE | HE | HE | HG | JE | JE | JE | JK | JK | KF | KF | KF | KF | KE |
| 750 pF | 751 | F | G | J | K | M | GH | GH | GH | GK | GK | HE | HE | HE | HG | HG | JE | JE | JE | JK | JK | KE | KE | KE | KF | KE |
| 820 pF | 821 | F | G | J | K | M | GH | GH | GH | GK | GK | HE | HE | HE | HG | HG | JE | JE | JE | JK | JK | KE | KE | KE | KF | KE |
| 910 pF | 102 | F | G | J | ĸ | M | СН | СН | СН | СН | GM | | HE | HE | HG | HG | JE | JK | JK | JK | JK | KE | KE | KE | KE | KE |
| 1,000 pr | 102 | F | G | J | K | M | GH | GK | GK | GH | GO | HE | HE | HE | HG | HG | JE | JK | JK | JK | JK | KE | KE | KE | KF | KE |
| 1,200 pF | 122 | F | G | J | K | M | GH | GK | GK | GH | GO | HE | HE | HE | HG | HG | JE | JK | JK | JK | JK | KE | KE | KE | KF | KF |
| 1,300 pF | 132 | F | G | J | К | М | GH | GK | GK | GH | GO | HE | HE | HE | HG | HE | JE | JK | JK | JK | JE | KE | KE | KE | KF | KF |
| 1,500 pF | 152 | F | G | J | K | М | GK | GK | GK | GK | GO | HE | HE | HE | HG | HE | JE | JK | JK | JK | JE | KE | KE | KE | KF | KF |
| 1,600 pF | 162 | F | G | J | K | M | GK | GK | GK | GK | | HE | HG | HG | HG | HG | JE | JK | JK | JK | JE | KE | KE | KE | KF | KE |
| 1,800 pF 2,000 pF | 182 | | G | J | ĸ | M | GK | GK | GK | GM | | HE | HG | HG | HG | ны | JE | JK | JK | JK | JE | KE | KE | KE | KF | KE |
| 2,000 pr | 202 | F | G | J | K | M | GK | GK | GK | GO | | HE | HG | HG | HE | HJ | JE | JK | JK | JE | JK | KE | KE | KE | KF | KE |
| 2,400 pF | 242 | F | G | J | K | M | GK | GH | GK | GO | | HE | HG | HG | HE | HJ | JK | JK | JK | JE | JL | KE | KE | KE | KE | KH |
| 2,700 pF | 272 | F | G | J | К | М | GK | GH | GK | GO | | HE | HG | HG | HE | нк | JK | JK | JK | JE | JL | KE | KE | KE | KE | КН |
| 3,000 pF | 302 | F | G | J | K | М | GK | GH | GK | | | HG | HG | HG | HE | НК | JK | JK | JK | JE | JL | KE | KE | KE | KE | KH |
| 3,300 pF | 332 | F | G | J | K | M | GK | GH | GK | | | HG | HG | HG | HG | | JK | JK | JK | JK | JN | KE | KE | KE | KE | KJ |
| 3,000 pF 3,000 pF | 302 302 | | 6 | J | ĸ | M | GK | GН GH | GM | | | HG HC | HG | HG | HG | | JK | JK | JK | JK | | KE KE | | | | KJ KI |
| 4.300 pF | 432 | F | G | J | K | M | GH | GH | GO | | | HG | HG | HG | HJ | | JK | JK | JK | JK | | KE | KF | KF | KF | NJ |
| 4,700 pF | 472 | F | G | J | K | M | GH | GH | GO | | | HG | HG | HG | HJ | | JK | JK | JK | JL | | KE | KF | KF | КН | |
| · · · | | Ra | ated \ | /oltag | e (VD | C) | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 |
| Capacitance | Cap Code | | Vol | tage (| Code | | С | В | D | F | G | C | В | D | F | G | С | В | D | F | G | С | В | D | F | G |
| | | C | ase | Size/ | Serie | es | | C | 1812 | H | | | C | 1825 | H | | | C | 2220 | Н | | | C | 2225 | Н | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).

These products are protected under US Patents 7,172,985 and 7,670,981, other patents pending, and any foreign counterparts.

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Table 1B – Capacitance Range/Selection Waterfall (1812 – 2225 Case Sizes) cont.

| | | Case Size/Series | | | | | | C | 1812 | 2H | | | C | 182 | 5H | | | C2 | 2220 | DH | | | C2 | 222 | 5H | |
|-------------|------|------------------|--------|--------|--------|------|-----|-----|------|------|------|----------|---------------|---------------|------------------|-----------------|----------------|----------------|---------------|---------------|-----------|-----|-----|------|------|------|
| | Can | | Vol | tage (| Code | | C | В | D | F | G | C | В | D | F | G | C | В | D | F | G | C | В | D | F | G |
| Capacitance | Code | R | ated \ | /oltag | je (VD |)C) | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 |
| | | Cap | acita | nce | Toler | ance | | | | | | Pro S | duct ee Ta | Avai ble 2 | labilit for C | ty an Chip 1 | d Chi Thick | p Thio ness | cknes Dime | s Co nsion | des Is | • | | | | |
| 5,100 pF | 512 | F | G | J | K | М | GH | GK | GO | | | HG | HE | HG | HK | | JK | JK | JK | JL | | KE | KF | KF | KH | |
| 5,600 pF | 562 | F | G | J | K | М | GH | GK | GO | | | HG | HE | HG | HK | | JK | JK | JK | JN | | KE | KF | KF | KH | |
| 6,200pF | 622 | F | G | J | K | M | GH | GK | | | | HG | HE | HG | | | JK | JE | JE | JN | | KE | KF | KF | KJ | |
| 6,800pF | 682 | F | G | J | K | M | GH | GM | | | | HG | HE | HJ | | | JK | JE | JK | JN | | KE | KF | KF | KJ | |
| 7,500pF | 752 | F | G | J | K | M | GH | GM | | | | HG | HE | HJ | | | JK | JE | JK | | | KF | KE | KF | | |
| 8,200 pF | 822 | F | G | J | K | M | GK | GO | | | | HG | HE | HJ | | | JK | JE | JL | | | KF | KE | KF | | |
| 9,100 pF | 912 | | | | | | GM | GO | | | | HE | HG | HK | | | JE | JE | JL | | | KF | KE | KH | | |
| 10,000 pF | 103 | | | | | | GM | GO | | | | HE | HG | HK | | | JE | JE | JL | | | KF | KE | KH | | |
| 12,000 pF | 123 | | | | | | GO | | | | | HE | HG | | | | JE | JK | JN | | | KE | KE | KH | | |
| 15,000 pF | 153 | | | | | | GO | | | | | HE | HJ | | | | JE | JL | | | | KE | KF | KJ | | |
| 18,000 pF | 183 | | | | | | | | | | | HG | ΗK | | | | JE | JL | | | | KE | КН | | | |
| 22,000 pF | 223 | | | | | | | | | | | HJ | | | | | JK | JN | | | | KF | KJ | | | |
| 27,000 pF | 273 | | | | | | | | | | | HJ | | | | | JL | JN | | | | KF | KJ | | | |
| 33,000 pF | 333 | | | | | | | | | | | НК | | | | | JN | | | | | КН | | | | |
| 39,000 pF | 393 | | | | | | | | | | | | | | | | | | | | | KJ | | | | |
| | Con | Ra | ated \ | /oltag | je (VD |)C) | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 |
| Capacitance | Code | | Vol | tage (| Code | | C | В | D | F | G | C | В | D | F | G | C | В | D | F | G | С | В | D | F | G |
| | | C | ase | Size/ | Serie | es | | C | 1812 | H | | | C | 1825 | Н | | | C | 2220 | Н | | | C | 2225 | H | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).



Table 1C - Capacitance Range/Selection Waterfall (2824 - 4540 Case Sizes)

| | | Ca | ise Siz Series | ze/ s | | C | 2824 | 4H | | | C | 304(| рн | | | C | 364(| ЭН | | | C | 454(| н | |
|---------------|-----------|--------|----------------------|----------|------------|----|------|-----|-----|------------|-------|----------|--------|--------|-----------------|--------|------------|-----------|----------|----------|----------|----------|---------------|-----|
| Capacitance | Сар | V V | oltage Co | de | C | В | D | F | G | С | В | D | F | G | С | В | D | F | G | C | В | D | F | G |
| | Code | | Rated | | 8 | 30 | 80 | 500 | 000 | 8 | 30 | 00 | 200 | 000 | 8 | 30 | 00 | 200 | 00 | 8 | 30 | 00 | 500 | 000 |
| | | | Itage (V anacitan | DC) | 20 | Ŷ | = | ¥ | 5 | <u>م</u> ا | roduc | i Αva | ilahil | itv an | | | ≓ knose | ≓ Codu | <u> </u> | ŝ | 9 | = | ~~ | 5 |
| | | . | Toleranc | e | | | | | | • | See 1 | Table : | 2 for | Chip 1 | l onn Thickr | iess [| Dimen | sions | | | | | | |
| 10 - 2,000 pF | 100 - 202 | J | K | М | | | | | | | | | | | | | | | | | | | | |
| 2,200 pF | 222 | J | K | M | TA | TA | TA | TA | TA | | | | | | | | | | | | | | | |
| 2,400 pF | 242 | J | K | M | | | | | | | | | | | | | | | | | | | | |
| 2,700 pF | 272 | J | K | M | TA | TA | TA | TA | TA | | | | | | | | | | | | | | | |
| 3,000 pF | 302 | J | K | M | | | | | | | | | | | | | | | | | | | | |
| 3,300 pF | 332 | J | K | M | TA | TA | TA | TA | TA | QB | QB | QB | QB | QB | | | | | | | | | | |
| 3,600 pF | 362 | J | K | М | | | | | | | | | | | | | | | | | | | | |
| 3,900 pF | 392 | J | K | М | TA | TA | TA | TA | ТВ | QB | QB | QB | QB | QB | MA | MA | MA | MA | MA | | | | | |
| 4,300 pF | 432 | J | K | M | L | | | | | | | | | | | | | | | | | | | |
| 4,700 pF | 472 | J | K | M | TA | TA | TA | TB | ТВ | QB | QB | QB | QB | QB | MA | MA | MA | MA | MA | SA | SA | SA | SA | SA |
| 5,100 pF | 512 | J | K | M | | | - | TO | TO | | | | | | | | | | | | | ~ ~ ~ | | ~ . |
| 5,600 pF | 562 | J | K | M | IA | IA | IA | IR | IC | QR | QB | QR | QB | QB | MA | MA | MA | MA | MA | SA | SA | SA | SA | SA |
| 6,200 pF | 622 | J | K | M | <u>-</u> . | | | | | | | | | | . <i>.</i> . | | | | | | | | | |
| 6,800 pF | 682 | J | K | M | TA | TA | TA | TB | | QB | QB | QB | QB | QC | MA | MA | MA | MA | MA | SA | SA | SA | SA | SA |
| 7,500 pF | 752 | J | K | M | <u>-</u> . | | | | | | | | | | . <i>.</i> . | | | | | | | | | |
| 8,200 pF | 822 | J | K | M | TA | TA | TA | TC | | QB | QB | QB | QC | QC | MA | MA | MA | MA | MB | SA | SA | SA | SA | SA |
| 9,100 pF | 912 | J | K | M | I | | | | | | | | | | l | | | | | | | | | |
| 10,000 pF | 103 | J | K | M | | | | | | QB | QB | QB | QC | QD | MA | MA | MA | MA | MB | SA | SA | SA | SA | SB |
| 12,000 pF | 123 | J | K | M | | | | | | QB | QB | QB | QD | | MA | MA | MA | MB | MB | SA | SA | SA | SA | SB |
| 15,000 pF | 153 | J | K | M | | | IB | | | QB QB | QB | QB | UD UD | | MA | MA | MA | MB | MC | SA | SA | SA | SB | SB |
| 18,000 pF | 183 | J | K | M | | TD | IB | | | QB | QB | QB | | | MA | MA | MA | MC | | SA | SA | SA | SB | SC |
| 22,000 pF | 223 | J | K | M | | | IC | | | QB | QB | UU 00 | | | MA | MA | MA | | | SA | SA | SA | 28 | |
| 27,000 pF | 273 | J | K | M | | | | | | QB | QB | UU 00 | | | MA | MA | MA | | | SA | SA | SA | 50 | |
| 33,000 pF | 333 | J | K | | | | | | | QB QB | | UU OD | | | MA | MA | MB | | | SA | SA | SA | | |
| 39,000 pF | 393 | J | ĸ | | | 10 | | | | UB OD | | Ųυ | | | | MD | IVID | | | SA | SA | 30 | | |
| 47,000 pF | 4/3 | J | ĸ | M | TC | | | | | | | | | | MA | MP | WC | | | SA | SA | SD | | |
| 68 000 pF | 692 | 1 | r k | M | | | | | | | | | | | | | | | | SA QA | SA CD | 00 90 | | |
| 82 000 pF | 823 | | ĸ | M | | | | | | | UV | | | | MP | WIC | | | | SA SA | SB | 30 | | |
| 01,000 pr | 104 | J 1 | | M | | | | | | | | | | | MC | | | | | CD SA | 00 00 | | | |
| 0.1 µF | 104 | J | ĸ | | | | | | | Ųυ | | | | | | | | | | SD CD | 30 | | | |
| 0.12 µP | 154 | | K | M | | | | | | | | | | | WIC | | | | | SC | | | | |
| 0.10 µ | 101 | | | ()(D.O.) | 9 | | 8 | 8 | 8 | 9 | | 8 | 8 | 8 | 9 | | 8 | 8 | 8 | 9 | | 8 | 8 | 8 |
| | Con | Kated | voitage | (VUC) | 50 | 63 | 10 | 15(| 20(| 50 | 63 | 10 | 15(| 20(| 50 | 63 | 10 | 151 | 20(| 50 | 63 | 10 | 15(| 20(|
| Capacitance | Code | Vo | oltage Co | de | C | B | D | F | G | C | B | D | F | G | C | B | D | F | G | C | B | D | F | G |
| | | Case | e Size/S | eries | | C | 2824 | Η | | | C | 3040 | Н | | | C | 3640 | н | | | C | 4540 | H | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).

These products are protected under US Patents 7,172,985 and 7,670,981, other patents pending, and any foreign counterparts.

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Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper C |)uantity | Plastic | Quantity |
|-----------|------|------------------------|---------|----------|---------|----------|
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| DG | 0805 | 1.25±0.15 | 0 | 0 | 2,500 | 10,000 |
| ED | 1206 | 1.00±0.10 | 0 | 0 | 2,500 | 10,000 |
| EF FO | 1206 | 1.20±0.15 | 0 | 0 | 2,500 | 10,000 |
| EG | 1200 | 1.00±0.10 1.25±0.15 | 0 | | 2,000 | |
| FU | 1210 | 1.2510.15 | 0 | 0 | 2,300 | 8 000 |
| FM | 1210 | 1 70+0 20 | 0 | 0 | 2,000 | 8 000 |
| FY | 1210 | 2.00+0.20 | 0 0 | 0 0 | 2,000 | 8,000 |
| FK | 1210 | 2.10±0.20 | Ő | Ő | 2,000 | 8,000 |
| FS | 1210 | 2.50±0.30 | 0 | 0 | 1,000 | 4,000 |
| LA | 1808 | 1.40±0.15 | 0 | 0 | 1,000 | 4,000 |
| LB | 1808 | 1.60±0.15 | 0 | 0 | 1,000 | 4,000 |
| LC | 1808 | 2.00±0.15 | 0 | 0 | 1,000 | 4,000 |
| GH | 1812 | 1.40±0.15 | 0 | 0 | 1,000 | 4,000 |
| GK | 1812 | 1.60±0.20 | 0 | 0 | 1,000 | 4,000 |
| GM | 1812 | 2.00±0.20 | 0 | 0 | 500 | 2,000 |
| GO | 1812 | 2.50±0.20 | 0 | 0 | 500 | 2,000 |
| | 1025 | 1.40±0.15 | 0 | 0 | 1,000 | 4,000 |
| | 1025 | 1.00±0.20 | 0 | 0 | 500 | 4,000 |
| нк | 1825 | 2.0010.20 | 0 | 0 | 500 | 2,000 |
| JE | 2220 | 1 40+0 15 | 0 | 0 | 1 000 | 4 000 |
| JK | 2220 | 1.60±0.20 | 0 | 0 | 1,000 | 4.000 |
| JL | 2220 | 2.00±0.20 | 0 | 0 | 500 | 2,000 |
| JN | 2220 | 2.50±0.20 | 0 | 0 | 500 | 2,000 |
| KE | 2225 | 1.40±0.15 | 0 | 0 | 1,000 | 4,000 |
| KF | 2225 | 1.60±0.20 | 0 | 0 | 1,000 | 4,000 |
| KH | 2225 | 2.00±0.20 | 0 | 0 | 500 | 2,000 |
| KJ | 2225 | 2.50±0.20 | 0 | 0 | 500 | 2,000 |
| TA | 2824 | 1.40±0.15 | 0 | 0 | 750 | 2,500 |
| IB | 2824 | 2.00±0.20 | 0 | 0 | 300 | 2,000 |
| | 2824 | 2.50±0.20 | 0 | 0 | 300 | 2,000 |
| | 3040 | 1.40 ± 0.15 | 0 | | 500 | 1,050 |
| | 3040 | 2.00±0.20 2.50+0.20 | 0 | 0 | 350 | 1,050 |
| MA | 3640 | 1 /0+0 15 | 0 | 0 | 250 | 1,400 |
| MB | 3640 | 2.00+0.20 | 0 | 0 | 250 | 1,550 |
| MC | 3640 | 2.50±0.20 | Ő | Ő | 250 | 1.000 |
| SA | 4540 | 1.40±0.15 | 0 | 0 | 200 | 1,500 |
| SB | 4540 | 2.00±0.20 | 0 | 0 | 200 | 1,500 |
| SC | 4540 | 2.50±0.20 | 0 | 0 | 200 | 1,500 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size | Range (mm) | Paper (|)uantity | Plastic | Quantity |

Package quantity based on finished chip thickness specifications.

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Table 2B – Bulk Packaging Quantities

| | Deekeging | Funo | Loose Pa | ackaging | Secure P | ackaging |
|----------|---------------|-------------------|----------|--------------|---------------|--------------------------|
| | Раскауту | гуре | Bulk Bag | (default) | 2" x 2" Waffl | e Pack/Tray ³ |
| | Packaging C-S | Spec ¹ | N/ | /A² | 7282, | /7292 |
| Case | e Size | Chip Thickness | Packagin | g Quantities | (pieces/unit | packaging) |
| EIA (in) | Metric (mm) | (mm) | Minimum | Maximum | Minimum | Maximum |
| 0402 | 1005 | | | | | 368 |
| 0603 | 1608 | All | | | | 368 |
| 0805 | 2012 | | | F0 000 | | 100 |
| 1206 | 3216 | ≤ 1.25 (nominal) | | 50,000 | | 126 |
| 1206 | 3216 | > 1.25 (nominal) | | | | 50 |
| 1210 | 3225 | | 1 | | 1 | 80 |
| 1808 | 4520 | | | | | 50 |
| 1812 | 4532 | | | | | 42 |
| 1825 | 4564 | | | 20,000 | | 20 |
| 2220 | 5650 |] | | | | 20 |
| 2225 | 5664 | | | | | 20 |

¹ The "Packaging C-Spec" is a 4-digit code which identifies the packaging type. When ordering, the proper code must be included in the 15th through 18th character positions of the ordering code. See "Ordering Information" section of this document for further details. Product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag). The 15th through 18th character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.

³ Also commonly referred to as "Chip Carrier" or "Molded Tray". All tray packaging options offer static protection.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size Code | Metric Size Code | | Dens Maxi Land P | sity Lev mum (I rotrusio | vel A: Most) on (mm |) | | Dens Medi Land P | sity Lev an (Nor rotrusio | vel B: minal) on (mm |) | | Dens Minii Land Pi | sity Lev mum (L rotrusio | vel C: .east) on (mm |) |
|---------------------|------------------------|------|------------------------|--------------------------------|---------------------------|-------|------|------------------------|---------------------------------|----------------------------|-------|------|--------------------------|--------------------------------|----------------------------|-------|
| oouc | oouc | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 |
| 1825 | 4564 | 2.15 | 1.60 | 6.90 | 6.90 | 7.90 | 2.05 | 1.40 | 6.80 | 6.00 | 7.30 | 1.95 | 1.20 | 6.70 | 5.30 | 7.00 |
| 2220 | 5650 | 2.75 | 1.70 | 5.50 | 8.20 | 6.50 | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | 2.55 | 1.30 | 5.30 | 6.60 | 5.60 |
| 2225 | 5664 | 2.70 | 1.70 | 6.90 | 8.10 | 7.90 | 2.60 | 1.50 | 6.80 | 7.20 | 7.30 | 2.50 | 1.30 | 6.70 | 6.50 | 7.00 |
| 2824 | 7260 | 3.45 | 1.70 | 6.60 | 9.60 | 7.60 | 3.35 | 1.50 | 6.50 | 8.70 | 7.00 | 3.25 | 1.30 | 6.40 | 8.00 | 6.70 |
| 3040 | 7610 | 3.70 | 1.70 | 10.70 | 10.10 | 11.70 | 3.60 | 1.50 | 10.60 | 9.20 | 11.10 | 3.50 | 1.30 | 10.50 | 8.50 | 10.80 |
| 3640 | 9210 | 4.45 | 1.70 | 10.70 | 11.60 | 11.70 | 4.35 | 1.50 | 10.60 | 10.70 | 11.10 | 4.25 | 1.30 | 10.50 | 10.00 | 10.80 |
| 4540 | - | 5.60 | 1.70 | 10.70 | 13.90 | 11.70 | 5.50 | 1.50 | 10.60 | 13.00 | 11.10 | 5.40 | 1.30 | 10.50 | 12.30 | 10.80 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.



Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Termination Finish | | | | |
|--|-----------------------|-----------------------|--|--|--|
| Tomeredure | SnPb | 100% Matte Sn | | | |
| Preheat/Soak | | | | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C | | | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | | | |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds | | | |
| Ramp-Up Rate (T_L to T_p) | 3°C/second maximum | 3°C/second maximum | | | |
| Liquidous Temperature (T _L) | 183°C | 217°C | | | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | | | |
| Peak Temperature (T _P) | 235°C | 260°C | | | |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum | 30 seconds maximum | | | |
| Ramp-Down Rate $(T_p to T_L)$ | 6°C/second maximum | 6°C/second maximum | | | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | | | |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.







Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test Condition | Limits |
|--|----------------|--|--|
| Visual and Mechanical | KEMET Internal | No defects that may affect performance (10X) | Dimensions according KEMET Spec Sheet |
| Capacitance (Cap) | KEMET Internal | C ≤ 1,000 pF Frequency: 1 MHz ±100 kHz Voltage*:1.0 V _{rms} ±0.2 V C > 1,000 pF Frequency: 1 kHz ±50 Hz Voltage: 1.0 V _{rms} ±0.2 V * See part number specification sheet for voltage | Within Tolerance |
| Dissipation Factor (DF) | KEMET Internal | C ≤ 1,000 pF Frequency: 1 MHz ±100 kHz Voltage*: 1.0 V _{rms} ±0.2 V C > 1,000 pF Frequency: 1 kHz ±50 Hz Voltage: 1.0 V _{rms} ±0.2 V * See part number specification sheet for voltage | Within Specification Dissipation factor (DF) maximum limit at 25°C = 0.1% |
| Insulation Resistance (IR) | KEMET Internal | 500 VDC applied for 120 ±5 seconds at 25°C | Within Specification To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ limit. Select the lower of the two limits: 1,000 megohm microfarads or 100 GΩ. |
| Temperature Coefficient of Capacitance (TCC) | KEMET Internal | Capacitance change with reference to +25°C and 0 VDC applied. * See part number specification sheet for voltage Step Temperature (°C) 1 +25°C 2 -55°C 3 +25°C (Reference Temperature) 4 +125°C | Within Specification: ±30 ppm / °C |



Table 4 – Performance & Reliability: Test Methods and Conditions cont.

| Stress | Reference | Test Condition | Limits |
|--|---------------------------|--|---|
| Dielectric Withstanding Voltage (DWV) | KEMET Internal | 150% of rated voltage for voltage rating of < 1,000 V 120% of rated voltage for voltage rating of \ge 1,000 V (5 \pm 1 seconds and charge/discharge not exceeding 50 mA) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit Withstand test voltage without insulation breakdown or damage. |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | KEMET Internal | Maximum % capacitance loss/decade hour | 0% Loss/Decade Hour |
| Terminal Strength | KEMET Internal | Shear stress test per specific case size, Time: 60 ±1 second. | No evidence of mechanical damage |
| Board Flex | AEC-Q200-005 | Standard Termination System 2.0 mm Flexible Termination System 3.0 mm Test Time: 60± 5 seconds Ramp Time: 1 mm/second | No evidence of mechanical damage |
| Resistance to Soldering Heat | MIL-STD-202 Method 210 | Condition B, no per-heat of samples, Single Wave Solder | No evidence of mechanical damage |
| Thermal Shock | MIL-STD-202 Method 107 | 300 cycles (-55°C to +150°C), 20 seconds transfer, 15 minute dwell | Measurement at 24 hours ±4 hours after test conclusion. Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Temperature Cycling | JESD22 Method JA-104 | 50 cycles (-55°C to +200°C) | Measurement at 24 hours ±4 hours after test conclusion. Cap: Initial Limit DF: Initial Limit IR: Initial Limit |



Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test Condition | Limits |
|---------------------------|---------------------------|---|---|
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and 200 VDC maximum Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5% |
| Moisture Resistance | MIL-STD-202 Method 106 | Number of Cycles Required: 10, 24 hours per cycle. Steps 7a and 7b not required | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Thermal Shock | MIL-STD-202 Method 107 | Number of Cycles Required: 5, (-55°C to 125°C) Dwell time 15 minutes. | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Test from 10 – 2,000 Hz | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Mechanical Shock | MIL-STD-202 Method 213 | 1,500 g's 0.5 millisecond Half-sine, Velocity Change: 15.4 feet/second (Condition F) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents. | Visual Inspection 10X Readable marking, no decoloration or stains. No physical damage. |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. In addition, temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within the time frame outlined in the table below:

| Termination Finish | Termination Finish Ordering Code ¹ | Storage Life | | |
|----------------------------|---|------------------------------------|--|--|
| 100% Matte Tin (Sn) | С | 1.5 years upon receipt | | |
| SnPb (5% Pb min.) | L | 1.5 years upon receipt | | |
| Gold (Au) 1.97 – 11.8 µin² | E | 6 months upon receipt ² | | |
| Gold (Au) 30 – 70 µin | F | 1.5 years upon receipt | | |
| Gold (Au) 100 µin min. | G | 1.5 years upon receipt | | |

¹ The fourteenth (14th) character position of the KEMET part number is assigned to identify and/or define the termination finish. For more information, see "Ordering Information" section of this document.

² Gold plating option "E" devices should remain in its factory sealed moisture sensitive packaging during storage. If the factory sealed packaging is disturbed please store any remaining packaged components in a dry box container to prevent oxidation of the termination finish.

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Construction (Typical)



Capacitor Marking (Optional):

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- · EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12, 16 and 24 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punche | | |
|-------------------|------|---------|--------------------|---------|--------------------|---|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | (W)* | Pitch | (P ₁)* | Pitch | (P ₁)* | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 - | - |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| 2824 | 16 | 12 | 12 | | | |
| 3040 - 4540 | 24 | 16 | 16 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 & 2220 | 16 | 12 | 12 | | | |
| Array 0508 & 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs
- Double the parts on each reel results in fewer reel changes and increased efficiency
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste

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Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|--|-------------------------------------|----------------------------|----------------------------|----------------------------|---------------------------|----------------------------------|--------------------------------|------------------|--|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T1 Maximum | | |
| 8 mm | | | | | 25.0 (0.984) | | | | | |
| 12 mm | 1.5+0.10/-0.0 (0.059+0.004/-0.0) | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.05 (0.079±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | |
| 16 mm | | | | | (1.181) | | | | | |
| 24 mm | 1.5+0.10/-0.0 (0.059+0.004/-0.0) | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.10 (0.078±0.003) | 30 (1.181) | 5 (0.196) | 0.250 (0.009) | 0.350 (0.013) | | |
| | | Varial | ble Dimensions | s – Millimeters | (Inches) | | | | | |
| Tape Size | Pitch | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B ₀ | & K ₀ | | |
| 8 mm | Single (4 mm) | 6.25 (0.246) | 3.5±0.05 (0.138±0.002) | 4.0±0.10 (0.157±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | | |
| 12 mm | Single (4 mm) & Double (8 mm) | 10.25 (0.404) | 5.5±0.05 (0.217±0.002) | 8.0±0.10 (0.315±0.004) | 4.6 (0.181) | 12.3 (0.484) | Not | o F | | |
| 16 mm | Triple (12 mm) | 14.25 (0.561) | 7.5±0.05 (0.138±0.002) | 12.0±0.10 (0.157±0.004) | 4.6 (0.181) | 16.3 (0.642) | NOL | сJ | | |
| 24 mm | 16 mm | 22.25 (0.875) | 11.5±0.10 (0.452±0.003) | 16.0±0.10 (0.629±0.004) | 3 (0.118) | 24.3 (0.956) | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6).

3. If S₁ < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Standard 481 paragraph 4.3 section b).

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3).

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4).

(e) for KPS Series product, A_n and B_n are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.

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Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | | | |
|--|-------------------------------------|--|---------------------------|---------------------------|----------------------------|-----------------|-------------------------------|--|--|
| Tape Size | D _o | D ₀ E ₁ P ₀ P ₂ T ₁ Maximum | | | | G Minimum | R Reference Note 2 | | |
| 8 mm | 1.5+0.10/-0.0 (0.059+0.004/-0.0) | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.05 (0.079±0.002) | 0.10 (0.004) Maximum | 0.75 (0.030) | 2 (0.984) | | |
| | | Variable D | imensions — M | illimeters (Inche | es) | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5±0.05 | 2.0±0.05 (0.079±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | |
| 8 mm | 8 mm Single (4 mm) | | (0.138±0.002) | 4.0±0.10 (0.157±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3).

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4).

e) see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6).



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 Kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |
| 24 mm | 0.1 to 1.6 newton (10 to 160 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ±10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | | | |
|--|-------------------|--|---------------------------------------|----------------------------|--|--|--|--|--|
| Tape Size | A B Minimum C | | С | D Minimum | | | | | |
| 8 mm | 170:0.00 | | | | | | | | |
| 12 mm | (7.008 ± 0.008) | 1.5 (0.059) | 13.0+0.5/-0.2 (0.521+0.02/-0.008) | 20.2 (0.795) | | | | | |
| 16 mm | or 330±0.20 | | | | | | | | |
| 24 mm | (13.000±0.008) | 1.2 (0.047) | 13.0 + -0.2 (0.521 + -0.008) | 21 (0.826) | | | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | | |
| 8 mm | | 8.4+1.5/-0.0 (0.331+0.059/-0.0) | 14.4 (0.567) | | | | | | |
| 12 mm | 50 | 12.4+2.0/-0.018.450(0.488+0.078/-0.0)(0.724) | | Shall accommodate tape | | | | | |
| 16 mm | (1.969) | 16.4+2.0/-0.0 (0.646+0.078/-0.0) | 22.4 (0.882) | width without interference | | | | | |
| 24 mm | | 25+1.0/-0.0 (0.984+0.039/-0.0) | 27.4+1.0/-1.0 (1.078+0.039/-0.039) | | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Waffle Tray Packaging Information – 2" x 2" w/ Static Protection

Figure 9 – Waffle Tray Dimensions – Inches (Millimeters)



| Caa | o Sizo | | 2" x 2" Waffle Tray Dimensions – Inches | | | | | | | | Packaging Quantity |
|---------------------|-------------|--------|---|--------|--------|--------|--------|--------|--------|---------|---------------------------|
| Uds | e 512e | М | M1 | M2 | M3 | Х | Y | Z | A° | MATRIX | (pcs/unit |
| EIA (in) | Metric (mm) | ±0.003 | ±0.003 | ±0.002 | ±0.002 | ±0.002 | ±0.002 | ±0.003 | ± 1/2° | (X x Y) | packaging) |
| 0402 | 1005 | 0.175 | 0.153 | 0.077 | 0.110 | 0.073 | 0.042 | 0.041 | 7 | 16 X 23 | 368 |
| 0504 | 1210 | 0.235 | 0.226 | 0.172 | 0.170 | 0.080 | 0.090 | 0.055 | 5 | 10 X 10 | 100 |
| 0603 | 1608 | 0.175 | 0.153 | 0.077 | 0.110 | 0.073 | 0.042 | 0.041 | 7 | 16 X 23 | 368 |
| 0805 | 2012 | 0.232 | 0.186 | 0.181 | 0.171 | 0.062 | 0.092 | 0.036 | 10 | 10 X 10 | 100 |
| 1005 | 2512 | 0.230 | 0.240 | 0.190 | 0.140 | 0.060 | 0.110 | 0.075 | 5 | 12 X 9 | 108 |
| 1206 ^{1,2} | 3216 | 0.194 | 0.228 | 0.193 | 0.124 | 0.067 | 0.130 | 0.065 | 5 | 14 X 9 | 126 |
| 1206 ^{1,3} | 3216 | 0.250 | 0.250 | 0.375 | 0.167 | 0.100 | 0.200 | 0.070 | 5 | 10 X 5 | 50 |
| 1210 | 3225 | 0.217 | 0.244 | 0.215 | 0.174 | 0.110 | 0.145 | 0.080 | 5 | 10 X 8 | 80 |
| 1808 | 4520 | 0.271 | 0.285 | 0.286 | 0.243 | 0.150 | 0.200 | 0.075 | 5 | 7 X 6 | 42 |
| 1812 | 4532 | 0.271 | 0.285 | 0.286 | 0.243 | 0.150 | 0.200 | 0.075 | 5 | 7 X 6 | 42 |
| 1825 | 4564 | 0.318 | 0.362 | 0.424 | 0.34 | 0.24 | 0.32 | 0.032 | 5 | 5 X 4 | 20 |
| 2220 | 5650 | 0.318 | 0.362 | 0.424 | 0.34 | 0.24 | 0.32 | 0.032 | 5 | 5 X 4 | 20 |
| 2225 | 5664 | 0.318 | 0.362 | 0.424 | 0.34 | 0.24 | 0.32 | 0.032 | 5 | 5 X 4 | 20 |

Table 9A – Waffle Tray Dimensions – Inches

¹ Packaging of 1206 (3216 metric) case size capacitors is dependent upon the nominal chip thickness of the device. See "Capacitance Range/Selection Waterfall" and "Chip Thickness/Tape & Reel Packaging Quantities" to identify the nominal chip thickness of the capacitor.

² Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of \leq 1.25mm (0.049 inches).

³ Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of > 1.25mm (0.049 inches).

Table 9B – Waffle Tray Dimensions – Millimeters

| Coo | o Ciro | | | 2" x 2" W | affle Tray | / Dimens i | ions – Mi | llimeters | | | Packaging Quantity |
|---------------------|-------------|-------|-------|-----------|------------|-------------------|-----------|-----------|--------|---------|---------------------------|
| Cas | e 512e | М | M1 | M2 | M3 | Х | Y | Z | A° | MATRIX | (pcs/unit |
| EIA (in) | Metric (mm) | ±0.08 | ±0.08 | ±0.05 | ±0.05 | ±0.05 | ±0.05 | ±0.08 | ± 1/2° | (X x Y) | packaging) |
| 0402 | 1005 | 4.45 | 3.89 | 1.96 | 2.79 | 1.85 | 1.07 | 1.04 | 7 | 16 X 23 | 368 |
| 0504 | 1210 | 5.97 | 5.74 | 4.37 | 4.32 | 2.03 | 2.29 | 1.40 | 5 | 10 X 10 | 100 |
| 0603 | 1608 | 4.45 | 3.89 | 1.96 | 2.79 | 1.85 | 1.07 | 1.04 | 7 | 16 X 23 | 368 |
| 0805 | 2012 | 5.89 | 4.72 | 4.60 | 4.34 | 1.57 | 2.34 | 0.91 | 10 | 10 X 10 | 100 |
| 1005 | 2512 | 5.84 | 6.10 | 4.83 | 3.56 | 1.52 | 2.79 | 1.91 | 5 | 12 X 9 | 108 |
| 1206 ^{1,2} | 3216 | 4.93 | 5.79 | 4.90 | 3.15 | 1.70 | 3.30 | 1.65 | 5 | 14 X 9 | 126 |
| 1206 ^{1,3} | 3216 | 6.35 | 6.35 | 9.53 | 4.24 | 2.54 | 5.08 | 1.78 | 5 | 10 X 5 | 50 |
| 1210 | 3225 | 5.51 | 6.20 | 5.46 | 4.42 | 2.79 | 3.68 | 2.03 | 5 | 10 X 8 | 80 |
| 1808 | 4520 | 6.88 | 7.24 | 7.26 | 6.17 | 3.81 | 5.08 | 1.91 | 5 | 7 X 6 | 42 |
| 1812 | 4532 | 6.88 | 7.24 | 7.26 | 6.17 | 3.81 | 5.08 | 1.91 | 5 | 7 X 6 | 42 |
| 1825 | 4564 | 8.08 | 9.19 | 10.77 | 8.64 | 6.10 | 8.13 | 0.81 | 5 | 5 X 4 | 20 |
| 2220 | 5650 | 8.08 | 9.19 | 10.77 | 8.64 | 6.10 | 8.13 | 0.81 | 5 | 5 X 4 | 20 |
| 2225 | 5664 | 8.08 | 9.19 | 10.77 | 8.64 | 6.10 | 8.13 | 0.81 | 5 | 5 X 4 | 20 |

¹ Packaging of 1206 (3216 metric) case size capacitors is dependent upon the nominal chip thickness of the device. See "Capacitance Range/Selection Waterfall" and "Chip Thickness/Tape & Reel Packaging Quantities" to identify the nominal chip thickness of the capacitor.

² Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of \leq 1.25mm (0.049 inches).

³ Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of > 1.25mm (0.049 inches).



Application Guide

Solder Fluxes and Cleaning

The use of water-soluble fluxes provides advantages of excellent solderability due to high activation. However, these fluxes contain organic acids that can induce arcing under high DC or AC voltages. Notable problem areas are underneath the MLCC where flux can be trapped between the ceramic material and PCB. It is therefore critical that PCBs are properly cleaned to remove all flux residue to maintain reliability.

Coating for High Voltage MLCCs

For MLCC ratings \geq 1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

| Dielectric | CTE (ppm/°C) |
|----------------------------|--------------|
| Class II BaTiO₃ | 10.7 |
| Class I CaZrO ₃ | 9.8 |

Slits in PCB

It is recommended to apply a slit in the PCB under the MLCC to improve washing of flux residue that may get trapped underneath. In some cases, it is not possible to slit entirely through the PCB due to underlying metal planes. It is also acceptable to apply a recessed slit under the MLCC which will also promote cleaning.

- Recommended for case sizes ≥1206
- The width (w) of the slit should be 1mm
- Length of the slit should be as short as possible to prevent damaging the MLCC due to mechanical stress of the PCB.
- Slits also reduce the risk of solder balls under MLCC which decreased the creepage distance.



Solder Resist

If a slit cannot be applied as above, it is recommended to not use solder resist directly under the MLCC. The use of solder resist material reduces the distance between MLCC ceramic material and PCB thus making it difficult to clean.

Solder Balls

Improper reflow techniques and/or improper washing can induce solder balls under or adjacent to the MLCC. Solder balls reduce the creepage distance between the MLCC terminations and increase the risk of arcing or damage to the ceramic material. To reduce the risk of solder balls:

- Follow KEMET's solder recommendations as outlined in the datasheet.
- If performing a cleaning procedure, properly clean the PCB per KEMET's cleaning recommendations.
- Add slit to the PCB as shown above.



High Voltage with Flexible Termination System (HV FT-CAP), COG Dielectric, 500 – 10,000 VDC (Commercial Grade)



Overview

KEMET's High Voltage with Flexible Termination (HV FT-CAP) surface mount MLCCs in COG dielectric address the primary failure mode of MLCCs-flex cracks. These devices utilize a pliable and conductive silver epoxy between the base metal and nickel barrier layers of the termination system which inhibits the transfer of board stress to the rigid ceramic body, therefore mitigating flex cracks which can result in low IR or short circuit failures. Flexible termination technology provides superior flex performance over standard termination systems. COG (NP0) dielectric capacitors exhibit no change in capacitance with respect to time and voltage and boasts a negligible change in capacitance with reference to ambient temperature. Capacitance change is limited to ±30ppm/°C from -55°C to +125°C. These devices exhibit low ESR at high frequencies and find conventional use as snubbers or filters in applications such as switching power supplies and lighting ballasts.

Benefits

- Operating temperature range of -55°C to +125°C
- Superior flex performance (up to 5 mm)
- Capacitance offerings ranging from 1 pF to 120 nF
- DC voltage ratings of 500 V, 630 V, 1 KV, 1.5 KV, 2 KV, 2.5 KV, 3 KV and 10KV
- EIA 0603, 0805, 1206, 1210, 1808, 1812, 1825, 2220 and 2225
- Extremely low ESR and ESL
- High ripple current capability
- No capacitance shift with voltage
- · Negligible capacitance shift with respect to temperature
- No piezoelectric noise
- · Lead (Pb)-Free, RoHS and REACH compliant

Applications

- · High frequency power converters
- Wide bandgap (WBG), silicon carbide (SiC) and gallium nitride (GaN) systems
- Snubber (high dV/dT)
- Resonant circuits (LLC, Wireless Charging, etc)
- Timing
- Filtering





Ordering Information

| С | 2225 | X | 393 | J | C | G | Α | C | TU |
|---------|--|-----------------------------|--|---|---|------------|----------------------------|---|--|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance ¹ | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ² | Packaging/Grade (C-Spec) |
| | 0603 0805 1206 1210 1808 1812 1825 2220 2225 | X = Flexible Termination | Two significant digits and number of zeros. | $B = \pm 0.10 \text{ pF}$ C = ±0.25 pF D = ±0.5 pF F = ±1% G = ±2% J = ±5% K = ±10% M = ±20% | C = 500 B = 630 D = 1,000 F = 1,500 G = 2,000 Z = 2,500 H = 3,000 K = 10,000 | G = COG | A = N/A | C = 100% Matte Sn L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ Additional capacitance tolerance offerings may be available. Contact KEMET for details.

² Additional termination finish options may be available. Contact KEMET for details.

Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) |
|--|---|
| Commerc | cial Grade ¹ |
| Bulk Bag | Not required (Blank) |
| 7" Reel/Unmarked | TU |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2mm pitch ² | 7081 |
| 13" Reel/Unmarked/2mm pitch ² | 7082 |
| Automot | ive Grade ³ |
| 7" Reel | AUTO |
| 13" Reel/Unmarked | AUT07411 (EIA 0603 and smaller case sizes) AUT07210 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2mm pitch ² | 3190 |
| 13" Reel/Unmarked/2mm pitch ² | 3191 |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices. For more information see "Capacitor Marking".

² The 2mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2mm pitch option see "Tape & Reel Packaging Information".

³ Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information".

³ For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information".

³ All Automotive packaging C-Specs listed exclude the option to laser mark components. The option to laser mark is not available on these devices. For more information see "Capacitor Marking".



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|----------------------------|---------------------------------|
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | |
| 0805 | 2012 | 2.00 (0.079) ±0.30 (0.012) | 1.25 (0.049) ±0.30 (0.012) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave or Solder Reflow |
| 1206 | 3216 | 3.30 (0.130) ±0.40 (0.016) | 1.60 (0.063) ±0.35 (0.013) | | 0.60 (0.024) ±0.25 (0.010) | | |
| 1210 | 3225 | 3.30 (0.130) ±0.40 (0.016) | 2.60 (0.102) ±0.30 (0.012) | | 0.60 (0.024) ±0.25 (0.010) | | |
| 1808 | 4520 | 4.70 (0.185) ±0.50 (0.020) | 2.00 (0.079) ±0.20 (0.008) | See Table 2 for Thickness | 0.70 (0.028) ±0.35 (0.014) | | |
| 1812 | 4532 | 4.50 (0.178) ±0.40 (0.016) | 3.20 (0.126) ±0.30 (0.012) | | 0.70 (0.028) ±0.35 (0.014) | N/A | Solder Reflow |
| 1825 | 4564 | 4.60 (0.181) ±0.40 (0.016) | 6.40 (0.252) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | Only |
| 2220 | 5650 | 5.90 (0.232) ±0.75 (0.030) | 5.00 (0.197) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | |
| 2225 | 5664 | 5.90 (0.232) ±0.75 (0.030) | 6.40 (0.248) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | |

Qualification/Certification

Commercial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance and Reliability.

Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions (excluding SnPb termination finish option).



Table 1A - Capacitance Range/Selection Waterfall (0603 - 1808 Case Sizes)

| | | C | ase | Siz | :e/ | Se | rie | S | C |)60 | 3X | C | 080 | 5X | | C 1 | 120 | 6X | | | C | 1210 | DX | | | | C | 180 | BX | | |
|------------------|-------------|----|--------|--------|------|-------|------|---|-----|------|------|-----|------|-------------------|----------|------------|-------------------|----------|----------|----------------|-------|----------|--------|--------|-----|-----|--------|--------|--------|--------|--------|
| | Cap | | Vo | oltag | e Co | ode | | | С | В | D | С | В | D | С | В | D | F | G | С | В | D | F | G | С | В | D | F | G | z | Н |
| Capacitance | Code | | Rated | l Voli | tage | e (VE | DC) | | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| | | Ca | apacit | tanc | e To | oler | anc | e | | 1 | | | | • | Pi | oduc | t Ava | ailabi | ility a | and C | hip 1 | Chick | iness | Cod | es | | | | | | ., |
| 1.0 - 9.1 pF* | 109 - 169* | В | C D | | | | | | | | | DG | DG | DG | | See | able | 2 10 | | <u>p i iii</u> | CKIIE | 55 D | illien | 510113 | LB | LB | LB | LB | LB | LB | LB |
| 10 pF | 100 | | | F | G | J | K | М | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 11 pF | 110 | | | F | G | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | | LB | LB | LB | LB | LB | LB |
| 12 pF | 120 | | | | G | J | ĸ | M | | | | | DG | | ES ES | ES ES | ES ES | ES ES | ES ES | FM | FM | FM | FM | FM | | LB | LB | LB | LB | LB | LB |
| 15 pF | 150 | | | F | G | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 16 pF | 160 | | | F | G | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 18 pF | 180 | | | F | G | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 20 pF | 200 | | | F | G | J | K | М | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 22 pF | 220 | | | F | G | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 24 pF 27 nF | 240 | | | | G | J | ĸ | M | | | | | | | ES FS | ES ES | ES ES | ES ES | ES ES | FM | FM | FM | FM | FM | | LB | LB | LB | LB | LB | LB |
| 30 pF | 300 | | | F | G | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 33 pF | 330 | | | F | G | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 36 pF | 360 | | | F | G | J | K | М | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 39 pF | 390 | | | F | G | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 43 pF | 430 | | | F | G | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 4/pF | 4/0 510 | | | | G | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | | FM | FM | FM | FM | LB | | | | | LB | LB |
| 56 nF | 560 | | | F | G | 1 | ĸ | M | | | | | DG | | ES | ES | ES | ES ES | ES | FM | FM | FM | FM | FM | | | | | | | |
| 62 pF | 620 | | | F | G | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 68 pF | 680 | | | F | G | J | К | М | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 75 pF | 750 | | | F | G | J | K | Μ | | | | DG | DG | DG | ES | ES | ES | ES | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 82 pF | 820 | | | F | G | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 91 pF | 910 | | | F | G | J | K | M | | 0.1 | 0.1 | DG | DG | DG | ES | ES | ES | ES | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 100 pF | 101 | | | | G | J | K | M | CJ | CJ | CJ | | DG | DG | ES | ES | ES | ES | | | FM | FM | FM | FM | | | LB | | | | |
| 120 nF | 121 | | | F | G | 1 | K | M | C.I | C.I | C.I | DG | DG | DG | ES | ES | ES | ES | FII | F7 | F7 | F7 | FM | FM | | | | | | | |
| 130 pF | 131 | | | F | G | J | K | M | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | ES | EU | FZ | FZ | FZ | FM | FM | LA | LA | LA | LA | LB | LC | LC |
| 150 pF | 151 | | | F | G | J | к | M | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | EF | EU | FZ | FZ | FZ | FM | FM | LA | LA | LA | LA | LB | LC | LC |
| 160 pF | 161 | | | F | G | J | K | М | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | EF | EU | FZ | FZ | FZ | FM | FM | LA | LA | LA | LA | LC | LC | LC |
| 180 pF | 181 | | | F | G | J | K | M | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | EF | EU | FZ | FZ | FZ | FM | FM | LA | LA | LA | LA | LC | LC | LC |
| 200 pF | 201 | | | F | G | J | K | M | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | EF | EU | FZ | FZ | FZ | FM | FM | | | LA | LA | LC | LC | |
| 220 pF 240 pF | 221 | | | | G | J | ĸ | M | | | LJ | | DG | | ES ES | ES ES | ES ES | EU | EU | | FZ | FZ F7 | FM | FM | | | | | | | |
| 270 pF | 271 | | | F | G | J | K | M | CJ | CJ | | DG | DG | DG | ES | ES | ES | EU | EU | FZ | FZ | FZ | FK | FK | LA | LA | LA | LB | LC | LC | |
| 300 pF | 301 | | | F | G | J | K | M | CJ | CJ | | DG | DG | DC | ES | ES | EF | EU | | FZ | FZ | FZ | FK | FK | LA | LA | LA | LB | LC | LC | |
| 330 pF | 331 | | | F | G | J | к | M | CJ | CJ | | DG | DG | DC | ES | ES | EF | EU | | FZ | FZ | FZ | FK | FK | LA | LA | LA | LB | LC | LC | |
| 360 pF | 361 | | | F | G | J | K | M | CJ | CJ | | DG | DG | DC | ES | ES | EF | EU | | FZ | FZ | FZ | FK | FS | LA | LA | LA | LB | LA | LC | |
| 390 pF | 391 | | | F | G | J | K | M | CJ | CJ | | DG | DG | DC | ES | ES | EF | EU | | FZ | FZ | FZ | FK | FS | LA | LA | LA | LB | LA | LC | _ |
| 430 pF | 431 | | | | G | J | K | M | CJ | CJ | | | DG | עע חח | ES | ES | | EU | | | FM | FM | FS | FS | | LB | | | | | |
| 470 pr 510 nF | 471 511 | | | F | G | 1 | K | M | | CJ | | | DG | םם | ES | ES | FII | FII | | F7 | FM | FM | FS | FS | | | | | | | |
| 560 pF | 561 | | | F | G | Ĵ | ĸ | M | CJ | CJ | | DG | DG | DG | ES | ES | EU | EU | | FZ | FM | FM | FS | FS | LA | LB | LB | LC | LB | | |
| 620 pF | 621 | | | F | G | J | К | М | CJ | CJ | | DG | DG | DG | ES | ES | EU | | | FZ | FM | FM | FS | FS | LA | LB | LB | LA | LC | | |
| 680 pF | 681 | | | F | G | J | K | М | CJ | CJ | | DG | DG | DG | ES | ES | EU | | | FZ | FM | FM | FS | FS | LB | LB | LB | LA | LC | | |
| 750 pF | 751 | | | F | G | J | K | M | | | | DG | DG | DG | ES | EF | EU | | | FZ | FM | FM | FM | | LB | LB | LB | LA | | | |
| 820 pF | 821 | | | | G | J | K | M | | | | DG | | DG | ES ES | | EU | | | | FM | FM | | | | | | | | | |
| 1.000 nF | 102 | | | F | G | .1 | K | M | | | | DC | DC | | ES | EF | EII | | | FM | FM | FM | FY | | | | LR | | | | |
| 1,000 pi | 102 | | Rated | l Voli | tage | • (VE |) () | | 0 | 30 | 000 | 8 | 30 | 000 | 00 | 30 | 000 | 500 | 000 | 00 | 30 | 000 | 500 | 000 | 00 | 30 | 000 | 200 | 000 | 500 | 000 |
| Capacitance | Cap Code | | Vo | oltag | e Co | ode | , | | C C | B | | C C | B | ب D | C C | B | ب D | ₩ F | 5 G | c S | B | ≓ D | ₩ F | б G | C C | B | ≂ D | ₩ F | 5 G | ิ Z | м Н |
| | Juc | | Case | e Siz | ze/S | Serie | es | | c | 0603 | X | c | 0805 | 5X | | C | 1206 | 5X | 1 | | C | 1210 | X | | | 1 | C | 1808 | X | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).



Table 1A – Capacitance Range/Selection Waterfall (0603 – 1808 Case Sizes) cont.

| | | Case Size/Series | C | 060 | 3X | C |)80 | 5X | | C 1 | 1200 | 6X | | | C | 1210 | DX | | | | C 1 | 808 | BX | | |
|-------------|-------------|-----------------------|---------------|-----|------|-----|-----|------|-----|---------------|----------------|---------------|------------------|----------------|---------------|----------------|------|--------------|---------|-----|------------|------|------|------|------|
| | Сар | Voltage Code | C | B | D | C | В | D | C | В | D | F | G | C | В | D | F | G | C | В | D | F | G | z | н |
| Capacitance | Code | Rated Voltage (VDC) | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| | | Capacitance Tolerance | | | | | | | Pr | oduc See 1 | t Ava Table | ailab 2 fo | ility a r Chi | and C p Thi | hip 1 ckne | Thick ss Di | imen | Cod sions | es s | | | | | | |
| 1,100 pF | 112 | F G J K M | | | | DC | DC | | EF | EU | ED | | | FM | FK | FK | FS | | LC | LC | LC | LB | | | |
| 1,200 pF | 122 | F G J K M | | | | DC | DC | | EF | EU | ED | | | FM | FK | FK | FS | | LC | LC | LC | LC | | | |
| 1,300 pF | 132 | F G J K M | | | | DC | DC | | EF | EU | ED | | | FM | FS | FS | | | LC | LC | LC | LC | | | |
| 1,500 pF | 152 | F G J K M | | | | DD | DD | | EF | EU | ED | | | FK | FS | FS | | | LC | LC | LC | LC | | | |
| 1,600 pF | 162 | F G J K M | | | | DD | DD | | EF | EU | ED | | | FK | FS | FS | | | LC | LC | LC | | | | |
| 1,800 pF | 182 | F G J K M | | | | DG | DG | | EF | EU | EF | | | FK | FS | FS | | | LC | LC | LC | | | | |
| 2,000 pF | 202 | F G J K M | | | | DG | DG | | EU | EQ | EF | | | FK | FL | FS | | | LC | LA | LB | | | | |
| 2,200 pF | 222 | F G J K M | | | | DG | DG | | EU | EQ | EF | | | FK | FL | FS | | | LC | LA | LB | | | | |
| 2,400 pF | 242 | F G J K M | | | | DG | DG | | EU | EQ | EU | | | FS | FL | FS | | | LC | LA | LB | | | | |
| 2,700 pF | 272 | F G J K M | | | | DG | DG | | EU | EQ | EU | | | FS | FL | FS | | | LC | LA | LC | | | | |
| 3,000 pF | 302 | F G J K M | | | | | | | EQ | EQ | | | | FS | FL | FF | | | LA | LA | LA | | | | |
| 3,300 pF | 332 | F G J K M | | | | | | | EQ | EQ | | | | FS | FM | FG | | | LA | LA | LA | | | | |
| 3,600 pF | 362 | F G J K M | | | | | | | ER | ER | | | | FL | FM | FG | | | LA | LB | LA | | | | |
| 3,900 pF | 392 | F G J K M | | | | | | | ER | ER | | | | FL | FY | FL | | | LA | LB | LA | | | | |
| 4,300 pF | 432 | F G J K M | | | | | | | ES | ES | | | | FM | FY | FL | | | LA | LC | LA | | | | |
| 4,700 pF | 472 | F G J K M | | | | | | | ES | ES | | | | FM | FY | FM | | | LA | LC | LB | | | | |
| 5,100 pF | 512 | F G J K M | | | | | | | EE | EE | | | | FY | FS | FM | | | LA | LB | LB | | | | |
| 5,200 pF | 562 | F G J K M | | | | | | | EF | EF | | | | FY | FS | FM | | | LB | LC | LC | | | | |
| 6,200pF | 622 | F G J K M | | | | | | | EF | EF | | | | FY | FE | FY | | | LC | LC | LC | | | | |
| 6,800pF | 682 | F G J K M | | | | | | | EU | EU | | | | FY | FE | FY | | | LC | LC | LC | | | | |
| 7,500pF | 752 | F G J K M | | | | | | | EU | EU | | | | FS | FF | FS | | | LA | LA | | | | | |
| 8,200pF | 822 | F G J K M | | | | | | | EU | EU | | | | FS | FF | FS | | | LA | LA | | | | | |
| 9,100 pF | 912 | F G J K M | | | | | | | EU | EU | | | | FF | FF | FS | | | LA | LA | | | | | |
| 10,000 pF | 103 | F G J K M | | | | | | | EU | EU | | | | FG | FG | FS | | | LA | LA | | | | | |
| 12,000 pF | 123 | F G J K M | | | | | | | EU | | | | | FG | FG | FM | | | LA | LA | | | | | |
| 15,000 pF | 153 | F G J K M | | | | | | | EU | | | | | FM | FM | FS | | | LB | LB | | | | | |
| 18,000 pF | 183 | F G J K M | | | | | | | | | | | | FM | FM | FS | | | LC | LC | | | | | |
| 22,000 pF | 223 | F G J K M | | | | | | | | | | | | FY | FY | FS | | | | | | | | | |
| 27,000 pF | 273 | F G J K M | | | | | | | | | | | | FS | FS | | | | | | | | | | |
| 33,000 pF | 333 | F G J K M | | | | | | | | | | | | FS | FS | | | | | | | | | | |
| | 0 | Rated Voltage (VDC) | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| Capacitance | Cap Code | Voltage Code | C | В | D | С | В | D | С | В | D | F | G | С | В | D | F | G | С | В | D | F | G | z | н |
| | | Case Size/Series | Size/Series C | | | | | X | | C | 1206 | X | | | C | 1210 | X | | | | C | 1808 | X | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).



Table 1B - Capacitance Range/Selection Waterfall (1812 - 2225 Case Sizes)

| | | | C | a | IS (Se | e S eri | Siz es | ze S | / | | | С | 18 | 12 | 2X | | | | | | C1 | 82 | 5X | | | | | C | 222 | 0X | | | | | (| C22 | 225 | Х | | |
|------------------|------------|---|--------|-----------|------------|---------------|-----------|------------|--------|----------|-----|------------------|----------|----------|----------|-----|-----|------------|---|---------------|-----------|----------|-----------|-----------|-------------|----------|------|----------|-------------|-------------|-----------|---------------|----------|-----|-----|-----|------|-----|-----------|-----------|
| | Cap | | | Vo | lta | ge | Co | de | | C | В | D | 1 | F | G | z | н | C | ; | в | D | F | G | z | н | C | В | D | F | G | z | н | С | В | D | F | G | z | н | К |
| Сар | Code | F | | | R | ate | d | | | 8 | 8 | 8 | 2 | 3 | 00 | 500 | 00 | E | 3 | õ | 000 | 200 | 000 | 200 | 8 | 8 | 8 | 000 | 000 | 8 | 200 | 8 | 8 | 8 | 00 | 00 | 8 | 000 | 00 | 000 |
| | | ┢ | _ | Vol Ca | lta na | ge (Incit | (VE an | DC) ICe | | 20 | 9 | = | 7 | <u> </u> | 3 | ñ | Ř | _ " | · | <u>ی</u> ۲ | ≓ Pord | ≌ uct | ⊼ ∆vai | ন lahi | ਿਲ litv: | and (| Chin | ≓ Thi | i ≓ ckne | ୍ଲ ୨୦୦ ଅ | ېر ode | <u>ଳ</u> ଽ | | 9 | 7 | 12 | 5 | 5 | Ř | 2 |
| | | | _ | T | ol | era | nc | e | | | | | | | | | | _ | | | Se | e Ta | ble 2 | for | Chi | p Th | ickn | ess | Dim | ensi | ons | | | , | | , | | | | |
| 10 pF | 100 | | F | 0 | 3 | J | ł | K | M | GB | GE | GE GE | G | B | GB | GB | GE | 3 | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 12 pF | 120 | | г F | | 3 | J | | ĸ | M | GB | GE | GE GE | G | В | GB | GB | GE | ŝ | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 13 pF | 130 | | F | 0 | 3 | J | 1 | ĸ | М | GB | GE | GE | G | в | GB | GB | GE | 3 | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 15 pF | 150 | | F | 0 | 3 | J | ŀ | K | М | GB | GE | GE | G | B | GB | GB | GE | 3 | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 16 pF 18 nF | 160 | | F | | 2 | J | ľ | K K | M | GB | GE | | G | B | GB | GB | GE | | | | | | | | | JK | JK | JK | JK | JK | JK | JK | | KF | KF | KF | KF | KF | KF | |
| 20 pF | 200 | | F | 6 | 3 | J | | ĸ | M | GB | GE | GB | G | B | GB | GB | GE | | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 22 pF | 220 | | F | 6 | 3 | J | k | ĸ | М | GB | GE | GB | G | в | GB | GB | GE | | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 24 pF | 240 | | F | 0 | 3 | J | k | K | М | GB | GE | GB | G | B | GB | GB | GE | 3 | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 27 pF 30 nF | 270 | | F F | () | i 2 | J | l K | K K | M M | GB | GE | GB | G | B | GB | GB | GE | | | | | | | | | JK | JK | JK JK | JK | JK .IK | JK | JK | | KF | KF | KF | KF | KF | KF | |
| 33 pF | 330 | | F | 6 | 3 | J | k | < l | M | GB | GE | GB | G | B | GB | GB | GE | | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 36 pF | 360 | | F | 6 | 3 | J | K | < | М | GB | GE | GB | G | B | GB | GB | GB | | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 39 pF | 390 | | F | 0 | 3 | J | K | < | М | GB | GE | GE GE | G | B | GB | GB | GE | 3 | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 43 p⊦ 47 nF | 430 | | F F | | 5 2 | J | l P | K K | M M | GB | GE | | G | B | GB | GB | GE | | | | | | | | | JK JK | JK | JK | JK | JK | JK | JK | KF KF | KF | KF | KF | KF | KF | KF | KF |
| 51 pF | 510 | | F | 0 | 3 | J | ŀ | ĸ | M | GB | GE | GE | G | B | GB | GB | GE | ś. | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | KE |
| 56 pF | 560 | | F | 0 | 3 | J | 1 | к | М | GB | GE | GB | G | в | GB | GB | GE | 3 | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | KE |
| 62 pF | 620 | | F | 0 | 3 | J | k | K | М | GB | GE | GE | G | B | GB | GB | GE | 3 | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | KF |
| 68 pF 75 pF | 680 750 | | F | | 2 | J | l P | K K | M | GB | GE | | G | B | GB | GB | GE | | | | | | | | | JK | JK | JK | JK | JK | JK | JK | | KF | KF | KF | KF | KF | KF | KF |
| 82 pF | 820 | | F | 6 | 3 | J | k | ĸ | M | GB | GE | GB | G | B | GB | GB | GE | | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | KF |
| 91 pF | 910 | | F | 6 | 3 | J | k | ĸ | М | GD | GE | GD | G | D | GD | GD | GD | | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | KH |
| 100 pF | 101 | | F | 0 | 3 | J | k | K | М | GD | GC | GD | G | D | GD | GD | GD | | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | KH |
| 110 pF 120 pF | 111 | | F | 6 | | J | K | | M M | GD | GL | | G | ם ח | GD | GD | GL | | | | | | | | | JK | JK | JK | JK | JK | JK | JK | | KF | KF | KF | KF | KF | KF | KJ K I |
| 130 pF | 131 | | F | 6 | 3 | J | K | < | M | GD | GE | GD | G | D | GD | GD | GD | | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | KJ |
| 150 pF | 151 | | F | 6 | 3 | J | 1 | к | М | GD | GE | GD | G | D | GD | GD | GK | | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 160 pF | 161 | | F | 0 | 3 | J | ŀ | K | М | GD | GE | GD | G | D | GD | GD | GK | | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 180 pF 200 pF | 201 | | F F | | 5 2 | J | l P | K K | M | GD | GL |) GL | G | ם ח | GD | GD | GN | | | | | | | | | JK JK | JK | JK | JK | JK | JK JK | JK | | KF | KF | KF | KF | KF | KF | |
| 220 pF | 221 | | F | 6 | 3 | J | ŀ | ĸ | M | GB | GE | GE | G | B | GB | GD | GN | 1 | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF | |
| 240 pF | 241 | | F | 6 | 3 | J | 1 | ĸ | М | GB | GE | GB | G | В | GB | GD | GN | 1 | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KE | KE | KE | KF | |
| 270 pF | 271 | | F | 0 | 3 | J | ŀ | K | М | GB | GE | GB | G | B | GB | GH | GN | 1 | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KE | KE | KE | KF | |
| 300 pF 330 nF | 301 | | F F | | i S | J | l r | K K | M M | GB | GE | GE | G | B | GB | GH | GO | | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KE | KE | KE | KF | |
| 360 pF | 361 | | F | 6 | 3 | J | k | ĸ | M | GB | GE | GB | G | B | GD | GK | GC | 5 | | | | | | | | JE | JE | JE | JE | JE | JK | JK | KE | KE | KE | KE | KE | KE | KF | |
| 390 pF | 391 | | F | 6 | 3 | J | k | ĸ | М | GB | GE | GB | G | в | GD | GK | GC | | | | | | | | | JE | JE | JE | JE | JE | JK | JK | KE | KE | KE | KE | KE | KE | KF | |
| 430 pF | 431 | | F | 0 | 3 | J | k | K | М | GB | GE | GB | G | B | GD | GK | | | | | | | | | HJ | JE | JE | JE | JE | JE | JK | JE | KE | KE | KE | KE | KE | KE | KF | |
| 470 pF 510 nF | 471 511 | | F F | () | i 2 | J | l K | K K | M M | GB | GE | GB | G | D B | GD GH | GK | | | | | | | | | HJ HJ | JE | JE | JE | JE | JE | JK | JK .IK | | KF | KF | KF | KE | KE | KF | |
| 560 pF | 561 | | F | 6 | 3 | J | . K | ĸ | М | GB | GE | GB | G | D | GH | GM | | | | | | | | | HJ | JK | JK | JK | JK | JK | JK | JL | KF | KF | KF | KF | KE | KE | KF | |
| 620 pF | 621 | | F | 0 | 3 | J | ŀ | к | М | GB | GE | GE GE | G | D | GH | GM | | | | | | | | | нк | JK | JK | JK | JK | JK | JK | JL | KF | KF | KF | KF | KE | KF | KH | |
| 680 pF | 681 | | F | 0 | 3 | J | ŀ | K | М | GB | GE | GE GE | G | D | GH | GO | | | | | | | | | HK | JE | JE | JE | JK | JK | JK | JL | KF | KF | KF | KF | KE | KF | KH | |
| /50 p⊦ 820 nF | 821 | | r F | | ן נ ק | J .I | | K | M M | GB GR | GE | 9 GE 1 GE | 6 G | D | ыK GK | | | | | | | | | | | JE | JE | JE | JK | JK | JK | JN | KE | KE | KE | KF | KE | KF | KH K.I | |
| 910 pF | 911 | | F | 0 | 3 | J | | ĸ | М | GB | GE | GB | G | H | GM | | | | | | | | | | | JE | JK | JK | JK | JK | JK | JN | KE | KE | KE | KF | KE | KF | KJ | |
| 1,000 pF | 102 | | F | 0 | 3 | J | ŀ | ĸ | М | GB | GE | GE | G | н | GM | | | | | | | | | | | JE | JK | JK | JK | JK | JK | JN | KE | KE | KE | KF | KE | KF | KJ | |
| 1,100 pF | 112 | + | F |) (| ا ام | J | +/ | × | M | GB | GE | GB | G | H 5 | GO 0 | - | - | + | _ | _ | 0 | 0 | 0 | HJ | 0 | JE | JK | JK | JK | JK | JK | 0 | KE | KE | KE | KF | KF | | - | 2 |
| | Can | | K | .d(| (\ (\ | /D(| ла С) | ay | 2 | 500 | 630 | 100 | 150 | | 200 | 250 | 300 | | ŝ | 630 | 100 | 150 | 200 | 250 | 300 | 20 | 630 | 100 | 150 | 200 | 250 | 300 | 500 | 630 | 100 | 150 | 200 | 250 | 300 | 1000 |
| Cap | Code | | 1 | /ol | Ita | ge | Co | ode | 9 | C | B | D | | F | G | Z | H | 0 | ; | В | D | F | G | Z | Н | C | B | D | F | G | Z | H | C | B | D | F | G | Z | H | K |
| | | | Ca | se | S | ize | /S | eri | es | | | (| C18 | 12 | X | | | | | | C | 1825 | X | | | | | C | 222 | DX | | | | | | C22 | 225) | (| | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).



Table 1B - Capacitance Range/Selection Waterfall (1812 - 2225 Case Sizes) cont.

| | | (| Cas | se Se | s S | ize es | 2/ | | | C 1 | 81 | 2X | | | | | C 1 | 182 | 5X | | | | | C2 | 222 | OX | | | | | (| C22 | 25 | X | | |
|-----------|-------------|----|------|----------|--------|-------------|---------------|-----|-----|------------|------|-----|-----|-----|-----|-----|------------|-------|------------|--------------|-------|--------------|------|------|------|-------|------|--------|-----|-----|----------|-----|-----|-----------|-----|------|
| Con | Сар | | Vol | ltag | ge C | Code | 9 | С | В | D | F | G | z | н | C | В | D | F | G | z | н | c | В | D | F | G | z | н | С | В | D | F | G | z | н | К |
| Cap | Code | | Val | Ra | ted | | • | 00 | 530 | 000 | 500 | 000 | 500 | 000 | 00 | 530 | 000 | 500 | 000 | 500 | 000 | 8 | 530 | 000 | 500 | 000 | 500 | 000 | 00 | 530 | 000 | 500 | 000 | 500 | 000 | 000 |
| | | | | pac | cita | anco | <u>)</u> е | | • | - | - | 7 | 7 | (m | | | Prod | luct. | _∾ Avai | ∣ ∾ Iabil | ity a | and (| Chip | Thic | kne | ss C | ode: | ი s | | | - | - | 10 | 0 | e | = |
| | | | T | ole | ran | ice | | | | | | | | | | | Se | e Ta | ble 2 | for | Chi | <u>p Thi</u> | ickn | ess | Dime | ensio | ons | | | | | | | _ | _ | _ |
| 1,200 pF | 122 | F | G | ; | J | K | M | GB | GB | GB | GH | GO | | | | | | | | HJ | | JE | JK | JK | JK | JK | JL | | KE | KE | KE | KF | KF | KF | | |
| 1,300 pF | 132 | F | G | i | J | K | M | GB | GB | GB | GH | GO | | | | | | | HE | HJ | | JE | JK | JK | JK | JE | JL | | KE | KE | KE | KF | KF | KH | | |
| 1,500 pF | 152 | F | G | | J | K | M | GB | GB | GB | GK | GO | | | | | | | HE | HK | | JE | JK | JK | JK | JE | JL | | KE | KE | KE | KF | KF | KH | | |
| 1,600 pF | 162 | | G | | J | K | M | GB | GD | GD | GK | | | | | | | | HG | нк | | JE | JK | JK | JK | JE | | | KE | KE | KE | KF | KE | KH | | |
| 1,800 pF | 182 | F | 6 | | J | ĸ | IVI | GB | GD | GU | GM | | | | | | | | HG | | | JE | JK | JK | JK | JE | JN | | KE | KE | KE | KF | KE | KH | | |
| 2,000 pF | 202 | | | ! | J | r v | | | СЦ | СП | GIVI | | | | | | | | пј | | | | | JK | JE | JK | | | | KE | NE VE | KF | KE | KJ V I | | |
| 2,200 pF | 222 | | | | 1 | ĸ | M | | СЦ | си Си | 60 | | | | | | | | пј | | | | | | JE | JK | | | | KE | | | | KJ | | |
| 2,400 pF | 242 | | 6 | | 1 | ĸ | M | CP | СЦ | CK | 60 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2,700 pF | 302 | F | 6 | | 1 | ĸ | M | GB | СН | CK | 00 | | | | | | | HE | нк | | | | | | IF | | | | KE | KE | KE | KE | KH | | | |
| 3 300 pF | 332 | F | G | | I | K | M | GB | GH | GK | | | | | | | | HG | TIIX | | | IK | IK | IK | IK | IN | | | KE | KE | KE | KE | KI | | | |
| 3 600 pF | 362 | F | G | | J | ĸ | м | GB | GH | GM | | | | | | | | HG | | | | JK | JK | JK | JK | JN | | | KF | KF | KF | KF | K.I | | | |
| 3 900 pF | 392 | F | G | | J | ĸ | м | GB | GH | GM | | | | | | | | HJ | | | | JK | JK | JK | JK | JN | | | KF | KF | KF | KF | K.J | | | |
| 4.300 pF | 432 | F | G | | J | ĸ | M | GH | GH | GO | | | | | | | | HJ | | | | JK | JK | JK | JK | 0.1 | | | KE | KF | KF | KF | | | | |
| 4.700 pF | 472 | F | G | | J | K | M | GH | GH | GO | | | | | | | | HJ | | | | JK | JK | JK | JL | | | | KE | KF | KF | KH | | | | |
| 5,100 pF | 512 | F | G | ; | J | К | М | GH | GK | GO | | | | | | HE | HG | HK | | | | JK | JK | JK | JL | | | | KE | KF | KF | КН | | | | |
| 5,600 pF | 562 | F | G | ; | J | К | м | GH | GK | GO | | | | | | HE | HG | нк | | | | JK | JK | JK | JN | | | | KE | KF | KF | кн | | | | |
| 6,200 pF | 622 | F | G | ; | J | Κ | М | GH | GK | GH | | | | | 1 | HE | HG | | | | | JK | JE | JE | JN | | | | KE | KF | KF | KJ | | | | |
| 6,800 pF | 682 | F | G | ; | J | Κ | М | GH | GM | GH | | | | | | HE | HJ | | | | | JK | JE | JK | JN | | | | KE | KF | KF | KJ | | | | |
| 7,500 pF | 752 | F | G | ; | J | Κ | М | GH | GM | GK | | | | | | HE | HJ | | | | | JK | JE | JK | | | | | KF | KE | KF | | | | | |
| 8,200 pF | 822 | F | G | ; | J | Κ | Μ | GK | GO | GK | | | | | | HE | HJ | | | | | JK | JE | JL | | | | | KF | KE | KF | | | | | |
| 9,100 pF | 912 | F | G | ; | J | Κ | M | GM | GO | GM | | | | | HE | HG | НК | | | | | JE | JE | JL | | | | | KF | KE | KH | | | | | |
| 10,000 pF | 103 | F | G | ; | J | Κ | Μ | GM | GO | GM | | | | | HE | HG | HK | | | | | JE | JE | JL | | | | | KF | KE | KH | | | | | |
| 12,000 pF | 123 | F | G | ; | J | Κ | Μ | GO | GH | GO | | | | | HE | HG | HE | | | | | JE | JK | JN | | | | | KE | KE | KH | | | | | |
| 15,000 pF | 153 | F | G | ; | J | Κ | Μ | GO | GH | GO | | | | | HE | HJ | HE | | | | | JE | JL | JE | | | | | KE | KF | KJ | | | | | |
| 18,000 pF | 183 | F | G | ; | J | Κ | М | GH | GH | | | | | | HG | НК | HG | | | | | JE | JL | JE | | | | | KE | KH | KE | | | | | |
| 22,000 pF | 223 | F | G | ; | J | Κ | M | GH | GH | | | | | | HJ | HE | HJ | | | | | JK | JN | JK | | | | | KF | KJ | KF | | | | | |
| 27,000 pF | 273 | F | G | ; | J | Κ | M | GK | GK | | | | | | HJ | HE | НК | | | | | JL | JN | JL | | | | | KF | KJ | KH | | | | | |
| 33,000 pF | 333 | F | G | ; | J | Κ | M | GM | GM | | | | | | нк | HE | НК | | | | | JN | JE | JN | | | | | КН | KE | KH | | | | | |
| 39,000 pF | 393 | F | G | ; | J | K | M | GO | GO | | | | | | HE | HE | | | | | | JE | JE | | | | | | KJ | KE | KJ | | | | | |
| 47,000 pF | 473 | F | G | | J | K | M | GO | GO | | | | | | HE | HE | | | | | | JE | JE | | | | | | KE | KE | | | | | | |
| 56,000 pF | 563 | F | G | | J | K | M | | | | | | | | HG | HG | | | | | | JK | JK | | | | | | KE | KE | | | | | | |
| 68,000 pF | 683 | F | G | | J | K | M | | | | | | | | HJ | HJ | | | | | | JL | JL | | | | | | KF | KF | | | | | | |
| 82,000 pF | 823 | F | G | | J | K | M | | | | | | | | HK | HK | | | | | | JL | JL | | | | | | KH | KH | | | | | | |
| 0.1 µF | 104 | F | G | | J | K | M | | | | | | | | HK | HK | | | | | | JN | JN | | | | | | KH | KH | | | | | | |
| U.12 µF | 124 | |) G | od ' | J | K | | | | - | - | | - | - | - | - | 0 | - | - | - | 0 | - | | - | | - | | - | ĸJ | ĸJ | - | - | - | - | - | |
| | | | .a.(| eu (V | DC | 11d() () | Je | 500 | 63(| 100 | 150 | 200 | 250 | 300 | 500 | 63(| 100 | 150 | 200 | 250 | 300 | 500 | 63(| 100 | 150 | 200 | 250 | 300 | 50(| 63(| 100 | 150 | 200 | 250 | 300 | 1000 |
| Cap | Cap Code | ١ | Vol | tag | je (| Cod | е | C | В | D | F | G | z | H | C | В | D | F | G | z | H | С | В | D | F | G | z | н | C | В | D | F | G | z | Н | к |
| | oue | Ca | se | Siz | ze/ | Ser | ies | | | C | 1812 | 2X | | | | | C | 1825 | 5X | | | | | C | 222(| X | | | | | | C22 | 25X | | | |

*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).



Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper C |)uantity | Plastic | Quantity |
|-----------|------|------------------------------------|---------|----------|---------|----------|
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| CJ | 603 | 0.80 ± 0.15* | 4,000 | 15,000 | 0 | 0 |
| DC | 805 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| | 805 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| DG FO | 1206 | 1.25 ± 0.15 0.78 + 0.20 | | | 2,500 | |
| FR | 1200 | 0.70 ± 0.20 0.90 ± 0.20 | 0 | 0 | 4,000 | 10,000 |
| ED | 1206 | 1.00 ± 0.10 | Ő | Ő | 2.500 | 10,000 |
| ES | 1206 | 1.00 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| EE | 1206 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EU | 1206 | 1.60 ± 0.25 | 0 | 0 | 2,000 | 8,000 |
| FZ | 1210 | 1.25 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| | 1210 | 1.00 ± 0.10 1.10 ± 0.10 | | | 2,500 | |
| FG | 1210 | 1 25 + 0 15 | 0 | 0 | 2,500 | 10,000 |
| FL | 1210 | 1.40 ± 0.15 | 0 0 | 0 0 | 2,000 | 8.000 |
| FY | 1210 | 2.00 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FK | 1210 | 2.10 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1,000 | 4,000 |
| LA | 1808 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| LB | 1808 | 1.60 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| | 1808 | 2.00 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| | 1012 | 1.00 ± 0.10 1.25 ± 0.15 | | 0 | 1,000 | 4,000 |
| GH | 1012 | 1.25 ± 0.15 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GK | 1812 | 1.60 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GM | 1812 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| GO | 1812 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| HE | 1825 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| HG | 1825 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| HJ | 1825 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| HK | 1825 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| JE | 2220 | 1.40 ± 0.15 | | 0 | 1,000 | 4,000 |
| JK | 2220 | 1.00 ± 0.20 2.00 + 0.20 | 0 | 0 | 500 | 4,000 |
| JN | 2220 | 2.50 + 0.20 | 0 | 0 | 500 | 2,000 |
| KE | 2225 | 1.40 ± 0.15 | ŏ | ŏ | 1.000 | 4.000 |
| KF | 2225 | 1.60 ± 0.20 | Ō | Ō | 1,000 | 4,000 |
| КН | 2225 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| KJ | 2225 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size | Range (mm) | Paper (|)uantity | Plastic | Quantity |

Package quantity based on finished chip thickness specifications.


Table 2B – Bulk Packaging Quantities

| Deeke | aing Tune | Loose Packaging | | | |
|----------|------------------------|------------------------|------------------------|--|--|
| Раска | jing type | Bulk Bag | (default) | | |
| Packagi | ng C-Spec ¹ | N | /A ² | | |
| Cas | e Size | Packaging Quantities (| pieces/unit packaging) | | |
| EIA (in) | Metric (mm) | Minimum | Maximum | | |
| 0603 | 1608 | | 50.000 | | |
| 0805 | 2012 | | | | |
| 1206 | 3216 | | 50,000 | | |
| 1210 | 3225 | | | | |
| 1808 | 4520 | 1 | | | |
| 1812 | 4532 | | | | |
| 1825 | 4564 | | 20,000 | | |
| 2220 | 5650 | | | | |
| 2225 | 5664 | | | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial Grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive Grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Metric Size Size | | Density Level A: Maximum (Most) Land Protrusion (mm) | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | | | |
|-------------------------|------|--|------|------|--|------|------|---|------|------|------|------|------|------|------|------|
| Coue | Coue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 0.99 | 1.44 | 1.66 | 4.47 | 2.71 | 0.89 | 1.24 | 1.56 | 3.57 | 2.11 | 0.79 | 1.04 | 1.46 | 2.42 | 1.81 |
| 1206 | 3216 | 1.59 | 1.62 | 2.06 | 5.85 | 3.06 | 1.49 | 1.42 | 1.96 | 4.95 | 2.46 | 1.39 | 1.22 | 1.86 | 4.25 | 2.16 |
| 1210 | 3225 | 1.59 | 1.62 | 3.01 | 5.90 | 4.01 | 1.49 | 1.42 | 2.91 | 4.95 | 3.41 | 1.39 | 1.22 | 2.81 | 4.25 | 3.11 |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 |
| 1812 | 4532 | 2.10 | 1.80 | 3.60 | 7.00 | 4.60 | 2.00 | 1.60 | 3.50 | 6.10 | 4.00 | 1.90 | 1.40 | 3.40 | 5.40 | 3.70 |
| 1825 | 4564 | 2.15 | 1.80 | 6.90 | 7.10 | 7.90 | 2.05 | 1.60 | 6.80 | 6.20 | 7.30 | 1.95 | 1.40 | 6.70 | 5.50 | 7.00 |
| 2220 | 5650 | 2.85 | 2.10 | 5.50 | 8.80 | 6.50 | 2.75 | 1.90 | 5.40 | 7.90 | 5.90 | 2.65 | 1.70 | 5.30 | 7.20 | 5.60 |
| 2225 | 5664 | 2.85 | 2.10 | 6.90 | 8.80 | 7.90 | 2.75 | 1.90 | 6.80 | 7.90 | 7.30 | 2.65 | 1.70 | 6.70 | 7.20 | 7.00 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.



Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/ J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Termination Finish | | | |
|--|-----------------------|-----------------------|--|--|
| Tomeredure | SnPb | 100% Matte Sn | | |
| Preheat/Soak | | | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C | | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | | |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds | | |
| Ramp-Up Rate (T_L to T_p) | 3°C/second maximum | 3°C/second maximum | | |
| Liquidous Temperature (T _L) | 183°C | 217°C | | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | | |
| Peak Temperature (T _P) | 235°C | 260°C | | |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum | 30 seconds maximum | | |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | 6°C/second maximum | | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | | |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.







Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test Condition | Limits |
|--|----------------|--|--|
| Visual and Mechanical | KEMET Internal | No defects that may affect performance (10X) | Dimensions according KEMET Spec Sheet |
| Capacitance (Cap) | KEMET Internal | C ≤ 1,000 pF Frequency: 1 MHz ±100 kHz Voltage*:1.0 V _{rms} ±0.2 V C > 1,000 pF Frequency: 1 kHz ±50 Hz Voltage: 1.0 V _{rms} ±0.2 V * See part number specification sheet for voltage | Within Tolerance |
| Dissipation Factor (DF) | KEMET Internal | C ≤ 1,000 pF Frequency: 1 MHz ±100 kHz Voltage*:1.0 V _{rms} ±0.2 V C > 1,000 pF Frequency: 1 kHz ±50 Hz Voltage: 1.0 V _{rms} ±0.2 V * See part number specification sheet for voltage | Within Specification Dissipation factor (DF) maximum limit at 25°C = 0.1% |
| Insulation Resistance (IR) | KEMET Internal | 500 VDC applied for 120 ±5 seconds at 25°C | Within Specification To obtain IR limit, divide MΩ-μF value by the capacitance and compare to GΩ limit. Select the lower of the two limits. 1,000 megohm microfarads or 100 GΩ. |
| Temperature Coefficient of Capacitance (TCC) | KEMET Internal | Capacitance change with reference to +25°C and 0 VDC applied. * See part number specification sheet for voltage Step Temperature (°C) 1 +25°C 2 -55°C 3 +25°C (Reference Temperature) 4 +125°C | Within Specification: ±30 ppm / °C |



Table 4 – Performance & Reliability: Test Methods and Conditions cont.

| Stress | Reference | Test Condition | Limits |
|--|-------------------------|---|---|
| | | See Dielectric Withstanding Voltage (DWV) Table (5 ±1 seconds and charge/discharge not exceeding 50 mA) | |
| | | EIA Case Size 500 V 630 V ≥ 1,000 V | |
| Dielectric Withstanding Voltage (DWV) | KEMET Internal | $ \begin{array}{ c c c c c } \hline 0603 & 130\% \mbox{ of rated voltage} \\ \hline 0805 & < 620 \mbox{ of rated voltage} \\ \hline 1206 & < 5.1n \mbox{ 150\% \mbox{ of rated voltage}} \\ \hline 1210 & < 5.1n \mbox{ 150\% \mbox{ of rated voltage}} \\ \hline 1210 & < 5.1n \mbox{ 150\% \mbox{ of rated voltage}} \\ \hline 1808 & \mbox{ of rated} \\ \hline voltage & < 2.5n \mbox{ 130\% \mbox{ of rated voltage}} \\ \hline 1812 & & < 2.2n \mbox{ 150\% \mbox{ of rated voltage}} \\ \hline 1825 & < 2.220 & < 2.225 & < 2.225 \\ \hline 2225 & & < 3.3n \mbox{ 150\% \mbox{ of rated voltage}} \\ \hline 130\% \mbox{ of rated voltage} \\ \hline 130\% \mbox{ of rated voltage} \\ \hline 2220 & & < 2.2n \mbox{ 150\% \mbox{ of rated voltage}} \\ \hline 2225 & & < 3.3n \mbox{ 150\% \mbox{ of rated voltage}} \\ \hline 130\% \mbox{ of rated voltage} \\ \hline 2225 & & < 3.3n \mbox{ 150\% \mbox{ of rated voltage}} \\ \hline 130\% \mbox{ of rated voltage} \\ \hline 2210 & & < 2.2n \mbox{ 150\% \mbox{ of rated voltage}} \\ \hline 2225 & & < 3.3n \mbox{ 150\% \mbox{ of rated voltage}} \\ \hline 120\% \mbox{ of rated voltage} \\ \hline 2210 & & < 3.3n \mbox{ 150\% \mbox{ of rated voltage}} \\ \hline 2225 & & < 3.3n \mbox{ 150\% \mbox{ of rated voltage}} \\ \hline 120\% \mbox{ of rated voltage} \\ \hline 120\% \mbox{ of rated voltage} \\ \hline 2210 & & < 3.3n \mbox{ 130\% \mbox{ of rated voltage}} \\ \hline 120\% \mbox{ of rated voltage} \\ \hline 2210 & & < 3.3n \mbox{ 130\% \mbox{ of rated voltage}} \\ \hline 120\% \mbox{ of rated voltage} \\ \hline 120\% of rated volt$ | Cap: Initial Limit DF: Initial Limit IR: Initial Limit Withstand test voltage without insulation breakdown or damage. |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | KEMET Internal | Maximum % capacitance loss/decade hour | 0% Loss/Decade Hour |
| Terminal Strength | KEMET Internal | Shear stress test per specific case size, Time: 60 ±1 second. Case Size Force 0603 5N 0805 9N ≥ 1206 18N | No evidence of mechanical damage |
| Board Flex | AEC-Q200-005 | Standard Termination System 2.0 mm Flexible Termination System 3.0 mm Test Time: 60 ±5 seconds Ramp Time: 1 mm/second | No evidence of mechanical damage |
| Solderability | J-STD-002 | Condition: 4 hours ± 15 minutes at 155°C dry bake apply all methods Test 245 ±5°C (SnPb & Pb-Free) | Visual Inspection. 95% coverage on termination. No leaching |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (~55°C to +125°C) 2 – 3 cycles per hour Soak Time 1 or 5 minutes | Measurement at 24 hours ±4 hours after test conclusion. Cap: Initial Limit DF: Initial Limit IR: Initial Limit |



Table 4 – Performance & Reliability: Test Methods and Conditions cont.

| Stress | Reference | Test Condition | Limits |
|---------------------------|---|---|---|
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and 200 VDC maximum Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5% |
| Moisture Resistance | MIL-STD-202 Method 106 | Number of Cycles Required: 10, 24 hours per cycle. Steps 7a and 7b not required | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Thermal Shock | MIL-STD-202 Method 107 | Number of Cycles Required: 5, (-55°C to 125°C) Dwell time 15 minutes. | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| High Temperature Life | e 1,000 hours at 125°C with 1.2 X rated voltage applied. MIL-STD-202 | | Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift |
| Storage Life | Method 108 | 1,000 hours at 150°C, Unpowered | DF Limits Maximum: 0.5% IR: 10% of Initial Limit |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Test from 10 – 2,000 Hz | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Mechanical Shock | MIL-STD-202 Method 213 | 1,500 g's 0.5 millisecond Half-sine, Velocity Change: 15.4 feet/second (Condition F) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents. | Visual Inspection 10X Readable marking, no decoloration or stains. No physical damage. |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction



Capacitor Marking (Optional)

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- · EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punche | d Paper |
|----------------------|------|---------|--------------------|---------|--------------------|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| | (W)* | Pitch | (P ₁)* | Pitch | (P ₁)* |
| 01005 - 0402 | 8 | | | 2 | 2 |
| 0603 | 8 | | | 2/4 | 2/4 |
| 0805 | 8 | 4 | 4 | 4 | 4 |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 |
| 1805 - 1808 | 12 | 4 | 4 | | |
| ≥ 1812 | 12 | 8 | 8 | | |
| KPS 1210 | 12 | 8 | 8 | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | |
| Array 0612 | 8 | 4 | 4 | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size. 2 mm pitch reel for 0805 EIA case size under development.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|--|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E, | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 16 mm | | (0.059) | | | | (1.181) | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | te 5 |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions — Millimeters (Inches) | | | | | | | | | |
|-----------|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|--|
| Tape Size | D _o | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | | |
| | Variable Dimensions — Millimeters (Inches) | | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | | | |
|--|--|---------------------------------------|--|--|--|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | | | |
| 8 mm | 178 ±0.20 | | | | | | | | |
| 12 mm | Or 220 10 20 | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | | | |
| 16 mm | (13.000 ±0.008) | | | 、 , | | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Application Guide

Solder Fluxes and Cleaning

The use of water-soluble fluxes provides advantages of excellent solderability due to high activation. However, these fluxes contain organic acids that can induce arcing under high DC or AC voltages. Notable problem areas are underneath the MLCC where flux can be trapped between the ceramic material and PCB. It is therefore critical that PCBs are properly cleaned to remove all flux residue to maintain reliability.

Coating for High Voltage MLCCs

For MLCC ratings \geq 1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

| Dielectric | CTE (ppm/°C) |
|----------------------------|--------------|
| Class II BaTiO₃ | 10.7 |
| Class I CaZrO ₃ | 9.8 |

Slits in PCB

It is recommended to apply a slit in the PCB under the MLCC to improve washing of flux residue that may get trapped underneath. In some cases, it is not possible to slit entirely through the PCB due to underlying metal planes. It is also acceptable to apply a recessed slit under the MLCC which will also promote cleaning.

- Recommended for case sizes ≥1206
- The width (w) of the slit should be 1mm
- Length of the slit should be as short as possible to prevent damaging the MLCC due to mechanical stress of the PCB.
- Slits also reduce the risk of solder balls under MLCC which decreased the creepage distance.



Solder Resist

If a slit cannot be applied as above, it is recommended to not use solder resist directly under the MLCC. The use of solder resist material reduces the distance between MLCC ceramic material and PCB thus making it difficult to clean.

Solder Balls

Improper reflow techniques and/or improper washing can induce solder balls under or adjacent to the MLCC. Solder balls reduce the creepage distance between the MLCC terminations and increase the risk of arcing or damage to the ceramic material. To reduce the risk of solder balls:

- Follow KEMET's solder recommendations as outlined in the datasheet.
- If performing a cleaning procedure, properly clean the PCB per KEMET's cleaning recommendations.
- Add slit to the PCB as shown above.





Overview

KEMET's High Temperature X7R Dielectric capacitors are formulated and designed for extreme temperature applications. Constructed of a robust and proprietary base metal electrode (BME) dielectric system, these devices are capable of reliable operation in temperatures up to 175°C. Providing an attractive combination of performance and robustness in general high temperature applications, High Temperature X7R dielectric capacitors are well suited for high temperature bypass and decoupling applications or frequency discriminating circuits where Q and stability of capacitance characteristics are not critical. They exhibit a predictable change in capacitance with respect to time, voltage and temperature up to 175°C.

KEMET's High Temperature X7R surface mount MLCCs are manufactured in state of the art ISO/TS 16949:2009 certified facilities and are proven to function reliably in harsh, high temperature and high humidity, down-hole environments. Concerned with flex cracks resulting from excessive stresses produced during board flexure and thermal cycling? These devices are available with KEMET's Flexible termination technology which inhibits the transfer of board stress to the rigid ceramic body, therefore mitigating flex cracks which can result in low IR or short circuit failures. Although flexible termination technology does not eliminate the potential for mechanical damage that may propagate during extreme environmental and handling conditions, it does provide superior flex performance over standard termination systems.

Benefits

- Operating temperature range of -55°C to +175°C
- Voltage derating not required
- Lead (Pb)-free, RoHS and REACH compliant
- · Base metal electrode (BME) dielectric system
- EIA 0402, 0603, 0805, 1206, 1210, and 1812 case sizes
- DC voltage ratings of 16 V, 25 V, 50 V, 100 V, and 200 V
- Capacitance offerings ranging from 2.7 nF to 3.3 μF
- Available capacitance tolerances of ±5%, ±10% & ±20%
- · Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish allowing for excellent solderability
- SnPb termination finish option available (5% Pb minimum)
- · Flexible termination option available upon request



Applications

- Decoupling
- Bypass
- Filtering
- Transient voltage suppression

Application Notes

X7R dielectric is not recommended for AC line filtering or pulse applications.

Voltage derating of these capacitors is not required for application temperatures up to 175°C.



Ordering Information

| C | 1210 | R | 225 | K | 3 | R | Α | С | T050 |
|---------|--|--|--|---------------------------------|--|------------|----------------------------|--|--|
| Ceramic | Case Size ¹ (L" x W") | Specification/ Series ¹ | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish | Packaging/ Grade (C-Spec)² |
| | 0402 0603 0805 1206 1210 1812 | G = 175°C with standard termination R = 175°C w/ Flexible termination | First two digits represent significant figures. Third digit specifies number of zeros. | J = ±5% K = ±10% M = ±20% | 4 = 16 3 = 25 5 = 50 1 = 100 2 = 200 | R = X7R | A = N/A | C = 100% Matte Sn L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" below |

¹ Flexible termination option is only available in 0603 (1608 metric) and larger case sizes.

Packaging C-Spec Ordering Options Table

| Packaging Type/ Unmarked ² | Packaging Ordering Code (C-Spec) |
|--|-------------------------------------|
| Bulk Bag | Blank ¹ |
| Waffle Tray | 7292 |
| 7" Tape & Reel | TU |
| 7" Tape & Reel / 2mm pitch ³ | 7081 |
| 7" Tape & Reel - 50 pcs | T050 |
| 7" Tape & Reel - 100 pcs | T100 |
| 7" Tape & Reel - 250 pcs | T250 |
| 7" Tape & Reel - 500 pcs | Т500 |
| 7" Tape & Reel - 1,000 pcs | T1K0 |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

² The terms "Marked" and "Unmarked" pertain to laser marking option of components. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking". Reeling quantities are dependent upon chip size and thickness dimension. When ordering using the "T1K0" packaging option, 1812 thru 2225 case size devices with chip thickness of ≥ 1.9 mm (nominal) may be shipped on multiple 7" reels or a single 13" reel. Additional reeling or packaging options may be available. Contact KEMET for details.

³ The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".



Dimensions - Millimeters (Inches) - Standard Termination



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|-------------------------------|----------------|-------------------------------|----------------------------|------------------------------------|
| 0402 | 1005 | 1.00 (0.040) ±0.05 (0.002) | 0.50 (0.020) ±0.05 (0.002) | | 0.30 (0.012) ±0.10 (0.004) | 0.30 (0.012) | Solder Reflow Only |
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | O al da a Wasa |
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | See Table 2 | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave Or Solder Doflow |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | for Thickness | 0.50 (0.02) ±0.25 (0.010) | | Soluel Reliow |
| 1210 | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | - | 0.50 (0.02) ±0.25 (0.010) | N/A | Solder Reflow Only |
| 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | | 0.60 (0.024) ±0.35 (0.014) | | Solder Reflow Only |

Dimensions – Millimeters (Inches) – Flexible Termination

| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|--|-------------------------------|--|------------------------------|-------------------------------|----------------------------|------------------------------------|
| 0603 | 1608 | 1.60 (0.063) ±0.17 (0.007) | 0.80 (0.032) ±0.15 (0.006) | | 0.45 (0.018) ±0.15 (0.006) | 0.58 (0.023) | Calder Wave |
| 0805 | 2012 | 2.00 (0.079) ±0.30 (0.012) | 2.00 (0.079) 1.25 (0.049) ±0.30 (0.012) ±0.30 (0.012) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave Or Solder Doflow |
| 1206 | 3216 | 3.30 (0.130) ±0.40 (0.016) | 1.60 (0.063) ±0.35 (0.013) | See Table 2 for Thickness | 0.60 (0.024) ±0.25 (0.010) | | Soluel Reliow |
| 1210 | 3225 | 3.30 (0.130) ±0.40 (0.016) | 2.60 (0.102) ±0.30 (0.012) | - | 0.60 (0.024) ±0.25 (0.010) | N/A | Solder Reflow Only |
| 1812 | 4532 <u>±0.40 (0.016)</u> ±0.40 (0.0178) ±0.40 (0.016) | | 3.20 (0.126) ±0.30 (0.012) | | 0.70 (0.028) ±0.35 (0.014) | | Solder Reflow Only |

Qualification/Certification

High temperature Industrial grade products meet or exceed the requirements outlined Table 4, Performance & Reliability. Qualification packages are available upon request.



Environmental Compliance

Lead (Pb)-Free, RoHS, and REACH compliant without exemptions (excluding SnPb termination finish option).

Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|--|
| Operating Temperature Range | -55°C to +175°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±15% (-55°C to +125°C) beyond 125°C see "Capacitance vs. Temperature Performance" plot – Reference Only |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | <3.0% |
| Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5±1 seconds and charge/discharge not exceeding 50 mA) |
| Dissipation Factor (DF) Maximum Limit at 25°C | See Dissipation Factor Limit Table |
| Insulation Resistance (IR) Limit at 25°C | 1,000 megohm microfarads or 100 GΩ (Rated voltage applied for 120±5 seconds at 25°C) |

Regarding aging rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours. To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits. Capacitance and dissipation factor (DF) measured under the following conditions:

1 kHz ±50 Hz and 1.0 ±0.2 Vrms if capacitance \leq 10 μ F

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

Dissipation Factor Limit Table

| Rated DC Voltage | Dissipation Factor |
|------------------|---------------------------|
| 16/25 | 3.5% |
| > 25 | 2.5% |

Post Environmental Limits

| | High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | | | | | | |
|------------|---|----------------------|-----------------------------------|----------------------|--------------------------|--|--|--|--|--|--|--|--|--|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | | | | | | | | | |
| VZD | 16/25 | A 11 | 5.0 | 1.20% | 10% of Initial | | | | | | | | | |
| X/R | >25 | All | 3.0 | ± 20% | Limit | | | | | | | | | |



Electrical Characteristics





Capacitance vs. Bias Voltage Performance (25 VDC Rated)



Capacitance vs. Bias Voltage Performance (1812 Case Size, 1.0 µF, 50 VDC Rated)





Table 1 – Capacitance Range/Selection Waterfall (0402 – 1812 Case Sizes)

| | | Ca | se Si Serie | ize/ s | | C04 | 02G | | CO | 603 | G/R | C0 | 805 | G/R | C1 | 2060 | G/R | C1 | 2100 | G/R | (| C181 | 2G/I | R |
|-------------|----------|-----|---|-----------|----|-----|-----|-----|----------|----------|-----|----|-------|---------|-----------|------|-----|-----------|-------|-----|----|------|------|-----|
| Canacitance | Can Code | Vo | ltage C | ode | 4 | 3 | 5 | 1 | 3 | 5 | 1 | 3 | 5 | 1 | 3 | 5 | 1 | 3 | 5 | 1 | 3 | 5 | 1 | 2 |
| oupuonanoe | oup ooue | Rat | Rated Voltage | | 16 | 25 | 50 | 100 | 25 | 50 | 100 | 25 | 50 | 100 | 25 | 50 | 100 | 25 | 50 | 100 | 25 | 50 | 100 | 200 |
| | | Са | Capacitance Product Availability and Chip Thickne Tolerance See Table 2 for Chip Thickness Dim | | | | | | | | | | kness | ensions | | | | | | | | | | |
| 2700 pF | 272 | J | K | M | BB | BB | BB | | | | | | | | | | | | | | | | | |
| 3300 pF | 332 | J | к | м | BB | BB | BB | | | | | | | | | | | | | | | | | |
| 3900 pF | 392 | J | К | м | BB | BB | BB | | | | | | | | | | | | | | | | | |
| 4700 pF | 472 | J | К | м | BB | BB | BB | | | | | | | | | | | | | | | | | |
| 5600 pF | 562 | J | К | м | BB | BB | BB | | | | | | | | | | | | | | | | | |
| 6800 pF | 682 | J | К | М | BB | BB | BB | | | | | | | | | | | | | | | | | |
| 8200 pF | 822 | Ĵ | к | м | BB | BB | BB | | | | | | | | | | | | | | | | | |
| 10000 pF | 103 | Ĵ | к | м | BB | BB | BB | | | | | | | | | | | | | | | | | |
| 12000 pF | 123 | L. | ĸ | M | BB | BB | | | | | | | | | | | | | | | | | | |
| 15000 pF | 153 | , | ĸ | M | BB | BB | | | | | | | | | | | | | | | | | | |
| 18000 pF | 183 | . J | K | M | BB | BB | | | CF | CF | | | | | | | | | | | | | | |
| 22000 pF | 223 | Ĭĭ | ĸ | M | RR | RR | | | CF | CE | | | | | | | | | | | | | | |
| 22000 pF | 223 | Ĭĭ | ĸ | M | | | | | CE | CE | | | | | | | | | | | | | | |
| 22000 pF | 273 | | | M | | | | | | CE | | | | | | | | | | | | | | |
| 20000 pF | 202 | | | M | | | | | | CE | | | | | | | | | | | | | | |
| 47000 pF | 393 | J | r V | IVI | DD | | | | CF CF | OF OF | | DN | DN | | | | | | | | | | | |
| 47000 pF | 4/3 | J | Γ. ν | | DD | | | | | | | | | | | | | | | | CN | CN | CN | CN |
| 50000 µF | 503 | J | ĸ | | | | | | | | | | | | | | | | | | GN | GN | GN | GN |
| 68000 pF | 683 | J | K | IVI N | | | | | | | | | DN | | | | | | | | | | | |
| 82000 pF | 823 | J | K | M | | | | | | | | DN | DN | | | | | | | | ~ | | ~~~ | 0.1 |
| 0.1 µF | 104 | J | K | M | | | | | CF | CF | | DN | DN | _ | ED | ED | | | | | GM | GM | GM | GM |
| 0.12 µF | 124 | J | K | M | | | | | CF | | | DP | DP | | ED | ED | | | | | | | | |
| 0.15 µF | 154 | J | K | M | | | | | CF | | | DP | DP | | ED | ED | | | | | | | | |
| 0.18 µF | 184 | J | K | M | | | | | | | | DF | DF | | ED | ED | | FE | FE | | | | | |
| 0.22 µF | 224 | J | K | M | | | | | | | | DG | DG | | EP | EP | | FE | FE | | GB | GB | | |
| 0.27 µF | 274 | J | K | M | | | | | | | | DG | DG | | EP | EP | | FF | FF | | GB | GB | | |
| 0.33 µF | 334 | J | K | M | | | | | | | | DP | | | EJ | EJ | | FF | FF | | GB | GB | | |
| 0.39 µF | 394 | J | K | M | | | | | | | | DP | | | EJ | EJ | | FG | FG | | GB | GB | | |
| 0.47 µF | 474 | J | K | M | | | | | | | | DG | | | EJ | EJ | | FG | FG | | GB | GB | | |
| 0.56 µF | 564 | J | K | M | | | | | | | | DG | | | EP | | | FH | FH | | GB | GB | | |
| 0.68 µF | 684 | J | K | M | | | | | | | | DG | | | EJ | | | FM | FM | | GC | GC | | |
| 0.82 µF | 824 | J | K | М | | | | | | | | | | | EJ | | | FK | FK | | GE | GE | | |
| 1 µF | 105 | J | K | M | | | | | | | | | | | EJ | | | FK | FK | | GH | GH | | |
| 1.2 µF | 125 | J | K | M | | | | | | | | | | | | | | FH | | | GJ | GJ | | |
| 1.5 µF | 155 | J | K | M | | | | | | | | | | | | | | FM | | | GL | GL | | |
| 1.8 µF | 185 | J | K | M | | | | | | | | | | | | | | FK | | | GE | | | |
| 2.2 µF | 225 | J | K | М | | | | | | | | | | | | | | FK | | | GG | | | |
| 2.7 µF | 275 | J | K | м | | | | | | | | | | | | | | | | | GJ | | | |
| 3.3 µF | 335 | J | K | М | | | | | | | | | | | | | | | | | GL | | | |
| | | Rat | ed Voli (VDC) | tage | 16 | 25 | 50 | 100 | 25 | 50 | 100 | 25 | 50 | 100 | 25 | 50 | 100 | 25 | 50 | 100 | 25 | 50 | 100 | 200 |
| Capacitance | Cap Code | Vo | ltage C | ode | 4 | 3 | 5 | 1 | 3 | 5 | 1 | 3 | 5 | 1 | 3 | 5 | 1 | 3 | 5 | 1 | 3 | 5 | 1 | 2 |
| | | Ca | ase Siz Series | ze/ | | C04 | 02G | | c | 6030 | G/R | C | 08050 | G/R | C | 206G | i/R | C | 1210G | /R | | C181 | 2G/R | |



| Table 2 – Chip | Thickness/ | Packaging | Quantities |
|----------------|------------|-----------|------------|
|----------------|------------|-----------|------------|

| Thickness | Case | Thickness ± | Paper C | Quantity | Plastic (| Quantity | |
|-----------|------|--------------|---------|----------|------------------|----------|--|
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| BB | 0402 | 0.50 ± 0.05 | 10,000 | 50,000 | 0 | 0 | |
| CF | 0603 | 0.80 ± 0.07* | 4,000 | 15,000 | 0 | 0 | |
| DN | 0805 | 0.78 ± 0.10* | 4,000 | 15,000 | 0 | 0 | |
| DP | 0805 | 0.90 ± 0.10* | 4,000 | 15,000 | 0 | 0 | |
| DF | 0805 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 | |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | |
| ED | 1206 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 | |
| EP | 1206 | 1.20 ± 0.20 | 0 | 0 | 2,500 | 10,000 | |
| EJ | 1206 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| FE | 1210 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 | |
| FF | 1210 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 | |
| FG | 1210 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | |
| FH | 1210 | 1.55 ± 0.15 | 0 | 0 | 2,000 | 8,000 | |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| FK | 1210 | 2.10 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 | |
| GC | 1812 | 1.10 ± 0.10 | 0 | 0 | 1,000 | 4,000 | |
| GE | 1812 | 1.30 ± 0.10 | 0 | 0 | 1,000 | 4,000 | |
| GH | 1812 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| GG | 1812 | 1.55 ± 0.10 | 0 | 0 | 1,000 | 4,000 | |
| GJ | 1812 | 1.70 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| GN | 1812 | 1.70 ± 0.20 | 0 | 0 | 1,000 | 4,000 | |
| GL | 1812 | 1.90 ± 0.20 | 0 | 0 | 500 | 2,000 | |
| GM | 1812 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 | |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| Code | Size | Range (mm) | Paper (| Quantity | Plastic Quantity | | |

Package quantity based on finished chip thickness specifications.



Table 3A – Land Pattern Design Recommendations per IPC-7351 – Standard Termination

| EIA Size | Metric Size | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | | | Dens Media Land Pi | sity Lev an (Noi rotrusio | vel B: minal) on (mm |) | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | |
|-------------|----------------|--|------|------|------|------|------|--------------------------|---------------------------------|----------------------------|------|---|------|------|------|------|--|
| ooue | ooue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 | |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 | |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 | |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 | |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 | |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 | |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





Table 3B - Land Pattern Design Recommendations per IPC-7351 - Flexible Termination

| EIA Metric Size Size Code Code | Metric Size | | Dens Maxi Land Pi | sity Lev mum (I rotrusio | vel A: Most) on (mm |) | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | |
|--------------------------------------|----------------|------|-------------------------|--------------------------------|---------------------------|------|--|------|------|------|---|------|------|------|------|------|
| | Coue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0603 | 1608 | 0.85 | 1.25 | 1.10 | 4.00 | 2.10 | 0.75 | 1.05 | 1.00 | 3.10 | 1.50 | 0.65 | 0.85 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 0.99 | 1.44 | 1.66 | 4.47 | 2.71 | 0.89 | 1.24 | 1.56 | 3.57 | 2.11 | 0.79 | 1.04 | 1.46 | 2.42 | 1.81 |
| 1206 | 3216 | 1.59 | 1.62 | 2.06 | 5.85 | 3.06 | 1.49 | 1.42 | 1.96 | 4.95 | 2.46 | 1.39 | 1.22 | 1.86 | 4.25 | 2.16 |
| 1210 | 3225 | 1.59 | 1.62 | 3.01 | 5.90 | 4.01 | 1.49 | 1.42 | 2.91 | 4.95 | 3.41 | 1.39 | 1.22 | 2.81 | 4.25 | 3.11 |
| 1812 | 4532 | 2.10 | 1.80 | 3.60 | 7.00 | 4.60 | 2.00 | 1.60 | 3.50 | 6.10 | 4.00 | 1.90 | 1.40 | 3.40 | 5.40 | 3.70 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Terminat | ion Finish | |
|--|-----------------------|-----------------------|--|
| Tomeredure | SnPb | 100% Matte Sn | |
| Preheat/Soak | | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds | |
| Ramp-Up Rate (T_L to T_p) | 3°C/second maximum | 3°C/second maximum | |
| Liquidous Temperature (T _L) | 183°C | 217°C | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | |
| Peak Temperature (T _P) | 235°C | 260°C | |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 30 seconds maximum | |
| Ramp-Down Rate $(T_p to T_L)$ | 6°C/second maximum | 6°C/second maximum | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | |

Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method | | | | | | | |
|------------------------|---------------------------------------|--|--|--|--|--|--|--|--|
| | | Appendix 1, Note: | | | | | | | |
| | | Package Size (L" x W") Force Duration | | | | | | | |
| Terminal Strength | JIS-C-6429 | 0402 5 N (0.51 kg) 60 seconds | | | | | | | |
| | | 0603 10 N (1.02 kg) | | | | | | | |
| | | ≥ 0805 18 N (1.83 kg) | | | | | | | |
| Board Flex | JIS-C-6429 | Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm for COG. Flexible termination system – 3.0 mm (minimum). | | | | | | | |
| | | Magnification 50 X. Conditions: | | | | | | | |
| Solderability | | a) Method B, 4 hours at 155°C, dry heat at 235°C | | | | | | | |
| | 5 510 002 | b) Method B at 215°C category 3 | | | | | | | |
| | | c) Method D, category 3 at 260°C | | | | | | | |
| Temperature Cycling | KEMET defined | 50 cycles (-55°C to +220°C). Measurement at 24 hours +/- 4 hours after test conclusion. | | | | | | | |
| | MII-STD-202 Method | Load Humidity: 1,000 hours 85°C/85% RH and rated voltage. Add 100 K ohm resistor. | | | | | | | |
| Biased Humidity | 103 | Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours +/-4 hours after test conclusion. | | | | | | | |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Unpowered. Measurement at 24 hours +/-2 hours after test conclusion. | | | | | | | |
| High Temperature Life | MIL-STD-202 Method 108 /EIA-198 | 1,000 hours at 175°C with 2 X rated voltage applied. | | | | | | | |
| Storage Life | KEMET defined | 200°C, 0 VDC for 1,000 hours. | | | | | | | |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2.000 Hz | | | | | | | |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Condition F. | | | | | | | |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. | | | | | | | |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction – Standard Termination



Construction – Flexible Termination





Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a "K" to identify KEMET, followed by two characters (per EIA–198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the "K" character only.

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.
- X7R dielectric products in capacitance values outlined below.

| EIA Case Size | Metric Size Code | Capacitance |
|---------------|------------------|-------------|
| 0603 | 1608 | ≤ 170 pF |
| 0805 | 2012 | ≤ 150 pF |
| 1206 | 3216 | ≤ 910 pF |
| 1210 | 3225 | ≤ 2,000 pF |
| 1808 | 4520 | ≤ 3,900 pF |
| 1812 | 4532 | ≤ 6,700 pF |
| 1825 | 4564 | ≤ 0.018 µF |
| 2220 | 5650 | ≤ 0.027 µF |
| 2225 | 5664 | ≤ 0.033 µF |

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 μ F. Orientation of marking is vendor optional.





Capacitor Marking (Optional) cont.

| | C | apacita | ance (p | F) For \ | /arious | Alpha/ | Numera | al Identif | iers | | | |
|-----------|------------------|---------|---------|----------|---------|--------|---------|------------|------------|-------------|--|--|
| Alaha | | | | | | Numera | ıl | | | | | |
| Alpna | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | |
| Character | Capacitance (pF) | | | | | | | | | | | |
| A | 0.10 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 | | |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 | | |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 | | |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 | | |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 | | |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 | | |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 | | |
| Н | 0.20 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 | | |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 | | |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 | | |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 | | |
| М | 0.30 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 | | |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 | | |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 | | |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 | | |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 | | |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 | | |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 | | |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 | | |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 | | |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 | | |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 | | |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 | | |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 | | |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 | | |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 | | |
| d | 0.40 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 | | |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 | | |
| f | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 | | |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 | | |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 | | |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 | | |
| у | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 | | |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punched Paper | | |
|----------------------|------|---------|--------------------|--------------------------|----------|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | (W)* | Pitch | (P ₁)* | Pitch (P ₁)* | | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 | |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | |
| Array 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P₁ carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|--|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum | | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 (1.181) | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | |
| 16 mm | | (0.059) | | | | | | | | | |
| | | , | Variable Dime | ensions – Mil | limeters (Inch | nes) | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ | | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | Note 5 | | | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_n and B_n are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|-----------|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|--|--|
| Tape Size | D ₀ E ₁ P ₀ P ₂ T ₁ Maximum | | | | | | R Reference Note 2 | | | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | | | |
| | Variable Dimensions — Millimeters (Inches) | | | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | | | |

1. The cavity defined by $A_{a'}B_{a}$ and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|-----------|--|--|--|--|--|--|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | | | | |
| 8 mm | 178 ±0.20 | | | | | | | | | |
| 12 mm | Or 220 10 20 | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | | | | |
| 16 mm | (13.000 ±0.008) | | | | | | | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | | | | |
| 12 mm | 50 (1.969) | 50 12.4 +2.0/-0.0 (1.969) (0.488 +0.078/-0.0) | | Shall accommodate tape width without interference | | | | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Overview

KEMET's Automotive Grade High Voltage surface mount MLCCs in X7R Dielectric feature a 125°C maximum operating temperature and are considered "temperature stable." The Electronics Industries Alliance (EIA) characterizes X7R dielectric as a Class II material. Components of this classification are fixed, ceramic dielectric capacitors suited for bypass and decoupling applications or for frequency discriminating circuits where Q and stability of capacitance characteristics are not critical. X7R exhibits a predictable change in capacitance with respect to time and voltage and boasts a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to ±15% from -55°C to +125°C.

Whether under-hood or in-cabin, these capacitors are designed to provide reliable performance in mission and safety critical automotive circuits. Stricter testing protocol and inspection criteria have been established for automotive grade products in recognition of potentially harsh environmental conditions. KEMET automotive grade series capacitors meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.

Applications

- Charging stations
- · LCD fluorescent backlight ballasts
- · Voltage multiplier circuits
- DC/DC converters
- Power supply
- LAN/WAN interface
- · High voltage decoupling
- Filters
- DC blocking
- ESD Protection



Ordering Information

| С | 1210 | C | 154 | К | С | R | Α | С | AUTO |
|---------|--|--------------------------|---|---------------------------------|---|------------|-------------------------|---------------------------------|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ¹ | Packaging/Grade (C-Spec) |
| | 0402 0603 0805 1206 1210 1808 1812 1825 2220 2225 | C = Standard | Two significant digits and number of zeros. | J = ±5% K = ±10% M = ±20% | C = 500 B = 630 D = 1,000 F = 1,500 G = 2,000 Z = 2,500 H = 3,000 | R = X7R | A = N/A | C = 100% Matte Sn | See "Packaging C-Spec Ordering Options Table" |

¹ Additional termination finish options may be available. Contact KEMET for details.

Built Into Tomorrow

1



Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) ³ |
|---|---|
| 7" Reel | AUTO |
| 13" Reel/Unmarked | AUT07411 (EIA 0603 and smaller case sizes) AUT07210 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2 mm pitch ² | 3190 |
| 13" Reel/Unmarked/2 mm pitch ² | 3191 |

¹ Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information."

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information."

³ All automotive packaging C-Specs listed exclude the option to laser mark components. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking."

³ For additional information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information."

Benefits

- AEC-Q200 automotive gualified
- -55°C to +125°C operating temperature range
- Industry-leading CV values
- Exceptional performance at high frequencies
- Lead (Pb)-free, RoHS and REACH compliant
- EIA 0402, 0603, 0805, 1206, 1210, 1808, 1812, 1825, 2220 & Non-polar device, minimizing installation concerns 2225 case sizes
- DC voltage ratings of 500 V, 630 V, 1 KV, 1.5 KV, 2 KV, 2.5 KV, and 3 KV
- Capacitance offerings ranging from 10 pF to 560 nF
- Available capacitance tolerances of ±5%, ±10%, and ±20%
- Low ESR and ESL
- - 100% pure matte tin-plated termination finish allowing for excellent solderability

Application Note

X7R dielectric is not recommended for AC line filtering or pulse applications. These capacitors and/or the assembled circuit board containing these capacitors may require a protective surface coating to prevent external surface arcing.


Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | tion Due To: | Days Prior To |
|-----------------------------|----------------------------------|---------------|------------------|
| C-Spec | Process/Product change | Obsolescence* | Implementation |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum |
| AUTO | Yes (without approval) | Yes | 90 days minimum |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | | PPAP (Product | Part Approval | Process) Leve | I |
|-----------------------------|---|---------------|---------------|---------------|---|
| C-Spec | 1 | 2 | 3 | 4 | 5 |
| KEMET assigned ¹ | • | • | • | • | • |
| AUTO | | | 0 | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|-------------------------------|-----------------|-------------------------------|----------------------------|---------------------------------|
| 0402 | 1005 | 1.00 (0.040) ±0.05 (0.002) | 0.50 (0.020) ±0.05 (0.002) | | 0.30 (0.012) ±0.10 (0.004) | 0.30 (0.012) | Solder Reflow Only |
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | |
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder wave or Solder reflow |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | | |
| 1210 | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | See Table 2 for | 0.50 (0.02) ±0.25 (0.010) | | |
| 1808 | 4520 | 4.70 (0.185) ±0.50 (0.020) | 2.00 (0.079) ±0.20 (0.008) | Thickness | 0.60 (0.024) ±0.35 (0.014) | | |
| 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | | 0.60 (0.024) ±0.35 (0.014) | N/A | Solder reflow |
| 1825 | 4564 | 4.50 (0.177) ±0.30 (0.012) | 6.40 (0.252) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | only |
| 2220 | 5650 | 5.70 (0.224) ±0.40 (0.016) | 5.00 (0.197) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | |
| 2225 | 5664 | 5.60 (0.220) ±0.40 (0.016) | 6.40 (0.248) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | |



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|--|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 Vdc Applied (TCC) | ±15% |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| ² Dielectric Withstanding Voltage (DWV) | See Dielectric Withstanding Voltage (DWV) Table (5 ±1 seconds and charge/discharge not exceeding 50 mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | 2.5% |
| ⁴ Insulation Resistance (IR) Minimum Limit at 25°C | See Insulation Resistance Limit Table (500 VDC applied for 120 ±5 seconds at 25°C) |

¹Regarding aging rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours.

²DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

³ Capacitance and dissipation factor (DF) measured under the following conditions:

1 kHz ±50 Hz and 1.0 ±0.2 $V_{\rm rms}$ if capacitance \leq 10 μF

12 OHz ±10 Hz and 0.5 ±0.1 V_{rms} if capacitance > 10 μ F

⁴ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 & Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

DWV HV

| EIA Case Size | 500V | 630V | ≥ 1000V |
|---------------|--------------------------|-------------|--------------------------|
| 0402 | 120% of rated voltage | N/A | N/A |
| 0603 | | | |
| 0805 | | | |
| 1206 | | | |
| 1210 | | | |
| 1808 | 150% of ra | ted voltage | 120% of rated voltage |
| 1812 | | | |
| 1825 | | | |
| 2220 | | | |
| 2225 | | | |



Post Environmental Limits

| | High Temperatu | ıre Life, Biased | l Humidity, Moist | ture Resistance | 9 |
|------------|---------------------|----------------------|-----------------------------------|----------------------|--------------------------|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance |
| | > 25 | | 3.0 | | |
| X7R | 16/25 | All | 5.0 | ±20% | 10% of Initial limit |
| | < 16 | | 7.5 | | |

Insulation Resistance Limit Table (X7R Dielectric)

| EIA Case Size | 1,000 Megohm Microfarads or 100 GΩ | 100 Megohm Microfarads or 10 GΩ |
|---------------|---------------------------------------|------------------------------------|
| 0402 | N/A | All |
| 0603 | N/A | All |
| 0805 | < 0.0039 µF | ≥ .0039 µF |
| 1206 | < 0.012 µF | ≥ 0.012 µF |
| 1210 | < 0.033 µF | ≥ 0.033 µF |
| 1808 | < 0.018 µF | ≥ 0.018 µF |
| 1812 | < 0.027 µF | ≥ 0.027 µF |
| 1825 | < 0.120 µF | ≥ 0.120 µF |
| 2220 | < 0.150 µF | ≥ 0.150 µF |
| 2225 | < 0.180 µF | ≥ 0.180 µF |



Table 1A – Capacitance Range/Selection Waterfall (0402 – 1812 Case Sizes)

| | | Ca: | se S Serie | ize/ s | C0402C | C | 0603 | BC | CO | 980 | 5C | | C | 1200 | 5C | | | С | 121(| C | | | | C 1 | 180 | BC | | | | | C1 | 812 | C ² | | |
|----------------|------------|-----------|----------------|-----------|--------|----|------|-----|-----|------|-----|----------|----------|----------|----------|-----------|-------|----------|------|------------|------------|----------|-------|------------|------|------|-------------|----------|----|------|----------|----------|-----------------------|-------|-------|
| Can | Сар | Volt | age (| Code | С | C | В | D | C | В | D | С | В | D | F | G | c | В | D | F | G | C | В | D | F | G | z | н | c | В | D | F | G | z | Н |
| Cap | Code | Rate | d Vo | tage | 003 | 00 | 30 | 000 | 009 | 330 | 000 | 009 | 30 | 000 | 500 | 000 | 8 | 330 | 000 | 500 | 80 | <u>s</u> | 30 | 000 | 500 | 8 | 500 | 00 | 8 | 330 | 00 | 500 | 80 | 500 | 000 |
| | | Cap | acita |) Ince | | | U | | | | - | L. | | | | N Thia | | | | | ∾ • • • | "' | 0 for | | . — | i ok | <u> 01</u> | m Dim | | | - | - | 7 | 7 | 3 |
| 10 pE | 100 | To | lerar | ice M | | | | - | DC | | | | | | | | TEM | EM | EM | - 36 EM | EM | | | | рп | ILD | IIESS | | | | CP | CP | CP | CP | CP |
| 10 pF 11 pF | 110 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 12 pF | 120 | J | K | М | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 13 pF 15 pF | 130 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB GB | GB | GB | GB |
| 16 pF | 160 | J | K | М | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 18 pF | 180 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 20 pF 22 nF | 200 | J | K | M | | | | | DG | DG | DG | ED FD | ED FD | ED FD | ED FD | FD | I FM | FM | FM | FM | FM | IB | LB | LB | LB | | | | GB | GB | GB GB | GB GB | GB | GB | GB |
| 24 pF | 240 | Ĵ | K | M | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 27 pF | 270 | J | K | М | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 30 pF 33 nF | 300 | J | K | M | | | | | DG | DG | | ED FD | ED FD | ED FD | ED FD | ED ED | I F M | FM | FM | FM | FM | | LB | LB | LB | | LB | LB | GB | GB | GB GB | GB GB | GB | GB | GB |
| 36 pF | 360 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 39 pF | 390 | J | K | М | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 43 p⊦ 47 nF | 430 470 | J | K | M | | | | | | DG | | ED FD | ED FD | ED FD | ED FD | ED FD | FM | FM | FM | FM | FM | | LB | LB | LB | | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 51 pF | 510 | Ĵ | K | M | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 56 pF | 560 | J | K | М | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 62 pF | 620 680 | J | K | M | | | | | DG | DG | DG | ED ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 75 pF | 750 | Ĵ | K | M | | | | | DG | DG | DG | ED | ED | ED | ED | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 82 pF | 820 | J | K | М | | | | | DG | DG | DG | ED | ED | ED | ED | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 91 pF | 910 101 | J | K | M | | | | | | DG | DG | ED | ED | ED | ED | EF | I FM | FM FM | FM | FM | FM | | LB | LB | LB | | LB | LB | GD | GD | GD | GD | GD | GD | GD |
| 110 pF | 111 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | ED | EG | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LC | LB | GD | GD | GD | GD | GD | GD | GD |
| 120 pF | 121 | J | K | М | | | | | DG | DG | DG | ED | ED | ED | ED | EG | FM | FM | FM | FM | FM | LA | LA | LA | LA | LB | LC | LB | GD | GD | GD | GD | GD | GD | GD |
| 130 pF | 131 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | ED | EG | FG | FG | FG | FM | FM | | | | | | | | GD | GD | GD | GD | GD | GD | GD |
| 180 pF | 181 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | EF | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LC | LC | LB | GD | GD | GD | GD | GD | GD | GK |
| 220 pF | 221 | J | K | М | | | | | DG | DG | DG | ED | ED | ED | EG | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LC | LC | LB | GB | GB | GB | GB | GB | GD | GB |
| 270 pF | 271 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | EG | EG | FG | FG | FG | FK | FK | | | LA | LB | | | | GB | GB | GB | GB GB | GB | GH | GB |
| 390 pF | 391 | J | K | M | | | | | DG | DG | DG | ED | ED | EF | EG | EG | FG | FG | FG | FK | FS | LA | LA | LA | LB | LB | LB | LC | GB | GB | GB | GB | GD | GK | GH |
| 470 pF | 471 | J | K | М | | | | | DG | DG | DG | ED | ED | EG | EF | EG | FG | FM | FM | FS | FS | LA | LB | LB | LC | LB | LB | LC | GB | GB | GB | GB | GD | GK | GH |
| 560 pF | 561 691 | J | K | M | | | | | DG | DG | DG | ED | ED | EG | EF | EG | FG | FM | FM | FS | FL | | | | | | | | GB | GB | GB | GD | GH | GH | GK |
| 820 pF | 821 | J | K | M | | | | | DG | DG | DG | ED | ED | ED | EF | EG | FG | FM | FM | FL | FL | LB | LB | LB | LA | LB | LC | LC | GB | GB | GB | GD | GH | GH | GK |
| 1,000 pF | 102 | J | К | м | BB | CG | CG | CG | DG | DG | DG | ED | ED | ED | EF | EG | FM | FM | FM | FL | FL | LB | LB | LB | LA | LB | LC | LC | GB | GB | GB | GB | GH | GH | GK |
| 1,200 pF | 122 | J | K | M | BB | CG | CG | | DG | DG | DG | ED | ED | ED | EG | EG | FM | FK | FK | FL | FM | | LC | LC | LB | LC | LA | | GB | GB | GB | GB | GН | GK | GK |
| 1,800 pF | 182 | J | K | M | 60 | CG | 00 | | DG | DG | DG | ED | ED | ED | EG | EG | FK | FS | FS | FL | FM | LC | LC | LC | LB | LC | LC | | GB | GD | GD | GB | GH | GK | |
| 2,200 pF | 222 | J | К | М | | CG | | | DG | DG | DG | ED | ED | ED | EG | EG | FK | FL | FL | FL | FM | LC | LA | LA | LB | LC | LC | | GB | GH | GH | GB | GH | GK | |
| 2,700 pF | 272 | J | K | M | | CG | | | DG | DG | DG | ED | ED | ED | EG | | FS | FL | FL | FL | FM | | LA | LA | | | | | GB | GB | GB | GH | GK | GM | |
| 3,900 pF | 392 | J | K | M | | CG | | | DG | DG | DG | ED | ED | ED | EG | | FL | FL | FL | FL | FK | LA | LA | LA | LB | LA | | | GB | GB | GB | GH | GM | GO | |
| 4,700 pF | 472 | J | К | м | | | | | DG | DG | DG | ED | ED | ED | EG | | FL | FL | FL | FL | FK | LA | LA | LA | LB | LC | | | GH | GH | GH | GH | GH | GO | |
| 5,600 pF | 562 | J | K | M | | | | | DG | DG | | ED | EF | EF | EF | | FL | FL | FL | FM | FK | | | | LC | | | | GH | GH | GH | GK | GK | | |
| 8,200 pF | 822 | J | K | M | | | | | DG | DG | | EF | EG | EG | EF | | FL | FL | FL | FK | 15 | LA | LB | LB | LC | | | | GH | GH | GH | GK | GM | | |
| 10,000 pF | 103 | J | K | М | | | | | DG | DG | | EF | EG | EG | EG | | FL | FL | FL | FK | | LA | LB | LB | LC | | | | GH | GH | GH | GK | GO | | |
| 12,000 pF | 123 | J Rate | K ed Vol | M tage | 9 | 0 | 0 | 8 | DG | DG | 00 | EG | EJ | EJ | 8 | 8 | FL | FL | FL | FK | 8 | | | LC 8 | | 8 | 8 | 8 | GB | GK | GK | GK | 8 | 8 | 00 |
| | Can | | (VDC |) | 20 | 20 | - 63 | 10 | 50 | 1 63 | 10(| 50 | - 63 | 10 | 15(| 20(| 20 | 63 | 10 | 15(| 20(| 20 | - 63 | 10 | 15(| 20(| 1 25(| 30(| 20 | 1 63 | 10 | 15(| 20 | 1 25(| : 30(|
| Cap | Code | Voli | age (| ode | C | | B | D | C | B | D | C | B | D | F | G | C | B | D | F | G | C | B | D | F | G | Z | H | | B | Ď | F | G | Z | H |
| | | | se si Serie | ze/ S | C0402C | C | 0603 | BC | C | 0805 | 5C | | C | 1206 | 6C | | | C | 1210 | C | | | | C | 1808 | BC | | | | | C1 | 812 | C² | | |

KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions). ² Available capacitance values available in <u>X7R with KONNEKT Technology</u>.



Table 1A - Capacitance Range/Selection Waterfall (0402 - 1812 Case Sizes) cont.

| | | Cas S | se S Serie | ize/ es | C0402C | C | 060 | 3C | С | 080 | 5C | | C | 120 | 6C | | | С | 121(| OC | | | | C | 180 | 8C | | | | | C1 | 812 | C ² | | |
|-----------|------|-----------|------------------|-------------|--------|----------|------|------|------|------|-------|-------|-------|------|-------|------|------|-----|------|------|-------|----------|------|-------|-------|------|------|------|------|-----|------|------|----------------|------|------|
| Can | Сар | Volt | age (| Code | C | С | В | D | С | В | D | С | В | D | F | G | С | В | D | F | G | С | В | D | F | G | z | н | С | В | D | F | G | z | н |
| Cap | Code | Rate | ed Vo | ltage | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 00 |
| | | | (VDC |) | 5(| 5 | ö | 9 | 5 | ö | 9 | 2 | ö | 9 | 15 | 5 | 5 | ö | 9 | 15 | 5 | 5 | ö | 9 | 15 | 20 | 25 | 8 | 5 | ö | 9 | 15 | 3 | 25 | 8 |
| | | Cap To | oacita olerar | ance Ice | | | | P | rodu | ct A | vaila | abili | ty ar | nd C | hip 1 | Thic | knes | s C | odes | - Se | ee Ta | able | 2 fo | r Chi | ip Tł | nick | ness | Dim | ensi | ons | | | | | |
| 15,000 pF | 153 | J | K | Μ | | | | | DG | | | EG | EJ | EJ | | | FL | FL | FL | FL | | LA | LC | LC | LC | | | | GB | GK | GK | GH | | | |
| 18,000 pF | 183 | J | K | Μ | | | | | DG | | | EJ | EJ | EJ | | | FL | FL | FL | FM | | LA | LE | LE | | | | | GB | GK | GK | GM | | | |
| 22,000 pF | 223 | J | K | M | | | | | DG | | | EJ | EJ | EJ | | | FL | FM | FM | FM | | LA | LE | LE | | | | | GB | GK | GK | GM | | | |
| 27,000 pF | 273 | J | K | М | | | | | | | | EJ | EJ | | | | FM | FK | FK | FK | | LA | LA | LA | | | | | GH | GB | GB | GO | | | |
| 33,000 pF | 333 | J | K | M | | | | | | | | EJ | EJ | | | | FM | FG | FH | FS | | LC | LA | LA | | | | | GH | GB | GB | GO | | | |
| 39,000 pF | 393 | J | K | M | | | | | | | | EJ | | | | | FK | FG | FH | FS | | LC | LA | LA | | | | | GH | GB | GB | | | | |
| 47,000 pF | 473 | J | K | M | | | | | | | | EJ | | | | | FK | FH | FK | | | LC | LA | LB | | | | | GH | GB | GC | | | | |
| 56,000 pF | 563 | J | K | М | | | | | | | | EJ | | | | | FG | FH | FK | | | LC | LA | LB | | | | | GH | GB | GE | | | | |
| 68,000 pF | 683 | J | K | M | | | | | | | | EJ | | | | | FG | FK | FS | | | LA | LA | LC | | | | | GE | GE | GE | | | | |
| 82,000 pF | 823 | J | K | M | | | | | | | | | | | | | FH | FK | | | | LA | LC | | | | | | GB | GE | GK | | | | |
| 0.10 µF | 104 | J | K | M | | | | | | | | | | | | | FK | FS | | | | LA | LC | | | | | | GB | GH | GJ | | | | |
| 0.12 µF | 124 | J | K | M | | | | | | | | | | | | | FK | | | | | LA | | | | | | | GE | GK | | | | | |
| 0.15 µF | 154 | J | K | M | | | | | | | | | | | | | FK | | | | | LB | | | | | | | GE | GN | | | | | |
| 0.18 µF | 184 | J | K | M | | | | | | | | | | | | | | | | | | | | | | | | | GF | | | | | | |
| 0.22 µF | 224 | J | K | M | | | | | | | | | | | | | | | | | | | | | | | | | GJ | | | | | | |
| 0.27 µF | 274 | J | K | M | | | | | | | | | | | | | | | | | | | | | | | | | GL | | | | | | |
| 0.33 µF | 334 | J | K | M | | <u> </u> | | _ | | | _ | | | _ | _ | _ | | | _ | _ | _ | <u> </u> | | _ | _ | _ | _ | _ | GS | | | _ | _ | _ | _ |
| | | Rate | ed Vo (VDC | itage) | 500 | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| Cap | Code | Volt | age (| Code | С | C | В | D | C | В | D | С | В | D | F | G | C | В | D | F | G | C | В | D | F | G | z | н | C | В | D | F | G | z | н |
| | Jue | Ca | se Si Serie | ize/ s | C0402C | C | 0603 | BC | C | 080 | 5C | | C | 1200 | 5C | | | C | 1210 | C | | | | C | 1808 | BC | | | | | C | 1812 | C² | | |

Table 1B - Capacitance Range/Selection Waterfall (1825-2225 Case Sizes)

| | | Ca | se Si Serie | ze/ s | | | C | 182 | 5C | | | | | C | 2220 | C | | | | | C | 222 | 5C | | |
|-------------|----------|---------|--------------------|-----------|-----|-----|-------|--------|--------|--------|-------|--------|------|-------|-------|------|-------|-------|------|-------|------|------|-------|------|------|
| Canacitanao | Сар | Vo | ltage C | ode | С | В | D | F | G | z | н | С | В | D | F | G | z | н | С | В | D | F | G | z | н |
| Capacitance | Code | Rated | Voltage | e (VDC) | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| | | Ca 1 | pacita: olerano | nce ce | | l | Produ | ıct Av | ailabi | lity a | nd Ch | ip Thi | ckne | ss Co | des – | See | Table | 2 for | Chip | Thick | ness | Dime | nsion | s | |
| 100 pF | 101 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 110 pF | 111 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 120 pF | 121 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 130 pF | 131 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 150 pF | 151 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 180 pF | 181 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 220 pF | 221 | J | K | M | HE | HE | HE | HE | HE | HE | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 270 pF | 271 | J | ĸ | M | HE | HE | HE | HE | HE | HE | HG | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 330 pF | 331 | J | ĸ | M | | | | | | | | JE | JE | JE | JE | JE | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 390 pF | 391 | J | ĸ | M | | | | | | | | JE | JE | JE | JE | JE | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 470 pF | 471 | J | K | М | HG | HG | HG | HG | HG | HG | HG | JE | JE | JE | JE | JE | JK | JK | KF | KF | KF | KF | KE | KE | KF |
| 560 pF | 561 | J | К | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KE | KE | KF |
| 680 pF | 681 | J | К | M | HG | HG | HG | HG | HG | HG | HG | JE | JE | JE | JK | JK | JK | JK | KF | KF | KF | KF | KE | KF | KF |
| 820 pF | 821 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JE | JE | JE | JK | JK | JK | JK | KE | KE | KE | KF | KE | KF | KF |
| | | Rated | Voltage | e (VDC) | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| Capacitance | Cap Code | Vo | ltage C | ode | С | В | D | F | G | Z | н | C | В | D | F | G | Z | н | C | В | D | F | G | Z | Н |
| | | Case | Size/S | Series | | | (| C1825 | C | | | | | C | 2220 | C | | | | | C | 2225 | C | | |

KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).

² Available capacitance values available in <u>X7R with KONNEKT Technology</u>.



Table 1B – Capacitance Range/Selection Waterfall (1825 – 2225 Case Sizes) cont.

| | | Ca | se Si Serie | ze/ s | | | C | 182 | 5C | | | | | C | 2220 | C | | | | | C | 2225 | 5C | | | | |
|-------------|----------|------------|--------------------|-----------|--------|-----|----------------|--------|--------|--------|-------|--------|------|--------|--------|--------|--------|--------|------|--------|----------------|-------------------|--------|--------|--------|--|--|
| Canacitanco | Сар | Vo | Itage C | ode | C | В | D | F | G | z | н | C | В | D | F | G | z | н | С | В | D | F | G | z | н | | |
| Capacitance | Code | Rated | Voltage | e (VDC) | 500 | 630 | 000 | 1500 | 000 | 500 | 000 | 500 | 630 | 000 | 1500 | 000 | 500 | 000 | 500 | 630 | 000 | 500 | 000 | 500 | 000 | | |
| | | Ca 1 | pacitar oleranc | ice ce | | | Produ | ict Av | ailabi | lity a | nd Ch | ip Thi | ckne | ss Co | des – | See ' | Table | 2 for | Chip | Thick | ness | Dimer | nsion | S | (7) | | |
| 1,000 pF | 102 | J | K | М | HG | HG | HG | HG | HG | HG | HG | JE | JK | JK | JK | JK | JK | JK | KE | KE | KE | KF | KE | KF | KF | | |
| 1,200 pF | 122 | J | K | М | HG | HG | HG | HG | HG | HG | HG | JE | JK | JK | JK | JK | JK | JK | KE | KE | KE | KF | KF | KF | KF | | |
| 1,500 pF | 152 | J | к | м | HG | HG | HG | HG | HG | HG | HG | JE | JK | JK | JK | JK | JK | JK | KE | KE | KE | KF | KF | KF | KF | | |
| 1,800 pF | 182 | J | к | м | HE | HE | HE | HE | HE | HG | HG | JE | JK | JK | JK | JK | JK | JK | KE | KE | KE | KF | KF | KF | KF | | |
| 2,200 pF | 222 | J | к | м | HE | HE | HE | HE | HE | HG | HG | JE | JK | JK | JE | JE | JK | JK | KF | KE | KE | KF | KF | KF | KF | | |
| 2,700 pF | 272 | J | к | м | HE | HE | HE | HE | HE | HG | | JK | JK | JK | JE | JE | JK | JK | KE | KE | KE | KE | KE | KF | KE | | |
| 3,300 pF | 332 | J | К | М | HE | HE | HE | HE | HE | HG | | JK | JK | JK | JE | JE | JK | JE | KE | KE | KE | KE | KE | KF | KE | | |
| 3,900 pF | 392 | J | к | м | HE | HE | HE | HE | HE | HG | | JK | JK | JK | JE | JE | JK | JE | KE | KF | KF | KE | KE | KF | KE | | |
| 4,700 pF | 472 | J | к | м | HE | HE | HE | HE | HE | HG | | JK | JK | JK | JE | JK | JE | JE | KE | KF | KF | KE | KE | KF | KE | | |
| 5.600 pF | 562 | J | к | м | HE | HE | HE | HE | HE | HG | | JK | JK | JK | JE | JK | JE | JE | KE | KF | KF | KE | KE | KF | KE | | |
| 6,800 pF | 682 | J | к | м | HE | HE | HE | HE | HE | HJ | | JK | JE | JE | JE | JK | JE | JE | KE | KF | KF | KE | KF | KE | KE | | |
| 8.200 pF | 822 | J | К | М | HE | HE | HE | HE | HE | HJ | | JK | JE | JE | JE | JK | JK | JK | KF | KE | KE | KE | KF | KF | KF | | |
| 10.000 pF | 103 | J | к | м | HE | HE | HE | HE | HJ | нк | | JE | JE | JE | JE | JL | JL | JL | KF | KE | KE | KE | KF | кн | КН | | |
| 12.000 pF | 123 | J | к | м | HE | HE | HE | HG | НJ | | | JE | JK | JK | JK | JL | JL | JL | KE | KE | KE | KE | KF | кн | кн | | |
| 15.000 pF | 153 | J | ĸ | M | HE | HE | HE | HG | нк | | | JE | JK | JK | JK | JL | JN | JN | KE | KE | KE | KE | KF | KJ | КJ | | |
| 18,000 pF | 183 | J | ĸ | M | HE | HE | HE | HG | | | | JE | JK | JK | JK | JN | | | KE | KE | KE | KE | КН | | | | |
| 22.000 pF | 223 | J | K | M | HE | HG | HG | HG | | | | JE | JK | JK | JK | JN | | | KE | KF | KF | KF | KJ | | | | |
| 27 000 pF | 273 | J | ĸ | M | HF | HG | HG | HG | | | | JE | JK | JK | JK | | | | KF | KF | KF | KF | K.J | | | | |
| 33 000 pF | 333 | Ĵ | ĸ | M | HF | HG | HG | HF | | | | JF | JK | JK | JK | | | | KF | KF | KF | KF | | | | | |
| 39 000 pF | 393 | Ĵ | ĸ | M | HF | HG | HG | HG | | | | JF | JK | JK | JF | | | | KF | KF | KF | KF | | | | | |
| 47 000 pF | 473 | Ĵ | ĸ | M | HF | HG | HG | HJ | | | | JF | JK | JK | JK | | | | KF | KF | KF | KF | | | | | |
| 56 000 pF | 563 | J | ĸ | M | HF | HG | HG | HJ | | | | JF | JF | JF | JI | | | | KF | KF | KF | KF | | | | | |
| 68 000 pF | 683 | , i | ĸ | M | HG | H.I | H.I | нк | | | | JE | JK | JK | | | | | KF | KF | KF | K.I | | | | | |
| 82 000 pF | 823 | , i | ĸ | M | HG | H.I | H.I | | | | | JE | | | JN | | | | KF | KF | KF | K.I | | | | | |
| 0.10 uF | 104 | Ĭ | ĸ | M | нG | нк | нк | | | | | IF | IN | IN | | | | | KE | КН | КН | KI | | | | | |
| 0.10 µF | 124 | Ĭ | ĸ | M | нG | HE | | | | | | IF | | IN | | | | | KE | КН | КН | | | | | | |
| 0.15 µF | 154 | , i | ĸ | M | HG | HE | | | | | | JK | JE | on | | | | | KE | K.I | K.I | | | | | | |
| 0.18 µF | 184 | | K | M | HG | HG | | | | | | JK | JE | | | | | | KE | KE | 1.0 | | | | | | |
| 0.22 µF | 224 | | K | M | HG | H.I | | | | | | JK | JK | | | | | | KE | KE | | | | | | | |
| 0.22 µr | 274 | | K | M | H.I | HJ | | | | | | JK | .11 | | | | | | KE | КН | | | | | | | |
| 0.33 µF | 334 | | K | M | H.I | 110 | | | | | | | JN | | | | | | KE | КН | | | | | | | |
| 0.30 µF | 304 | | K | M | НК | | | | | | | .IN | | | | | | | КН | KI | | | | | | | |
| 0.09 µi | 474 | | K | M | | | | | | | | .IN | | | | | | | КН | KI | | | | | | | |
| 0.56 µF | 564 | | ĸ | M | | | | | | | | | | | | | | | KI | | | | | | | | |
| 0.56 µF | 564 | .1 | ĸ | M | | | | | | | | | | | | | | | | | | | | | | | |
| 0.00 pi | | Rated | Voltage | e (VDC) | 00 | 30 | 000 | 500 | 000 | 500 | 000 | 00 | 30 | 00 | 500 | 000 | 500 | 000 | 8 | 30 | 00 | 200 | 000 | 500 | 000 | | |
| Canacitance | Can Code | Vo | ltane C | ode | C C | B | = D | F | 5 | ั 7 | ы | C C | B | - D | ₩ F | 5 0 | ั 7 | м н | C C | B | 7 D | ~ F | 5 | 7 7 | м н | | |
| Sapacitance | | 00 Caco | Sizo/G | Sorioc | Ū | | ت _ا | 1925 | r r | - | | Ū | | ت م | | r T | - | | ۴, | | ت _ا | | r r | - | | | |
| | | Juase | 312e/3 | series | | | Ľ | ,1023 | 0 | | | | | L L | ~~~ | • | | | 1 | C2225C | | | | | | | |

KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).



Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic | Quantity | | | | | | |
|-----------|-------------------|------------------------------------|---------|----------------------|---------------------------|----------|--|--|--|--|--|--|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | | | | | |
| BB | 0402 | 0.50 ± 0.05 | 10,000 | 50,000 | 0 | 0 | | | | | | |
| BD | 0402 | 0.55 ± 0.05 | 10,000 | 50,000 | 0 | 0 | | | | | | |
| CG | 0603 | 0.80 ± 0.10* | 4,000 | 15,000 | | | | | | | | |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | | | | | | |
| | 1200 | 1.00 ± 0.10 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 | | | | | | |
| FG | 1200 | 1.20 ± 0.15 | 0 | 0 | 2,300 | 8 000 | | | | | | |
| F.I | 1200 | 1 70 + 0 20 | 0 | 0 | 2,000 | 8,000 | | | | | | |
| FG | 1210 | 1.25 ± 0.15 | Ő | 0 0 | 2,500 | 10.000 | | | | | | |
| FL | 1210 | 1.40 ± 0.15 | 0 | 0 | 2,000 | 8,000 | | | | | | |
| FH | 1210 | 1.55 ± 0.15 | 0 | 0 | 2,000 | 8,000 | | | | | | |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 | | | | | | |
| FK | 1210 | 2.10 ± 0.20 | 0 | 0 | 2,000 | 8,000 | | | | | | |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1,000 | 4,000 | | | | | | |
| LE | 1808 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 | | | | | | |
| | 1808 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | | | | | | |
| | 1000 | 1.00 ± 0.15 2.00 ± 0.15 | 0 | 0 | 1,000 | 4,000 | | | | | | |
| GB | 1812 | 2.00 ± 0.13 | 0 | 0 | 1,000 | 4,000 | | | | | | |
| 60 60 | 1812 | 1 10 + 0 10 | 0 | 0 | 1,000 | 4 000 | | | | | | |
| GE | 1812 | 1.30 ± 0.10 | 0 | 0 | 1,000 | 4.000 | | | | | | |
| GH | 1812 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | | | | | | |
| GF | 1812 | 1.50 ± 0.10 | 0 | 0 | 1,000 | 4,000 | | | | | | |
| GK | 1812 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 | | | | | | |
| GJ | 1812 | 1.70 ± 0.15 | 0 | 0 | 1,000 | 4,000 | | | | | | |
| GN | 1812 | 1.70 ± 0.20 | 0 | 0 | 1,000 | 4,000 | | | | | | |
| GL | 1812 | 1.90 ± 0.20 | 0 | 0 | 500 | 2,000 | | | | | | |
| GM | 1812 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 | | | | | | |
| 63 | 1012 | 2.10 ± 0.20 2.50 ± 0.20 | | 0 | 500 | 2,000 | | | | | | |
| HF | 1825 | 2.30 ± 0.20 | 0 | 0 | 1 000 | 2,000 | | | | | | |
| HG | 1825 | 1.60 + 0.20 | 0 | 0 | 1,000 | 4,000 | | | | | | |
| HJ | 1825 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 | | | | | | |
| НК | 1825 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 | | | | | | |
| JE | 2220 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | | | | | | |
| JK | 2220 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 | | | | | | |
| JL | 2220 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 | | | | | | |
| JN | 2220 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 | | | | | | |
| KE | 2225 | 1.40 ± 0.15 | U O | 0 | 1,000 | 4,000 | | | | | | |
| KF KU | 2225 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 | | | | | | |
| KJ | 2225 | 2.50 ± 0.20 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 | | | | | | |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | | | | | |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | 7" Reel 13" Reel 13" Reel | | | | | | | |

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape & Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size | Metric Size Code Density Level A: Maximum (Most) Land Protrusion (mm) | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | | | |
|-------------|--|------|------|--|------|------|------|---|------|------|------|------|------|------|------|------|
| Coue | Coue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 1.50 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 |
| 1825 | 4564 | 2.15 | 1.60 | 6.90 | 6.90 | 7.90 | 2.05 | 1.40 | 6.80 | 6.00 | 7.30 | 1.95 | 1.20 | 6.70 | 5.30 | 7.00 |
| 2220 | 5650 | 2.75 | 1.70 | 5.50 | 8.20 | 6.50 | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | 2.55 | 1.30 | 5.30 | 6.60 | 5.60 |
| 2225 | 5664 | 2.70 | 1.70 | 6.90 | 8.10 | 7.90 | 2.60 | 1.50 | 6.80 | 7.20 | 7.30 | 2.50 | 1.30 | 6.70 | 6.50 | 7.00 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

The KEMET families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. The KEMET recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Drofile Feature | Terminat | ion Finish |
|--|-----------------------|-----------------------|
| Fromereature | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate (T_L to T_p) | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T _L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |



Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.





Construction





Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a "K" to identify KEMET, followed by two characters (per EIA–198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the "K" character only.

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.
- X7R dielectric products in capacitance values outlined below.

| EIA Case Size | Metric Size Code | Capacitance |
|---------------|------------------|-------------|
| 0603 | 1608 | ≤ 170 pF |
| 0805 | 2012 | ≤ 150 pF |
| 1206 | 3216 | ≤ 910 pF |
| 1210 | 3225 | ≤ 2,000 pF |
| 1808 | 4520 | ≤ 3,900 pF |
| 1812 | 4532 | ≤ 6,700 pF |
| 1825 | 4564 | ≤ 0.018 µF |
| 2220 | 5650 | ≤ 0.027 µF |
| 2225 | 5664 | ≤ 0.033 µF |

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 μ F. Orientation of marking is vendor optional.





Capacitor Marking (Optional) cont.

| | Capacitance (pF) For Various Alpha/Numeral Identifiers | | | | | | | | | | | | |
|-----------|--|-----|----|-----|-------|--------|---------|-----------|------------|-------------|--|--|--|
| Alaba | | | | | | Numera | al | | | | | | |
| Alpha | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | |
| Character | Capacitance (pF) | | | | | | | | | | | | |
| Α | 0.10 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 | | | |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 | | | |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 | | | |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 | | | |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 | | | |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 | | | |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 | | | |
| Н | 0.20 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 | | | |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 | | | |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 | | | |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 | | | |
| М | 0.30 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 | | | |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 | | | |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 | | | |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 | | | |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 | | | |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 | | | |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 | | | |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 | | | |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 | | | |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 | | | |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 | | | |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 | | | |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 | | | |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 | | | |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 | | | |
| d | 0.40 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 | | | |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 | | | |
| f | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 | | | |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 | | | |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 | | | |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 | | | |
| у | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 | | | |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punched Paper | | |
|----------------------|--------------|---------|--------------------|--------------------------|----------|--|
| EIA Case Size | Size (W)* | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | | Pitch | (P ₁)* | Pitch (P ₁)* | | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 | |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | |
| Array 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|--|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum | | |
| 8 mm | 1.0 (0.039) | | | | | 25.0 (0.984) | | | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 (1.181) | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | |
| 16 mm | | (0.059) | | | | | | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ | | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | Note 5 | | | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|-----------|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|--|--|
| Tape Size | D ₀ E ₁ P ₀ P ₂ T ₁ Maximum G Minim | | | | | | R Reference Note 2 | | | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | | | |
| | | Variable D | imensions – M | illimeters (Inche | es) | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Nata 1 | | | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|-----------|--|---------------------------------------|--|--|--|--|--|--|--|--|
| Tape Size | А | B Minimum C | | D Minimum | | | | | | |
| 8 mm | 178 ±0.20 | | | | | | | | | |
| 12 mm | Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | | | | |
| 16 mm | (13.000 ±0.008) | | X | | | | | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Application Guide

Solder Fluxes and Cleaning

The use of water-soluble fluxes provides advantages of excellent solderability due to high activation. However, these fluxes contain organic acids that can induce arcing under high DC or AC voltages. Notable problem areas are underneath the MLCC where flux can be trapped between the ceramic material and PCB. It is therefore critical that PCBs are properly cleaned to remove all flux residue to maintain reliability.

Coating for High Voltage MLCCs

For MLCC ratings \geq 1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

| Dielectric | CTE (ppm/°C) |
|----------------------------|--------------|
| Class II BaTiO₃ | 10.7 |
| Class I CaZrO ₃ | 9.8 |

Slits in PCB

It is recommended to apply a slit in the PCB under the MLCC to improve washing of flux residue that may get trapped underneath. In some cases, it is not possible to slit entirely through the PCB due to underlying metal planes. It is also acceptable to apply a recessed slit under the MLCC which will also promote cleaning.

- Recommended for case sizes ≥1206
- The width (w) of the slit should be 1mm
- Length of the slit should be as short as possible to prevent damaging the MLCC due to mechanical stress of the PCB.
- Slits also reduce the risk of solder balls under MLCC which decreased the creepage distance.



Solder Resist

If a slit cannot be applied as above, it is recommended to not use solder resist directly under the MLCC. The use of solder resist material reduces the distance between MLCC ceramic material and PCB thus making it difficult to clean.

Solder Balls

Improper reflow techniques and/or improper washing can induce solder balls under or adjacent to the MLCC. Solder balls reduce the creepage distance between the MLCC terminations and increase the risk of arcing or damage to the ceramic material. To reduce the risk of solder balls:

- Follow KEMET's solder recommendations as outlined in the datasheet.
- If performing a cleaning procedure, properly clean the PCB per KEMET's cleaning recommendations.
- Add slit to the PCB as shown above.





Overview

The KEMET Automotive Grade Flexible Termination (FT-CAP) multilayer ceramic capacitor in X7R dielectric incorporates a unique, flexible termination system that is integrated with KEMET's standard termination materials. A conductive silver epoxy is utilized between the base metal and nickel barrier layers of KEMET's standard termination system in order to establish pliability while maintaining terminal strength, solderability and electrical performance. This technology was developed in order to address the primary failure mode of MLCCs – flex cracks, which are typically the result of excessive tensile and shear stresses produced during board flexure and thermal cycling. Flexible termination technology inhibits the transfer of board stress to the rigid ceramic body, therefore mitigating flex cracks which can result in low IR or short circuit failures.

Although this technology does not eliminate the potential for mechanical damage that may propagate during extreme environmental and handling conditions, it does provide superior flex performance over standard termination systems. FT-CAP complements KEMET's Open Mode, Floating Electrode (FE-CAP), Floating Electrode with Flexible Termination (FF-CAP) and KEMET Power Solutions (KPS) product lines by providing a complete portfolio of flex mitigation solutions. Combined with the stability of an X7R dielectric and designed to accommodate all capacitance requirements, these flex-robust devices are RoHS-compliant, offer up to 5 mm of flex-bend capability and exhibit a predictable change in capacitance with respect to time and voltage. Capacitance change with reference to ambient temperature is limited to $\pm 15\%$ from -55° C to $\pm 125^{\circ}$ C.

Whether underhood or in-cabin, these capacitors are designed to provide reliable performance in a mission and safety of critical automotive circuits. Stricter testing protocol and inspection criteria have been established for automotive grade products in recognition of potentially harsh environmental conditions. KEMET automotive grade series capacitors meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.



Ordering Information

| С | 1206 | Х | 106 | K | 4 | R | Α | С | AUTO |
|---------|--|-----------------------------|--|---------------------------------|--|------------|-------------------------|------------------------------------|--|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ¹ | Packaging/ Grade (C-Spec) ² |
| | 0603 0805 1206 1210 1808 1812 1825 2220 2225 | X = Flexible termination | Two significant digits and number of zeros | J = ±5% K = ±10% M = ±20% | 9 = 6.3 8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 2 = 200 A = 250 | R = X7R | A = N/A | C = 100% Matte Sn | See "Packaging C-Spec Ordering Options Table" |

¹ Additional termination finish options may be available. Contact KEMET for details.

Built Into Tomorrow

1



Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) ³ |
|---|---|
| 7" Reel | AUTO |
| 13" Reel/Unmarked | AUTO7411 (EIA 0603 and smaller case sizes) AUTO7210 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2 mm pitch ² | 3190 |
| 13" Reel/Unmarked/2 mm pitch ² | 3191 |

¹ Reeling tape options (paper or plastic) are dependent on capacitor case size (L x W) and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information."

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information."

³ All automotive packaging C-Specs listed exclude the option to laser mark components. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking."

³ For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information."

Benefits

- · AEC-Q200 automotive qualified
- -55°C to +125°C operating temperature range
- Superior flex performance (up to 5 mm)
- · High capacitance flex mitigation
- · Lead (Pb)-free, RoHS and REACH compliant
- EIA 0603, 0805, 1206, 1210, 1808, 1812, 1825, 2220, and 2225 case sizes
- DC voltage ratings of 6.3 V, 10 V, 16 V, 25 V, 50 V, 100 V, 200 V, and 250 V
- Capacitance offerings ranging from 180 pF to 22 μF
- Available capacitance tolerances of ±5%, ±10%, and ±20%
- · Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish allowing for excellent solderability

Applications

Typical applications include circuits with a direct battery or power source connection, critical and safety relevant circuits without (integrated) current limitation and any application that is subject to high levels of board flexure or temperature cycling. Examples include raw power input side filtering (power plane/bus), high current applications (automobile battery line) and circuits that cannot be fused to open. Markets include consumer, medical, industrial (power supply), automotive, aerospace and telecom.



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | tion Due To: | Days Prior To |
|-----------------------------|----------------------------------|---------------|------------------|
| C-Spec | Process/Product change | Obsolescence* | Implementation |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum |
| AUTO | Yes (without approval) | Yes | 90 days minimum |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | | PPAP (Product | Part Approval | Process) Leve | I |
|-----------------------------|---|---------------|---------------|---------------|---|
| C-Spec | 1 | 2 | 3 | 4 | 5 |
| KEMET assigned ¹ | • | • | • | • | • |
| AUTO | | | 0 | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|-------------------|---------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|----------------------------|------------------------------------|
| 0603 ¹ | 1608 | 1.60 (0.063) ±0.17 (0.007) | 0.80 (0.032) ±0.15 (0.006) | | 0.45 (0.018) ±0.15 (0.006) | 0.58 (0.023) | Colder wave |
| 0805 ² | 2012 | 2.00 (0.079) ±0.30 (0.012) | 1.25 (0.049) ±0.30 (0.012) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder wave Or Solder reflew |
| 1206 | 3216 | 3.30 (0.130) ±0.40 (0.016) | 1.60 (0.063) ±0.35 (0.013) | | 0.60 (0.024) ±0.25 (0.010) | | Soluei Tellow |
| 1210 | 3225 | 3.30 (.130) ±0.40 (.016) | 2.60 (0.102) ±0.30 (0.012) | | 0.60 (0.024) ±0.25 (0.010) | | |
| 1808 | 4520 | 4.70 (0.185) ±0.50 (0.020) | 2.00 (0.079) ±0.20 (0.008) | See Table 2 for Thickness | 0.70 (0.028) ±0.35 (0.014) | | |
| 1812 | 4532 | 4.50 (0.178) ±0.40 (0.016) | 3.20 (0.126) ±0.30 (0.012) | | 0.70 (0.028) ±0.35 (0.014) | N/A | Solder reflow |
| 1825 | 4564 | 4.60 (0.181) ±0.40 (0.016) | 6.40 (0.252) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | only |
| 2220 | 5650 | 5.90 (0.232) ±0.75 (0.030) | 5.00 (0.197) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | |
| 2225 | 5664 | 5.90 (0.232) ±0.75 (0.030) | 6.40 (0.248) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | |

¹ For capacitance values \geq 0.56 µF add 0.03 (0.001) to length tolerance dimension with exception on capacitance value 0.22 µF 50V add 0.08 (0.003) to length tolerance dimension.

² For capacitance values 1.0 μ F or ≥ 2.2 μ F add 0.05 (0.002) to length tolerance dimension.



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±15% |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| ² Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | See Dissipation Factor Limit table |
| ⁴ Insulation Resistance (IR) Minimum Limit at 25°C | See Insulation Resistance Limit table (Rated voltage applied for 120 ±5 seconds at 25°C) |

¹ Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 48 or 1,000 hours. Please refer to a part number specific datasheet for referee time details

²DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

³ Capacitance and dissipation factor (DF) measured under the following conditions:

1 kHz ± 50 Hz and 1.0 ± 0.2 $V_{\rm rms}$ if capacitance \leq 10 μF

120 Hz ± 10 Hz and 0.5 ± 0.1 V_{rms} if capacitance > 10 μ F

⁴ To obtain IR limit, divide $M\Omega - \mu F$ value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."



Insulation Resistance Limit Table

| EIA Case Size | Rated DC Voltage | 1,000 megohm microfarads or 100 GΩ | 500 megohm microfarads or 10 GΩ | 100 megohm microfarads or 10 GΩ |
|---------------|------------------|---------------------------------------|------------------------------------|------------------------------------|
| 0602 | ≤ 200 V | < 0.047 µF | ≥ 0.047 µf < 0.47 µf | ≥ 0.47 µf |
| 0003 | 250 V | N/A | N/A | ALL |
| 00051 | ≤ 200 V | < 0.15 µF | ≥ 0.15 µF < 2.2 µf | ≥ 2.2 µf |
| 0805 | 250 V | < .027 µF | N/A | ≥ .027 µF |
| 1000 | ≤ 200 V | < 0.47 µF | ≥ 0.47 µF < 2.2 µf | ≥ 2.2 µf |
| 1200 | 250 V | < 0.12 µF | N/A | ≥ 0.12 µF |
| 10102 | ≤ 200 V | < 0.39 µF | ≥ 0.39 µF < 10 µf | ≥ 10 µf |
| 1210- | 250 V | < 0.27 µF | N/A | ≥ 0.27 µF |
| 1805 | ALL | ALL | N/A | N/A |
| 1808 | ALL | ALL | N/A | N/A |
| 1812 | ALL | < 2.2 µF | ≥ 2.2 µF | N/A |
| 1825 | ALL | ALL | N/A | N/A |
| 2220 | ALL | < 10 µF | ≥ 10 µF | N/A |
| 2225 | ALL | ALL | N/A | N/A |

¹ For Capacitance value 1.0 μF (50 V) IR should be calculated under 100 megohm microfarads or 10 GΩ. ² For Capacitance value 4.7 μF (50 V) IR should be calculated under 100 megohm microfarads or 10 GΩ.

Dissipation Factor (DF) Limit Table

| EIA Case Size | Rated DC Voltage | Capacitance | Dissipation Factor (Maximum %) | EIA Case Size | Rated DC Voltage | Capacitance | Dissipation Factor (Maximum %) |
|-------------------|---------------------|-------------|--------------------------------------|-------------------|---------------------|-------------|--------------------------------------|
| | < 16 | | 5.0 | | < 16 | All | 5.0 |
| 06.021 | 16/25 | < 1.0 µF | 3.5 | 1206 ³ | 16/25 | All | 3.5 |
| 0003 | > 25 | | 2.5 | | > 25 | All | 2.5 |
| | All | ≥ 1.0 µF | 10.0 | | < 16 | All | 5.0 |
| | . 16 | < 4.7 µF | 5.0 | | 16 | All | 3.5 |
| | < 10 | ≥ 4.7 µF | 10.0 | | 25 | < 10 µF | 3.5 |
| | 10 | < 4.7 µF | 3.5 | 1210 ⁴ | 25 | ≥ 10 µF | 10.0 |
| | 10 | ≥ 4.7 µF | 10.0 | | > 25 | All | 2.5 |
| 0805 ² | 0.5 | < 2.2 µF | 3.5 | | 50 | All | 2.5 |
| | 25 | ≥ 2.2 µF | 10.0 | | > 50 | All | 2.5 |
| | | <1.0 µF | 2.5 | | < 16 | All | 5.0 |
| | > 25 | . 1.0 | 10.0 | 1808 - 2225 | 16/25 | All | 3.5 |
| | | ≥ 1.0 µF | 10.0 | | > 25 | All | 2.5 |

¹ For Capacitance values 0.22 μ F (16 and 25 Volts) DF is 5% and for Capacitance value 4.7 μ F (25 V) DF is 3.5%.

 2 For Capacitance values 2.2 μF (6.3, 10, and 16 Volts) DF is 10%.

 3 For Capacitance values 4.7 and 10 μF (All Voltages) and 2.2 μF (25 and 50 Volts) DF is 10%.

⁴ For Capacitance values \geq 10 μ F (\leq 16 V) DF is 10% and for Capacitance value 4.7 μ F (50 V) DF is 5%



Post Environmental Limits

| High | Temperature | Life, Biased | Humidity, Mo | oisture Resis | tance |
|-------------------|---------------------|--------------|--------------------------------------|----------------------|--------------------------|
| EIA Case Size | Rated DC Voltage | Capacitance | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance |
| | < 16 | | 7.5 | | |
| 06021 | 16/25 | < 1.0 µF | 5.0 | | |
| 0003 | > 25 | | 3.0 | | |
| | All | ≥ 1.0 µF | 20.0 | | |
| | × 16 | < 4.7 µF | 7.5 | | |
| | < 10 | ≥ 4.7 µF | 20.0 | | |
| 0805² | 16 | < 4.7 µF | 5.0 | | |
| | 10 | ≥ 4.7 µF | 20.0 | | |
| | 25 | < 2.2 µF | 5.0 | | |
| | 25 | ≥ 2.2 µF | 20.0 | | |
| | > 0 € | < 1.0 µF | 3.0 | | |
| | > 25 | ≥ 1.0 µF | 20.0 | | |
| | < 16 | All | 7.5 | ±20% | 10% of Initial limit |
| 1206 ³ | 16/25 | All | 5.0 | | |
| | > 25 | All | 3.0 | | |
| | < 16 | All | 7.5 | | |
| | 16 | All | 5.0 | | |
| | 25 | < 10µF | 5.0 | | |
| 1210 ^₄ | 25 | ≥ 10µF | 20.0 | | |
| | > 25 | All | 3.0 | | |
| | 50 | All | 3.0 | | |
| | > 50 | All | 3.0 | | |
| | < 16 | All | 7.5 | | |
| 1808 - 2225 | 16/25 | All | 5.0 | | |
| | > 25 | All | 3.0 | | |

¹ For Capacitance values 0.22 μF (16 and 25 V) DF is 7.5%.

 2 For Capacitance values 2.2 μF (6.3, 10, and 16 V) DF is 20%.

 3 For Capacitance values 4.7 and 10 μF (All Voltages) and 2.2 μF (25 and 50 V) DF is 20%.

⁴ For Capacitance values \geq 10 μ F (\leq 16 V) DF is 20% and for Capacitance value 4.7 μ F (50 V) DF is 7.5%



Table 1A – Capacitance Range/Selection Waterfall (0603 – 1210 Case Sizes)

| | | Cas S | se S Serie | ize/ es | | | C | :06 | 03 | x | | | | | C | :08 | 05) | X | | | C1206X | | | | | | | | | | (| C12 | 10) | (| | |
|-----------|------------|---|-----------------|------------|----------|----|----------|-----|-----|----------|-------|------|------------|-------|------|-----|------|-----|----------|-----|-----------------|-------|-------|--------|-------|-------|------|------|----------|-----|------|-----|-----|-----|-----|-----|
| Can | Сар | Voli | tage C | Code | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A |
| | Code | Rate | ed Vol (VDC) | tage) | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 |
| | | Cap | Toler | ance | | | | | F | rod | uct / | Avai | ' labil | ity a | nd C | hip | Thic | kne | ss C | ode | s – S | see 1 | Fable | e 2 fe | or Cl | hip T | hicl | knes | s Di | men | sion | s | | | | |
| 180 pF | 181 | J | K | М | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | DR | DR | | | | | | | | | | | | | | | | |
| 220 pF | 221 | J | К | М | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | DR | DR | | | | | | | | | | | | | | | | |
| 270 pF | 271 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | DR | DR | | | | | | | | | | | | | | | | |
| 330 pF | 331 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | DR | DR | | | | | | | | | | | | | | | | |
| 390 pF | 391 | J | K | М | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | DR | DR | | | | | | | | | | | | | | | | |
| 470 pF | 471 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | DR | DR | | | | | | | | | | | | | | | | |
| 560 pF | 561 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | DR | DR | | | | | | | | | | | | | | | | |
| 680 pF | 681 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | DR | DR | | | | | | | | | | | | | | | | |
| 820 pF | 821 | J | K | М | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | DR | DR | | | | | | | | | | | | | | | | |
| 1,000 pF | 102 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | | | | | | | | |
| 1,200 pF | 122 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | | | | | | | | |
| 1,500 pF | 152 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | | | | | | | | |
| 1,800 pF | 182 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | | | | | | | | |
| 2,200 pF | 222 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN |
| 2,700 pF | 2/2 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN |
| 3,300 pF | 332 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN |
| 3,900 pF | 392 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN |
| 4,/00 p⊦ | 4/2 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN |
| 5,600 pF | 562 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN |
| 6,800 pF | 682 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN |
| 8,200 pF | 822 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN |
| 10,000 pF | 103 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN |
| 12,000 pF | 123 | J | K | IVI | | CJ | UJ | CJ | UJ | CJ | | | DR | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FN | FN |
| 15,000 pF | 100 | J | K | IVI M | | CJ | UJ CJ | CJ | CJ | CJ | | | | DR | DR | DK | DR | עע | DK | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | | FN | FN | FN | FN | | FN | FN |
| 18,000 pF | 183 | J | K | IVI | UJ CJ | CJ | CJ | CJ | CJ | C J | | | DR | DR | DR | DR | DR | DD | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | FN | FN | FN | FN | FN | FN | FIN | FN |
| 22,000 pF | 223 | J | r v | | | CJ | CJ | CJ | CJ | | | | | | | חח | | סט | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | | | | | | | | |
| 27,000 pF | 2/3 | J | N N | | | CJ | CJ | CJ | CJ | | | | | | | | | סט | D2 | | EQ | EQ | EQ | EQ | EQ | EQ | EQ | EQ | | | | | | | | |
| 20,000 pF | 202 | J | | | | 01 | CJ | CJ | CJ | CJ | | | | | | | | | DS | | | EQ | EQ | EQ | EQ | | EQ | EQ | | | | | | | | |
| 47 000 pF | 393 172 | J | L K | M | | | 0.0 | CJ | | | | | | אט | חם | אט | חח | סט | DO DO | | | | | EQ | EQ | FD | FC | FC | | | | | | | FO | FO |
| 47,000 pr | 4/3 | Rate | ed Vol | tage | <u></u> | | | | 0.0 | 0 | 0 | 0 | 6 | | 10 | 10 | | 0 | 0 | 0 | | | | 10 | | 0 | 0 | 0 | m | | | | | 0 | 0 | 0 |
| | Can | (VDC) 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 | | | | | 25 | ف | Ĭ | ۳ | 25 | 5(| 10 | 20 | 25 | ق | Ĭ | Ĩ | 25 | 5(| 9 | 20 | 25 | ف | Ĭ | Ĕ | 25 | 5(| 10 | 20 | 25 | | | | | |
| Cap | Code | Voli | tage C | Code | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | A 9 8 4 3 5 1 2 | | | | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | | | |
| | | Ca | se Si Serie | ze/ s | | | | C06 | 03X | | | | | | | C08 | 05X | | | | C1206X | | | | | | | | C12 | 10X | | | | | | |



Table 1A - Capacitance Range/Selection Waterfall (0603 - 1210 Case Sizes) cont.

| | | Ca | se S Serie | ize/ es | | | (| C06 | 03 | x | | | | | 0 | :08 | 05) | ĸ | | | C1206X | | | | | | | | (| C12 | 10) | (| | | | |
|-----------|------|--------------------------------|----------------------|------------|-----|-----|-----|-----|-----|------|-------|------|------|-------|------|------------|------|-----|------|-----|--------|-------|-------|--------|-------|-------|-----------|------|-------------|-----|------|-----|-----------|-----|-----|-----|
| Cap | Сар | Vol | tage C | Code | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A |
| | Code | Rat | ed Vol (VDC | tage) | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 |
| | | Cap | Toler | ance | | | 1 | | F | Prod | uct / | Avai | abil | itv a | nd C | ; hip | Thic | kne | ss C | ode | s – S | See 1 | Table | e 2 fe | or Cl | hip T | ' hicl | knes | s Di | men | sion | S | | | | |
| 56 000 nF | 563 | | K | М | C.I | C.I | C.I | C.I | C.I | | | | חח | חח | חח | חח | חח | DS | DG | DG | FO | FO | FO | FO | FO | FO | ES | ES | FN | FN | FN | FN | FN | FN | FO | FO |
| 68 000 pF | 683 | J | K | M | C.J | CJ | CJ | CJ | CJ | | | | סס | DD | DD | DD | DD | DS | DG | DG | FO | FO | FO | FO | FO | FO | FS | FS | FN | FN | FN | FN | FN | FN | FO | FO |
| 82 000 pF | 823 | J | ĸ | M | C.J | CJ | CJ | CJ | CJ | | | | סס | DD | DD | DD | DD | DS | 20 | 00 | FO | FO | FO | FO | FO | FO | FS | FS | FN | FN | FN | FN | FN | FO | FA | FA |
| 0 10 µF | 104 | J | ĸ | M | C.J | CJ | CJ | CJ | CJ | | | | DR | DR | DR | DR | DR | DS | | | FO | FO | FO | FO | FO | FO | FM | FM | FN | FN | FN | FN | FN | FX | F7 | F7 |
| 0.12 µF | 124 | Ĵ | ĸ | M | C.J | CJ | CJ | CJ | CJ | | | | DR | DR | DR | DR | DD | DG | | | FR | FR | FR | FR | FR | FR | FU | FM | FN | FN | FN | FN | FN | FX | FU | FU |
| 0.15 µF | 154 | J | K | M | CJ | CJ | CJ | CJ | CJ | | _ | _ | DR | DR | DR | DR | DD | DG | | | FR | FR | FR | FR | FR | FR | FU | FH | FO | FO | FO | FO | FO | FX | FM | FM |
| 0.18 µF | 184 | Ĵ | ĸ | м | CJ | CJ | CJ | CJ | | | | | DR | DR | DR | DR | DD | DG | | | ER | ER | ER | ER | ER | ER | EM | EM | FO | FO | FO | FO | FO | FX | FK | FK |
| 0.22 µF | 224 | J | ĸ | M | CJ | CJ | CJ | CJ | CJ | | | | DR | DR | DR | DR | DD | DG | | | ER | ER | ER | ER | ER | ER | EH | EH | FO | FO | FO | FO | FO | FX | FK | FK |
| 0.27 uF | 274 | J | K | M | СJ | CJ | CJ | | | | | | DD | DD | DD | DD | DD | | | | EO | EO | EO | EO | ER | EM | | | FO | FO | FO | FO | FO | FX | FP | FP |
| 0.33 uF | 334 | Ĵ | ĸ | M | СJ | CJ | CJ | | | | | | DD | DD | DD | DD | DD | | | | EO | EO | EO | EO | ER | EU | | | FX | FX | FX | FX | FX | FX | FM | FM |
| 0.39 µF | 394 | J | K | M | CJ | CJ | CJ | | | | | | DG | DG | DG | DG | DS | | | | EO | EO | EO | EO | ER | EU | | | FX | FX | FX | FX | FX | FX | FK | FK |
| 0.47 uF | 474 | J | K | M | CJ | CJ | CJ | CJ | | | | | DD | DD | DD | DD | DS | | | | ER | ER | ER | ER | ER | EU | | | FX | FX | FX | FX | FX | FX | FS | FS |
| 0.56 µF | 564 | Ĵ | K | M | | | | | | | | | DD | DD | DD | DG | DH | | | | ES | ES | ES | ES | ER | EM | | | FX | FX | FX | FX | FX | FA | | |
| 0.68 µF | 684 | J | K | M | 1 | | | | | | | | DD | DD | DD | DG | DH | | | | ET | ET | ET | ET | ES | EM | | | FX | FX | FX | FX | FX | FZ | | |
| 0.82 µF | 824 | J | K | M | 1 | | | | | | | | DD | DD | DD | DG | | | | | EF | EF | EF | EF | ES | EH | | | FA | FA | FA | FA | FA | FL | | |
| 10 uF | 105 | J | K | M | сJ | сJ | CJ | | | | _ | _ | סס | DD | DD | DG | DH | | | | FF. | EF. | EF. | EU | FS | FH | | | FU | FU | FU | FU | FU | FM | | |
| 12 µF | 125 | Ĵ | ĸ | M | | | 00 | | | | | | DS | DS | DS | 20 | | | | | FS. | FS | FS | FU | FH | | | | FU | FU | FU | FU | . 0 F7 | FH | | |
| 1.5 µF | 155 | Ĵ | ĸ | M | | | | | | | | | DG | DG | DG | | | | | | FS | FS | FS | FU | FH | | | | FU | FU | FU | FU | F7 | FM | | |
| 1.8 µF | 185 | J | K | M | | | | | | | | | DG | DG | DG | | | | | | ES | ES | ES | EF | EH | | | | FU | FU | FU | FU | FZ | FJ | | |
| 2.2 µF | 225 | Ĵ | ĸ | M | | | | | | | | | DG | DG | DG | DG | рт | | | | FA | FA | FA | EH | FH | | | | F.J | FJ | F.J | F.J | F7 | FK | | |
| 2.7 µF | 275 | J | K | M | | | | | | | | | | | | | | | | | FN | FN | FN | FH | | | | | FF | FF | FF | F7 | FU | | | |
| 3.3 uF | 335 | Ĵ | ĸ | M | | | | | | | | | | | | | | | | | FS | FS | FS | FH | | | | | FA | FA | FA | FM | FM | | | |
| 39 uF | 395 | Ĵ | ĸ | M | | | | | | | | | | | | | | | | | FF | FF | FF | FH | | | | | F7 | F7 | F7 | F7 | FK | | | |
| 47 uF | 475 | Ĵ | ĸ | M | | | | | | | | | DΗ | рн | DH | DH | | | | | FA | FA | FA | FA | FA | | | | FO | FO | FO | F7 | FS | | | |
| 5.6 µF | 565 | Ĵ | ĸ | M | | | | | | | | | | 5 | 5 | | | | | | FH | FH | FH | | | | | | FA | FA | FA | FU | | | | |
| 6.8 µF | 685 | J | K | M | | | | | | | _ | _ | | _ | _ | _ | | | | | FH | FH | FH | | | _ | | | F7 | F7 | F7 | FM | | | | |
| 8.2 µF | 825 | J | K | M | | | | | | | | | | | | | | | | | EH | EH | EH | | | | | | FU | FU | FU | FK | | | | |
| 10 uF | 106 | J | ĸ | M | | | | | | | | | DH | DH | | | | | | | EA | EA | EA | EA | | | | | FS | FS | FS | FS | | | | |
| 22 uF | 226 | J | K | M | | | | | | | | | [| | | | | | | | | | | | | | | | FS | FS | | | | | | |
| | | Rat | ed Vol | tage | e. | • | 9 | 2 | • | 8 | 8 | 20 | m. | 0 | 9 | 2 | | 8 | 8 | 20 | m. | • | 9 | 2 | | 8 | 8 | 20 | m. | • | 9 | 2 | 0 | 8 | 0 | ß |
| | Can | | 5 5 7 2 7 7 7 9 (OV) | | | | | 5 | ٩ | - | - | 7 | 2 | 1 | 3 | 5 | 9 | - | - | 2 | 2 | = | 5 | 5 | 9 | - | - | 7 | 2 | 7 | 21 | 5 | | | | |
| Cap | Code | e Voltage Code 9 8 4 3 5 1 2 A | | | | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | | | | | | |
| | | Ca | ise Si Serie | ze/ s | | | | C06 | 03X | | | | | | | C08 | 05X | | | | C1206X | | | | | | | C12 | 1 0X | | | | | | | |



Table 1B – Capacitance Range/Selection Waterfall (1808 – 2225 Case Sizes)

| | | Cas S | se S Serie | ize/ es | | C18 | 08X | | | C | 1812 | X | | | C18 | 25X | | C2220X | | | | | C22 | 25X | | |
|------------------|------|----------|----------------|------------|------------------|-----|-----|------|--------|--------|---------|--------|------------|-------|------|---------------|--------|---------|--------|-------|--------|-------|-------|-----|-----|-----|
| Сар | Cap | Volt | tage (| Code | 5 | 1 | 2 | A | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A |
| | Code | Rate | ed Vol (VDC | ltage) | 50 | 100 | 200 | 250 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 |
| | | Cap | Toler | ance | | 1 | | Prod | uct Av | ailabi | lity an | d Chip |) Thicl | kness | Code | s – Se | e Tabl | e 2 foi | r Chip | Thick | ness l | Dimen | sions | | | |
| 4,700 pF | 472 | J | K | М | LD | LD | LD | | | | - | | | | | | | | | | | | | | | |
| 5,600 pF | 562 | J | К | M | LD | LD | LD | | | | | | | | | | | | | | | | | | | |
| 6,800 pF | 682 | J | K | M | LD | LD | LD | | GB | GB | GB | GB | GB | | | | | | | | | | | | | |
| 8,200 pF | 822 | J | K | M | LD | LD | LD | | GB | GB | GB | GB | GB | | | | | | | | | | | | | |
| 10,000 pF | 103 | J | K | M | LD | LD | LD | | GB | GB | GB | GB | GB | | | | | | | | | | | | | |
| 12,000 pF | 123 | J | K | M | LD | LD | LD | | GB | GB | GB | GB | GB | | | | | | | | | | | | | |
| 15,000 pF | 153 | J | K | M | LD | LD | LD | | GB | GB | GB | GB | GB | | | | | | | | | | | | | |
| 18,000 pF | 183 | J | K | M | LD | LD | LD | | GB | GB | GB | GB | GB | | | | | | | | | | | | | |
| 22,000 pF | 223 | J | K | M | | | | | GB | GB | GB | GB | GB | НВ | HB | HB | HB | | | | | | | | | |
| 27,000 pF | 2/3 | J | ĸ | M | | | | | GB | GB | GB | GB | GB | НВ | НВ | НВ | НВ | | | | | | | | | |
| 30,000 pF | 303 | J | ĸ | M | | | | | GB | GB | GB | GB | GB | НВ | HR | HR | HB | | | | | | | | | |
| 47.000 pT | 473 | J | ĸ | M | | | | | GB | GB | GB | GB | GB | HR | HR | HR | HR | | | | | | | | | |
| 56 000 pF | 563 | J | ĸ | M | | | | | GB | GB | GB | GB | GB | HB | HB | HB | HB | | | | | | | | | |
| 68 000 pF | 683 | J | ĸ | M | | | | | GB | GB | GB | GB | GB | HB | HB | HB | HB | | | | | | | | | |
| 82.000 pF | 823 | J | K | M | LD | | | | GB | GB | GB | GB | GB | НВ | HB | HB | HB | JC | JC | JC | JC | JC | | | | |
| 0.10 µF | 104 | Ĵ | к | м | LD | | | | GB | GB | GB | GB | GB | НВ | НВ | НВ | НВ | JC | JC | JC | JC | JC | кс | KC | кс | кс |
| 0.12 µF | 124 | J | к | м | LD | | | | GB | GB | GB | GB | GB | НВ | НВ | НВ | НВ | JC | JC | JC | JC | JC | кс | KC | KC | кс |
| 0.15 µF | 154 | J | к | м | LD | | | | GB | GB | GB | GE | GE | НВ | HB | HB | НВ | JC | JC | JC | JC | JC | КС | KC | KC | кс |
| 0.18 µF | 184 | J | К | М | LD | | | | GB | GB | GB | GF | GG | HB | HB | HB | HB | JC | JC | JC | JC | JC | KC | KC | KC | KC |
| 0.22 µF | 224 | J | K | М | | | | | GB | GB | GB | GG | GG | HB | HB | HB | HB | JC | JC | JC | JC | JC | KC | KC | KC | KC |
| 0.27 µF | 274 | J | K | M | | | | | GB | GB | GG | GG | GG | HB | HB | HB | HB | JC | JC | JC | JC | JC | KB | KC | KC | KC |
| 0.33 µF | 334 | J | K | M | | | | | GB | GB | GG | GG | GG | HB | HB | HB | HB | JC | JC | JC | JC | JC | KB | KC | KC | KC |
| 0.39 µF | 394 | J | K | M | | | | | GB | GB | GG | GG | GG | HB | HB | HD | HD | JC | JC | JC | JC | JC | KB | KC | KC | KC |
| 0.47 µF | 474 | J | K | M | | | | | GB | GB | GG | GJ | GJ | HB | HB | HD | HD | JC | JC | JC | JC | JC | KB | KC | KD | KD |
| 0.56 µF | 564 | J | K | M | | | | | GC | GC | GG | | | HB | HD | HD | HD | JC | JC | JC | JD | JD | KB | KC | KD | KD |
| 0.68 µF | 684 | J | K | M | | | | | GC | GC | GG | | | НВ | HD | HD | HD | JC | JC | JD | JD | JD | KB | KC | KD | KD |
| 0.82µ⊦ | 824 | J | K | M | | | | | GE | GE | GG | | | НВ | HF | HF | HF | JC | JC | JF | JF | JF | KB | KC | KE | KE |
| 1.0μF | 105 | J | K | M | | | | | GE | GE | GG | | | НВ | HF | HF | HF | JC | JC | JF | JF | J⊦ | KB | KD | KE | KE |
| 1.2 μF | 125 | J | ĸ | M | | | | | GB | GB | GB | | | НВ | | | | JC | JC | | | | KB | KE | KE | KE |
| 1.5 µr 1.8 µF | 185 | J | ĸ | M | | | | | GE | GE | GE | | | но | | | | | | | | | | | | |
| 1.0 μF 2.2 μF | 225 | | K | M | | | | | GG | GG | GG | | | HE | | | | IF | IF | | | | KD | | | |
| 2.2 μι 2 7 μF | 275 | .1 | ĸ | M | | | | | GL | G.I | G.I | | | | | | | 51 | 51 | | | | ND | | | |
| 3.3 µF | 335 | J | ĸ | M | | | | | GI | GI | GI | | | | | | | | | | | | | | | |
| 4.7 µF | 475 | J | ĸ | M | | | | | GK | GK | | | | | | | | | | | | | | | | |
| 10 µF | 106 | Ĵ | ĸ | M | | | | | GK | | | | | | | | | JF | JO | | | | | | | |
| 15 µF | 156 | J | К | М | | | | | | | | | | | | | | JO | | | | | | | | |
| 22 µF | 226 | J | K | M | | | | | | | | | | | | | | JO | | | | | | | | |
| | | Rate | ed Vo (VDC | ltage) | age 250 2200 250 | | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | | |
| Сар | Cap | Volt | tage (| Code | 5 | 1 | 2 | Α | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 A 3 5 1 2 A | | 5 | 1 | 2 | A | | | | | |
| - | Coue | Ca | se Si Serie | ze/ s | | C18 | 08X | | | C | :1812 | x | | | C18 | 25X | | C2220X | | | | | C22 | 25X | | |



Table 2 - Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic | Quantity |
|-----------|-------------------|-------------------------------|---------|----------------------|---------|----------|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| CJ | 0603 | 0.80 ±0.15* | 4,000 | 15,000 | 0 | 0 |
| DR | 0805 | 0.78 ±0.20 | 0 | 0 | 4,000 | 10,000 |
| DD | 0805 | 0.90 ±0.10 | 0 | 0 | 4,000 | 10,000 |
| DS | 0805 | 1.00 ±0.20 | 0 | 0 | 2,500 | 10,000 |
| DG | 0805 | 1.25 ±0.15 | 0 | 0 | 2,500 | 10,000 |
| | 0805 | 1.25 ±0.20 | 0 | 0 | 2,500 | 10,000 |
| | 1000 | 1.25 ± 0.25 | 0 | 0 | 2,500 | 10,000 |
| | 1200 | 0.78 ± 0.20 | 0 | 0 | 4,000 | |
| | 1200 | 0.90 ±0.20 | 0 | 0 | 4,000 | 10,000 |
| FS | 1200 | 1 00 +0 20 | 0 | 0 | 2 500 | 10,000 |
| FT | 1200 | 1 10 +0 20 | 0 | 0 | 2,500 | 10,000 |
| FF | 1200 | 1 20 +0 15 | 0 | 0 | 2,500 | 10,000 |
| FM | 1206 | 1 25 +0 15 | Ő | Ő | 2,000 | 10,000 |
| FH | 1206 | 1.60 +0.20 | 0 | 0 | 2,000 | 8.000 |
| EU | 1206 | 1.60 ±0.25 | 0 | 0 | 2.000 | 8,000 |
| EA | 1206 | 1.60 ±0.35 | 0 | 0 | 2,000 | 8,000 |
| FN | 1210 | 0.78 ±0.20 | 0 | 0 | 4,000 | 10,000 |
| FQ | 1210 | 0.90 ±0.20 | 0 | 0 | 4,000 | 10,000 |
| FX | 1210 | 0.95 ±0.20 | 0 | 0 | 4,000 | 10,000 |
| FE | 1210 | 1.00 ±0.10 | 0 | 0 | 2,500 | 10,000 |
| FA | 1210 | 1.10 ±0.15 | 0 | 0 | 2,500 | 10,000 |
| FZ | 1210 | 1.25 ±0.20 | 0 | 0 | 2,500 | 10,000 |
| FL | 1210 | 1.40 ±0.15 | 0 | 0 | 2,000 | 8,000 |
| FH | 1210 | 1.55 ±0.15 | 0 | 0 | 2,000 | 8,000 |
| FU | 1210 | 1.55 ±0.20 | 0 | 0 | 2,000 | 8,000 |
| FP | 1210 | 1.60 ±0.20 | 0 | 0 | 2,000 | 8,000 |
| FM | 1210 | 1.70 ±0.20 | 0 | 0 | 2,000 | 8,000 |
| FJ | 1210 | 1.85 ±0.20 | 0 | 0 | 2,000 | 8,000 |
| FK | 1210 | 2.10 ±0.20 | 0 | 0 | 2,000 | 8,000 |
| F5 | 1210 | 2.50 ±0.30 | 0 | 0 | 1,000 | 4,000 |
| | 1000 | 0.90 ±0.10 | | 0 | 2,500 | |
| GC | 1012 | 1.00 ±0.10 | 0 | 0 | 1,000 | 4,000 |
| GC | 1012 | 1.10 ± 0.10 1 30 +0 10 | 0 | 0 | 1,000 | 4,000 |
| GE | 1812 | 1.50 ±0.10 | 0 | 0 | 1,000 | 4,000 |
| GG | 1812 | 1.55 +0.10 | ů 0 | Ő | 1,000 | 4 000 |
| GK | 1812 | 1.60 +0.20 | 0 | 0 0 | 1,000 | 4.000 |
| GJ | 1812 | 1.70 ±0.15 | 0 | 0 | 1.000 | 4.000 |
| GL | 1812 | 1.90 ±0.20 | 0 | 0 | 500 | 2,000 |
| HB | 1825 | 1.10 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| HC | 1825 | 1.15 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| HD | 1825 | 1.30 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| HF | 1825 | 1.50 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| JC | 2220 | 1.10 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| JD | 2220 | 1.30 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| JF | 2220 | 1.50 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| JO | 2220 | 2.40 ±0.15 | 0 | 0 | 500 | 2,000 |
| КВ | 2225 | 1.00 ±0.15 | | 0 | 1,000 | 4,000 |
| KC | 2225 | 1.10 ±0.15 | 0 | U | 1,000 | 4,000 |
| KD KC | 2225 | 1.30 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| KE | 2225 | 1.40 ±0.15 | 7". D | 10// D = - | 1,000 | 4,000 |
| Thickness | Case Size1 | Thickness ± Range (mm) | / Keel | IJ KEEI | / Keel | lis Keel |
| Coue | 31201 | | Paper Q | uantity' | Plastic | quantity |

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information."



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size Code | Metric Size Code | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | |
|---------------------|------------------------|--|------|------|------|--|------|------|------|---|------|------|------|------|------|------|
| | | С | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0603 | 1608 | 0.85 | 1.25 | 1.10 | 4.00 | 2.10 | 0.75 | 1.05 | 1.00 | 3.10 | 1.50 | 0.65 | 0.85 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 0.99 | 1.44 | 1.66 | 4.47 | 2.71 | 0.89 | 1.24 | 1.56 | 3.57 | 2.11 | 0.79 | 1.04 | 1.46 | 2.42 | 1.81 |
| 1206 | 3216 | 1.59 | 1.62 | 2.06 | 5.85 | 3.06 | 1.49 | 1.42 | 1.96 | 4.95 | 2.46 | 1.39 | 1.22 | 1.86 | 4.25 | 2.16 |
| 1210 | 3225 | 1.59 | 1.62 | 3.01 | 5.90 | 4.01 | 1.49 | 1.42 | 2.91 | 4.95 | 3.41 | 1.39 | 1.22 | 2.81 | 4.25 | 3.11 |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 |
| 1812 | 4532 | 2.10 | 1.80 | 3.60 | 7.00 | 4.60 | 2.00 | 1.60 | 3.50 | 6.10 | 4.00 | 1.90 | 1.40 | 3.40 | 5.40 | 3.70 |
| 1825 | 4564 | 2.15 | 1.80 | 6.90 | 7.10 | 7.90 | 2.05 | 1.60 | 6.80 | 6.20 | 7.30 | 1.95 | 1.40 | 6.70 | 5.50 | 7.00 |
| 2220 | 5650 | 2.85 | 2.10 | 5.50 | 8.80 | 6.50 | 2.75 | 1.90 | 5.40 | 7.90 | 5.90 | 2.65 | 1.70 | 5.30 | 7.20 | 5.60 |
| 2225 | 5664 | 2.85 | 2.10 | 6.90 | 8.80 | 7.90 | 2.75 | 1.90 | 6.80 | 7.90 | 7.30 | 2.65 | 1.70 | 6.70 | 7.20 | 7.00 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805, and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

The KEMET families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/ J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

T_P

T,

T_{smir}

25

Temperature T_{sma}, Maximum Ramp-up Rate = 3°C/second Maximum Ramp-down Rate = 6°C/second

25°C to Peak

Time

| Drofile Feature | Termination Finish | | | | | | |
|--|-----------------------|-----------------------|--|--|--|--|--|
| Fromereature | SnPb | 100% Matte Sn | | | | | |
| Preheat/Soak | | | | | | | |
| Temperature Minimum (T _{smin}) | 100°C | 150°C | | | | | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | | | | | |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds | | | | | |
| Ramp-Up Rate (T_L to T_p) | 3°C/second maximum | 3°C/second maximum | | | | | |
| Liquidous Temperature (T _L) | 183°C | 217°C | | | | | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | | | | | |
| Peak Temperature (T _P) | 235°C | 260°C | | | | | |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 30 seconds maximum | | | | | |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | 6°C/second maximum | | | | | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | | | | | |



Storage & Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are guite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction





Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a "K" to identify KEMET, followed by two characters (per EIA–198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the "K" character only.

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.
- X7R dielectric products in capacitance values outlined below.

| EIA Case Size | Metric Size Code | Capacitance | | | |
|---------------|------------------|-------------|--|--|--|
| 0603 | 1608 | ≤ 170 pF | | | |
| 0805 | 2012 | ≤ 150 pF | | | |
| 1206 | 3216 | ≤ 910 pF | | | |
| 1210 | 3225 | ≤ 2,000 pF | | | |
| 1808 | 4520 | ≤ 3,900 pF | | | |
| 1812 | 4532 | ≤ 6,700 pF | | | |
| 1825 | 4564 | ≤ 0.018 µF | | | |
| 2220 | 5650 | ≤ 0.027 µF | | | |
| 2225 | 5664 | ≤ 0.033 µF | | | |

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 μ F. Orientation of marking is vendor optional.





Capacitor Marking (Optional) cont.

| Capacitance (pF) For Various Alpha/Numeral Identifiers | | | | | | | | | | | | |
|--|------------------|-----|----|-----|-------|--------|---------|-----------|------------|-------------|--|--|
| Alaba | Numeral | | | | | | | | | | | |
| Alpha | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | |
| Character | Capacitance (pF) | | | | | | | | | | | |
| A | 0.10 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 | | |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 | | |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 | | |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 | | |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 | | |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 | | |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 | | |
| Н | 0.20 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 | | |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 | | |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 | | |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 | | |
| М | 0.30 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 | | |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 | | |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 | | |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 | | |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 | | |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 | | |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 | | |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 | | |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 | | |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 | | |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 | | |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 | | |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 | | |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 | | |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 | | |
| d | 0.40 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 | | |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 | | |
| f | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 | | |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 | | |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 | | |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 | | |
| у | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 | | |


Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | | Embosse | ed Plastic | Punche | d Paper |
|----------------------|------|---------|--------------------|---------|--------------------|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| | (W)* | Pitch | (P ₁)* | Pitch | (P ₁)* |
| 01005 - 0402 | 8 | | | 2 | 2 |
| 0603 | 8 | | | 2/4 | 2/4 |
| 0805 | 8 | 4 | 4 | 4 | 4 |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 |
| 1805 - 1808 | 12 | 4 | 4 | | |
| ≥ 1812 | 12 | 8 | 8 | | |
| KPS 1210 | 12 | 8 | 8 | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | |
| Array 0612 | 8 | 4 | 4 | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size. 2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 16 mm | | (0.059) | | | | (1.181) | | | |
| | Variable Dimensions — Millimeters (Inches) | | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | te 5 |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_a and B_a are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions — Millimeters (Inches) | | | | | | |
|-----------|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) |
| | Variable Dimensions – Millimeters (Inches) | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant Dimensions — Millimeters (Inches) | | | | | |
|-----------|--|---------------------------------------|--|--|--|--|
| Tape Size | А | B Minimum | C | D Minimum | | |
| 8 mm | 178 ±0.20 | | | | | |
| 12 mm | Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | |
| 16 mm | (13.000 ±0.008) | | X | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Overview

KEMET's Commercial "L" Series with Tin/Lead Termination surface mount capacitors in X5R dielectric are designed to meet the needs of critical applications where tin/lead end metallization is required. KEMET's tin/lead electroplating process is designed to meet a 5% minimum lead content and address concerns for a more robust and reliable lead containing termination system. As the bulk of the electronics industry moves towards RoHS compliance, KEMET continues to provide tin/lead terminated products for military, aerospace and industrial applications and will ensure customers have a stable and long-term source of supply.

Benefits

- -55°C to +85°C operating temperature range
- · Temperature stable dielectric

Ordering Information

- Reliable & robust termination system
- EIA 0402, 0603, 0805, 1206, and 1210 case sizes
- DC voltage ratings of 4 V, 6.3 V, 10 V, 16 V, 25 V, 35 V, and 50 V
- Capacitance offerings ranging from 12 nF to 22 μF
- Available capacitance tolerances of ±10% and ±20%
- Non-polar device, minimizing installation concerns
- SnPb plated termination finish (5% Pb minimum)
- SnPb plated termination finish option is available on other surface mount product series upon request.

KEMET's X5R dielectric features an 85°C maximum operating temperature and is considered "semi-stable." The Electronics Industries Alliance (EIA) characterizes X5R dielectric as a Class II material. Components of this classification are fixed, ceramic dielectric capacitors suited for bypass and decoupling applications or for frequency discriminating circuits where Q and stability of capacitance characteristics are not critical. X5R exhibits a predictable change in capacitance with respect to time and voltage and boasts a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to $\pm 15\%$ from -55°C to +85°C.

Applications

Typical applications include decoupling, bypass, and filtering. Markets include military, aerospace and industrial.



| C | 1210 | C | 106 | K | 4 | Р | Α | L | TU |
|---------|--------------------------------------|--------------------------|---|--------------------------|--|------------|-------------------------|------------------------------------|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ¹ | Packaging/Grade (C-Spec) |
| | 0402 0603 0805 1206 1210 | C = Standard | Two significant digits and number of zeros. | K = ±10% M = ±20% | 7 = 4 9 = 6.3 8 = 10 4 = 16 3 = 25 6 = 35 5 = 50 | P = X5R | A = N/A | L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ Additional termination finish options may be available. Contact KEMET for details.

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Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) |
|--|---|
| Bulk Bag/Unmarked | Not required (Blank) |
| 7" Reel/Unmarked | TU |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) |
| 7" Reel/Marked | ТМ |
| 13" Reel/Marked | 7040 (EIA 0603) 7215 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2mm pitch ² | 7081 |
| 13" Reel/Unmarked/2mm pitch ² | 7082 |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking".

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|---------------|---------------|-----------------|----------------|----------------------------|-----------------------|
| 0402 | 1005 | 1.00 (0.040) | 0.50 (0.020) | | 0.30 (0.012) | 0.30 | Solder Reflow |
| 0402 | 1005 | ±0.05 (0.002) | ±0.05 (0.002) | | ±0.10 (0.004) | (0.012) | Only |
| 0602 | 1600 | 1.60 (0.063) | 0.80 (0.032) | | 0.35 (0.014) | 0.70 | |
| 0003 | 1000 | ±0.15 (0.006) | ±0.15 (0.006) | | ±0.15 (0.006) | (0.028) | |
| 0005 | 2012 | 2.00 (0.079) | 1.25 (0.049) | See Table 2 for | 0.50 (0.02) | 0.75 | Solder Wave or |
| 0805 | 2012 | ±0.20 (0.008) | ±0.20 (0.008) | Thickness | ±0.25 (0.010) | (0.030) | Solder Reflow |
| 1006 | 2016 | 3.20 (0.126) | 1.60 (0.063) | | 0.50 (0.02) | | |
| 1200 | 3210 | ±0.20 (0.008) | ±0.20 (0.008) | | ±0.25 (0.010) | NI/A | |
| 1010 | 2005 | 3.20 (0.126) | 2.50 (0.098) |] | 0.50 (0.02) | IN/A | Solder Reflow |
| 1210 | 3225 | ±0.20 (0.008) | ±0.20 (0.008) | | ±0.25 (0.010) | | Only |



Qualification/Certification

Commercial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance & Reliability.

Environmental Compliance

These devices do not meet RoHS criteria due to the concentration of Lead (Pb) in the termination finish.

Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +85°C |
| Capacitance Change with Reference to +25°C and 0 Vdc Applied (TCC) | ±15% |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 5.0% |
| ² Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5±1 seconds and charge/discharge not exceeding 50mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | See Dissipation Factor Limit Table |
| ⁴Insulation Resistance (IR) Minimum Limit at 25°C | See Insulation Resistance Limit Table (Rated voltage applied for 120±5 secondss at 25°C) |

¹ Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 48 or 1,000 hours. Please refer to a part number specific datasheet for referee time details.

² DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

³ See part number specification sheet for frequency and voltage for Capacitance, Dissipation Factor, and TCC measurement conditions.

⁴ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."



Post Environmental Limits

| High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | |
|---|---------------------|----------------------|-----------------------------------|----------------------|--------------------------|--|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | |
| | > 25 | < 1.0 µF | 7.5 | | | |
| | | ≥ 1.0 µF | 20.0 | ±20% | 10% of Initial Limit | |
| X5R 25 | 05 | < 2.2 µF | 7.5 | | | |
| | 20 | ≥ 2.2 µF | 20.0 | | | |
| | . 05 | < 0.56 µF | 7.5 | | | |
| | < 25 | ≥ 0.56 µF | 20.0 | | | |

Dissipation Factor Limit Table

| Rated DC Voltage | Capacitance | Dissipation Factor (Maximum %) |
|---------------------|-------------|-----------------------------------|
| > 25 | < 1.0 µF | 5.0 |
| | ≥ 1.0 µF | 10.0 |
| 25 | < 2.2 µF | 5.0 |
| | ≥ 2.2 µF | 10.0 |
| < 25 | < 0.56 µF | 5.0 |
| | ≥ 0.56 µF | 10.0 |

Insulation Resistance Limit Table

| EIA Case Size | 1,000 Megohm Microfarads or 100 GΩ | 500 Megohm Microfarads or 10 GΩ | 100 Megohm Microfarads or 10 GΩ |
|---------------|---------------------------------------|------------------------------------|------------------------------------|
| 0201 | N/A | ALL | N/A |
| 0402 | < .012 µF | ≥ .012 µF < 1.0 µF | ≥ 1.0 µF |
| 0603 | < .047 µF | ≥ .047 µf < 1.0 µF | ≥ 1.0 µF |
| 0805 | < 0.15 µF | ≥ 0.15 µF < 1.0 µF | ≥ 1.0 µF |
| 1206 | < 0.47 µF | ≥ 0.47 µF < 1.0 µF | ≥ 1.0 µF |
| 1210 | < 0.39 µF | ≥ 0.39 µF < 1.0 µF | ≥ 1.0 µF |
| 1812 | < 2.2 µF | ≥ 2.2 µF | N/A |

4



Table 1 – Capacitance Range/Selection Waterfall (0402 – 1210 Case Sizes)

| | 0 | Case Sei | Size/ ries | | C04 | 020 | ; | (| C06 | 030 | ; | | C |)80 | 5 C | | | C12 | 060 | ; | | | C12 | 100 | ; | |
|-------------|-------------|-------------|---------------|----|-----|------|-------|-------|--------|-----|------|----------|------|------|------------|-----|------|--------|--------|-------|-------|-------|------|-------|----|----|
| Cap | Cap | Voltag | e Code | 7 | 9 | 8 | 4 | 7 | 9 | 8 | 4 | 7 | 9 | 8 | 4 | 3 | 9 | 8 | 4 | 3 | 9 | 8 | 4 | 3 | 6 | 5 |
| - up | Code | Rated Volt | age (VDC) | 4 | 6.3 | 10 | 16 | 4 | 6.3 | 10 | 16 | 4 | 6.3 | 10 | 16 | 25 | 6.3 | 10 | 16 | 25 | 6.3 | 10 | 16 | 25 | 35 | 50 |
| | | Cap To | lerance | | | Prod | uct A | vaila | bility | and | Chip | Thic | knes | s Co | des - | See | Tabl | e 2 fo | or Chi | ip Th | ickne | ess D | imen | sions | 5 | |
| 12,000 pF | 123 | K | М | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | |
| 15,000 pF | 153 | K | М | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | |
| 18,000 pF | 183 | K | М | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | |
| 22,000 pF | 223 | K | М | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | |
| 27,000 pF | 273 | K | M | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | |
| 33,000 pF | 333 | K | М | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | |
| 39,000 pF | 393 | K | М | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | |
| 47,000 pF | 473 | K | M | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | |
| 56,000 pF | 563 | K | М | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | |
| 68,000 pF | 683 | K | M | RR | BB | BB | BB | | | | | | | | | | | | | | | | | | | |
| 82,000 pF | 823 | K | M | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | |
| 0.10 µF | 104 | K | M | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | |
| 0.27 µF | 274 | K | M | | | | | CG | CG | CG | CG | | | | | | EB | EB | EB | EB | | | | | | |
| 0.33 µF | 334 | K | М | | | | | CG | CG | CG | CG | | | | | | EB | EB | EB | EB | | | | | | |
| 0.39 µF | 394 | K | М | | | | | CG | CG | CG | CG | | | | | | EB | EB | EB | EB | FD | FD | FD | FD | FD | FD |
| 0.47 µF | 474 | K | М | | | | | CG | CG | CG | CG | DN | DN | DN | DN | DN | EC | EC | EC | EC | FD | FD | FD | FD | FD | FD |
| 0.56 µF | 564 | K | М | | | | | CG | CG | CG | CG | DP | DP | DP | DP | DP | ED | ED | ED | ED | FD | FD | FD | FD | FD | FD |
| 0.68 µF | 684 | K | М | | | | | CG | CG | CG | CG | DP | DP | DP | DP | DE | EE | EE | EE | EE | FD | FD | FD | FD | FD | FD |
| 0.82 µF | 824 | K | М | | | | | CG | CG | CG | CG | DF | DF | DF | DF | DF | EF | EF | EF | EF | FF | FF | FF | FF | FF | FF |
| 1.0 µF | 105 | K | М | | | | | CG | CG | CG | CG | DG | DG | DG | DG | DG | EF | EF | EF | EH | FH | FH | FH | FH | FH | FH |
| 1.2 µF | 125 | K | М | | | | | | | | | DN | DN | DN | DN | | EC | EC | EC | EC | FD | FD | FD | FD | | |
| 1.5 μF | 155 | K | М | | | | | | | | | DN | DN | DN | DN | | EC | EC | EC | EC | FD | FD | FD | FD | | |
| 1.8 µF | 185 | K | М | | | | | | | | | DP | DP | DP | DP | | EC | EC | EC | EC | FD | FD | FD | FD | | |
| 2.2 µF | 225 | K | М | | | | | | | | | DP | DP | DP | DP | | EE | EE | EE | EE | FG | FG | FG | FG | | |
| 2.7 µF | 275 | K | М | | | | | | | | | DL | DL | DL | DL | | EF | EF | EF | EF | FG | FG | FG | FG | | |
| 3.3 µF | 335 | K | М | | | | | | | | | DE | DE | DE | DH | | EH | EH | EH | EH | FH | FH | FH | FH | FM | FM |
| 3.9 µF | 395 | K | М | | | | | | | | | DH | DH | DH | DH | | EH | EH | EH | EH | FJ | FJ | FJ | FJ | FK | FK |
| 4.7 μF | 475 | K | М | | | | | | | | | DH | DH | DH | DG | | EH | EH | EH | EH | FK | FK | FK | FE | FS | FS |
| 5.6 µF | 565 | К | М | | | | | | | | | DH | DH | DH | | | EK | EK | EH | | FG | FG | FG | FE | | |
| 6.8 µF | 685 | K | М | | | | | | | | | DH | DH | DH | | | EK | EK | EH | | FJ | FJ | FJ | FJ | | |
| 8.2 µF | 825 | K | М | | | | | | | | | | | | | | ED | ED | EH | | FK | FK | FK | FG | | |
| 10 µF | 106 | K | М | | | | | | | | | | | | | | EH | EH | EH | | FK | FK | FK | FH | | |
| 22 µF | 226 | K | М | | | | | | | | | <u> </u> | | | | | | | | | FH | FH | FJ | | | |
| | | Rated Volt | age (VDC) | 4 | 6.3 | 10 | 16 | 4 | 6.3 | 10 | 16 | 4 | 6.3 | 9 | 16 | 25 | 6.3 | 6 | 16 | 25 | 6.3 | 6 | 16 | 25 | 35 | 50 |
| Capacitance | Cap Code | Voltag | e Code | 7 | 9 | 8 | 3 | 7 | 9 | 8 | 4 | 7 | 9 | 8 | 4 | 3 | 9 | 8 | 4 | 3 | 9 | 8 | 4 | 3 | 6 | 5 |
| | | Case Siz | e/Series | | C04 | 02C | | | C06 | 03C | | | C | 0805 | iC | | | C12 | 06C | | | | C12 | 10C | | |



| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic (| Quantity |
|-----------|-------------------|-------------|---------|----------------------|-----------|----------|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| BB | 0402 | 0.50 ± 0.05 | 10,000 | 50,000 | 0 | 0 |
| CG | 0603 | 0.80 ± 0.10 | 4,000 | 15,000 | 0 | 0 |
| DN | 0805 | 0.78 ± 0.10 | 4,000 | 15,000 | 0 | 0 |
| DP | 0805 | 0.90 ± 0.10 | 4,000 | 15,000 | 0 | 0 |
| DL | 0805 | 0.95 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| DE | 0805 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| DF | 0805 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| DH | 0805 | 1.25 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| EB | 1206 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| EK | 1206 | 0.80 ± 0.10 | 0 | 0 | 2,000 | 8,000 |
| EC | 1206 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| ED | 1206 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| EE | 1206 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EH | 1206 | 1.60 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FD | 1210 | 0.95 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| FE | 1210 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FF | 1210 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FG | 1210 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| FH | 1210 | 1.55 ± 0.15 | 0 | 0 | 2,000 | 8,000 |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FJ | 1210 | 1.85 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FK | 1210 | 2.10 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1,000 | 4,000 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic | Quantity |

Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".



Table 2B – Bulk Packaging Quantities

| Dookog | ing Tune | Loose P | ackaging | | | | | | |
|----------|------------------------|------------------------|------------------------|--|--|--|--|--|--|
| Раскау | ing type | Bulk Bag (default) | | | | | | | |
| Packagii | ng C-Spec ¹ | N/A ² | | | | | | | |
| Case | e Size | Packaging Quantities (| pieces/unit packaging) | | | | | | |
| EIA (in) | Metric (mm) | Minimum | Maximum | | | | | | |
| 0402 | 1005 | | | | | | | | |
| 0603 | 1608 | | | | | | | | |
| 0805 | 2012 | | 50,000 | | | | | | |
| 1206 | 3216 | | | | | | | | |
| 1210 | 3225 | 1 | | | | | | | |
| 1808 | 4520 | | | | | | | | |
| 1812 | 4532 | | | | | | | | |
| 1825 | 4564 | | 20,000 | | | | | | |
| 2220 | 5650 | | | | | | | | |
| 2225 | 5664 | | | | | | | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial Grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive Grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.

7



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size | Metric Size | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | | | Dens Media Land Pi | sity Lev an (Noi rotrusio | vel B: minal) on (mm |) | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | |
|-------------------|----------------|--|------|------|------|------|------|--------------------------|---------------------------------|----------------------------|------|---|------|------|------|------|--|
| ooue | ooue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 | |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 | |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 | |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 | |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 | |
| 1210 ¹ | 3225 | 1.50 | 1.60 | 2.90 | 5.60 | 3.90 | 1.40 | 1.40 | 2.80 | 4.70 | 3.30 | 1.30 | 1.20 | 2.70 | 4.00 | 3.00 | |

¹ Only for capacitance values $\ge 22 \ \mu F$

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/ J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Terminati | ion Finish |
|--|-----------------------|-----------------------|
| Tomeredure | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate $(T_L to T_P)$ | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T_L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T_{p} to T_{l})$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | | Test or Inspection M | ethod | | | | | | |
|------------------------|---------------------------|--|-------------------------------|-----------------|---|--|--|--|--|--|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds. | | | | | | | | |
| Board Flex | JIS-C-6429 | Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm fo COG. Flexible termination system – 3.0 mm (minimum). | | | | | | | | |
| | | Magnification 50 X. Condition | | | | | | | | |
| | | a) Method B, 4 hours a | t 155°C, dry heat at 235°C | | | | | | | |
| Solderability | J-STD-002 | b) Method B at 215°C o | category 3 | | | | | | | |
| | | c) Method D, category | 3 at 260°C | | | | | | | |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 Cycles (-55°C to +125 | urs +/-4 hours after test con | clusion. | | | | | | |
| | MIL-STD-202 Method | Load Humidity: 1,000 hours 85°C/85% RH and rated voltage. Add 100 K ohm resistor. Measurement at 24 hours +/-4 hours after test conclusion. | | | | | | | | |
| Blased Humidity | 103 | Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours +/-4 hours after test conclusion. | | | | | | | | |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours +/-4 hours after test conclusion. | | | | | | | | |
| Thermal Shock | MIL-STD-202 Method 107 | -55°C/+125°C. Note: Number of cycles required – 300. Maximum transfer time – 20 seconds. Dwell time – 15 minutes. Air – Air. | | | | | | | | |
| | | 1,000 hours at 85°C with 2 X rated voltage applied excluding the following: | | | | | | | | |
| | | Case Size | Capacitance | Applied Voltage | | | | | | |
| | MII-STD-202 Method | 0402 | ≥ 0.22 µF | |] | | | | | |
| High Temperature Life | 108 | 0603 | ≥ 1.0 µF | | | | | | | |
| | /EIA-198 | 0805 | ≥ 4.7 µF | 1.5 X | | | | | | |
| | | 1206 | ≥ 2.2 µF | - | | | | | | |
| | | 1210 | ≥ 10 µF | - | | | | | | |
| Storage Life | MIL-STD-202 Method 108 | d 150°C, 0 VDC for 1,000 hours. | | | | | | | | |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz | | | | | | | | |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Con | dition F. | | | | | | | |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemica | l, OKEM Clean or equivalent | i. | | | | | | |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction (Typical)





Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a "K" to identify KEMET, followed by two characters (per EIA–198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the "K" character only.

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.
- X7R dielectric products in capacitance values outlined below.

| EIA Case Size | Metric Size Code | Capacitance |
|---------------|------------------|-------------|
| 0603 | 1608 | ≤ 170 pF |
| 0805 | 2012 | ≤ 150 pF |
| 1206 | 3216 | ≤ 910 pF |
| 1210 | 3225 | ≤ 2,000 pF |
| 1808 | 4520 | ≤ 3,900 pF |
| 1812 | 4532 | ≤ 6,700 pF |
| 1825 | 4564 | ≤ 0.018 µF |
| 2220 | 5650 | ≤ 0.027 µF |
| 2225 | 5664 | ≤ 0.033 µF |

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 μ F. Orientation of marking is vendor optional.





Capacitor Marking (Optional) cont.

| | Capacitance (pF) For Various Alpha/Numeral Identifiers | | | | | | | | | | | | |
|-----------|--|-----|----|-----|-------|----------|---------|-----------|------------|-------------|--|--|--|
| Alaba | | | | | | Numera | al | | | | | | |
| Alpha | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | |
| Character | | | | | Сара | acitance | e (pF) | | | | | | |
| A | 0.10 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 | | | |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 | | | |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 | | | |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 | | | |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 | | | |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 | | | |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 | | | |
| Н | 0.20 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 | | | |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 | | | |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 | | | |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 | | | |
| М | 0.30 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 | | | |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 | | | |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 | | | |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 | | | |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 | | | |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 | | | |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 | | | |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 | | | |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 | | | |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 | | | |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 | | | |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 | | | |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 | | | |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 | | | |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 | | | |
| d | 0.40 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 | | | |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 | | | |
| f | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 | | | |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 | | | |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 | | | |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 | | | |
| у | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 | | | |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punche | d Paper |
|----------------------|------|---------|------------|--------------------|----------|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| | (W)* | Pitch | Pitch | (P ₁)* | |
| 01005 - 0402 | 8 | | | 2 | 2 |
| 0603 | 8 | | | 2/4 | 2/4 |
| 0805 | 8 | 4 | 4 | 4 | 4 |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 |
| 1805 - 1808 | 12 | 4 | 4 | | |
| ≥ 1812 | 12 | 8 | 8 | | |
| KPS 1210 | 12 | 8 | 8 | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | |
| Array 0612 | 8 | 4 | 4 | | |

*Refer to Figures 1 and 2 for W and P₁ carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|--|--|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum | | | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | | |
| 16 mm | | (0.059) | | | | (1.181) | | | | | | |
| | | , | Variable Dime | ensions – Mil | limeters (Incl | nes) | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ | | | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | te 5 | | | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | | Constant [|)imensions — M | lillimeters (Inch | es) | | | | | | | | | | |
|-----------|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|--|--|--|--|--|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | | | | | | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | | | | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | | | | | | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | | | | | | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | | | | | | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant | Dimensions — Millimete | rs (Inches) | | | | |
|-----------|-----------------|---------------------------------------|--|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | |
| 8 mm | 178 ±0.20 | | | | | | |
| 12 mm | Or 220 10 20 | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | |
| 16 mm | (13.000 ±0.008) | | | | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Overview

KEMET's Automotive Grade High Voltage surface mount MLCCs in COG dielectric are temperature compensating and are suited for resonant circuit applications or those where Q and stability of capacitance characteristics are required. COG exhibits no change in capacitance with respect to time and voltage and boasts a negligible change in capacitance with reference to ambient temperature. Capacitance change is limited to ±30ppm/°C from -55°C to +125°C. Their exceptional performance at high frequencies has made COG high voltage the preferred dielectric choice of design engineers worldwide. Whether under-hood or in-cabin, these capacitors are designed to provide reliable performance in mission and safety critical automotive circuits. Stricter testing protocol and inspection criteria have been established for automotive grade products in recognition of potentially harsh environmental conditions. KEMET automotive grade series capacitors meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.

Benefits

- · AEC-Q200 automotive qualified
- Operating temperature range of -55°C to +125°C
- Capacitance offerings ranging from 1 pF to 0.15 μF
- DC voltage ratings of 500 V, 630 V, 1 KV, 1.5 KV, 2 KV, 2.5 KV and 3 KV
- EIA 0402, 0603, 0805, 1206, 1210, 1808, 1812, 1825, 2220, 2225, 2824, 3040, 3640 and 4540 case sizes
- Extremely low ESR and ESL
- High ripple current capability
- No capacitance shift with voltage
- Negligible capacitance shift with respect to temperature
- No piezoelectric noise
- Lead (Pb)-Free, RoHS and REACH compliant

Applications

- High frequency power converters
- Wide bandgap (WBG), silicon carbide (SiC) and gallium nitride (GaN) systems
- Snubber (high dV/dT)
- Resonant circuits (LLC, Wireless Charging, etc)
- Timing
- Filtering





Ordering Information

| С | 1210 | C | 332 | J | С | G | Α | С | AUTO |
|---------|--|--------------------------|---|---|---|------------|----------------------------|---------------------------------|--|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance ¹ | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ² | Packaging/Grade (C-Spec) |
| | 0402 0603 0805 1206 1210 1808 1812 1825 2220 2225 2824 3040 3640 4540 | C = Standard | Two significant digits and number of zeros. | $B = \pm 0.10 \text{ pF}$ $C = \pm 0.25 \text{ pF}$ $D = \pm 0.5 \text{ pF}$ $F = \pm 1\%$ $G = \pm 2\%$ $J = \pm 5\%$ $K = \pm 10\%$ $M = \pm 20\%$ | C = 500 B = 630 D = 1,000 F = 1,500 G = 2,000 Z = 2,500 H = 3,000 | G = COG | A = N/A | C = 100% Matte Sn | See "Packaging C-Spec Ordering Options Table" |

¹ Additional capacitance tolerance offerings may be available. Contact KEMET for details.

 $^{\rm 2}$ Additional termination finish options may be available. Contact KEMET for details.

Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) ³ |
|---|---|
| 7" Reel | AUTO |
| 13" Reel/Unmarked | AUT07411 (EIA 0603 and smaller case sizes) AUT07210 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2 mm pitch ² | 3190 |
| 13" Reel/Unmarked/2 mm pitch ² | 3191 |

¹ Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information".

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

³ All Automotive packaging C-Specs listed exclude the option to laser mark components. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking".

³ For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information."



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | Days Prior To | | | | |
|-----------------------------|----------------------------------|---------------|------------------|--|--|--|
| C-Spec | Process/Product change | Obsolescence* | Implementation | | | |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum | | | |
| AUTO | Yes (without approval) | Yes | 90 days minimum | | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | | PPAP (Product Part Approval Process) Level | | | | | | | | | | | | |
|-----------------------------|---|--|---|---|---|--|--|--|--|--|--|--|--|--|
| C-Spec | 1 | 1 2 3 | | 4 | 5 | | | | | | | | | |
| KEMET assigned ¹ | • | • | • | • | • | | | | | | | | | |
| AUTO | | | 0 | | | | | | | | | | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only

3



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|--------------------------------|--------------------------------|-----------------|-------------------------------|----------------------------|---------------------------------|
| 0402 | 1005 | 1.00 (0.040) ±0.05 (0.002) | 0.50 (0.020) ±0.05 (0.002) | _ | 0.30 (0.012) ±0.10 (0.004) | 0.30 (0.012) | Solder Reflow Only |
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | |
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave or Solder Reflow |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | | |
| 1210 | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | | |
| 1808 | 4520 | 4.70 (0.185) ±0.50 (0.020) | 2.00 (0.079) ±0.20 (0.008) | | 0.60 (0.024) ±0.35 (0.014) | | |
| 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | See Table 2 for | 0.60 (0.024) ±0.35 (0.014) | - | |
| 1825 | 4564 | 4.50 (0.177) ±0.30 (.012) | 6.40 (0.252) ±0.40 (0.016) | Thickness | 0.60 (0.024) ±0.35 (0.014) | | |
| 2220 | 5650 | 5.70 (0.224) ±0.40 (0.016) | 5.00 (0.197) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | N/A | Solder Reflow |
| 2225 | 5664 | 5.60 (0.220) ±0.40 (0.016) | 6.40 (0.248) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | Only |
| 2824 | 7260 | 7.10 (0.280) ±0.40 (0.016) | 6.10 (0.240) ±0.40 (0.016) | | 1.27 (0.050) ±0.40 (0.016) | - | |
| 3040 | 7610 | 7.60 (0.300) ±0.40 (0.016) | 10.20 (0.402) ±0.40 (0.016) | _ | 1.27 (0.050) ±0.40 (0.016) | | |
| 3640 | 9210 | 9.10 (0.358) ±0.40 (0.016) | 10.20 (0.402) ±0.40 (0.016) | | 1.27 (0.050) ±0.40 (0.016) | | |
| 4540 | - | 11.40 (0.449) ±0.40 (0.016) | 10.20 (0.402) ±0.40 (0.016) | | 1.27 (0.050) ±0.40 (0.016) | | |

4



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|--|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±30 ppm/°C |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 0% |
| ¹ Dielectric Withstanding Voltage (DWV) | See Dielectric Withstanding Voltage (DWV) Table (5 ±1 seconds and charge/discharge not exceeding 50 mA) |
| ² Dissipation Factor (DF) Maximum Limit at 25°C | 0.1% |
| ³ Insulation Resistance (IR) Limit at 25°C | 1,000 megohm microfarads or 100 GΩ (500 VDC applied for 120 ±5 seconds at 25°C) |

¹DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

² Capacitance and dissipation factor (DF) measured under the following conditions:

1 MHz ±100 kHz and 1.0 V_{rms} ±0.2 V if capacitance ≤ 1,000 pF

1 kHz ±50 Hz and 1.0 V $_{\rm rms}$ ±0.2 V if capacitance > 1,000 pF

 3 To obtain IR limit, divide M Ω - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."



Dielectric Withstanding Voltage (DWV)

| EIA Case Size | 500V | 630V | ≥ 1000V | | | | | |
|---------------|-----------------------|---|---------|--|--|--|--|--|
| 0402 | 120% of rated voltage | N/A | N/A | | | | | |
| 0603 | | 130% of rated voltage | | | | | | |
| 0805 | | < 620pF 150% of rated voltage ≥ 620pF 130% of rated voltage | | | | | | |
| 1206 | | < 5.1nF 150% of rated voltage ≥ 5.1nF 130% of rated voltage | | | | | | |
| 1210 | | < 7.5nF 150% of rated voltage ≥ 7.5nF 130% of rated voltage | | | | | | |
| 1808 | 150% of rated voltage | 50% of rated voltage > 5 1nF 130% of rated voltage | | | | | | |
| 1812 | | < 12nF 150% of rated voltage ≥ 12nF 130% of rated voltage | | | | | | |
| 1825 | | < 22nF 150% of rated voltage ≥ 22nF 130% of rated voltage | | | | | | |
| 2220 | | < 27nF 150% of rated voltage ≥ 27nF 130% of rated voltage | | | | | | |
| ±2225 | | < 33nF 150% of rated voltage ≥ 33nF 130% of rated voltage | | | | | | |

Post Environmental Limits

| | High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | | | | | | | |
|------------|---|----------------------|-----------------------------------|----------------------|--------------------------|--|--|--|--|--|--|--|--|--|--|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | | | | | | | | | | |
| COG | All | All | 0.5 | 0.3% or ±0.25 pF | 10% of Initial Limit | | | | | | | | | | |

6



Table 1A - Capacitance Range/Selection Waterfall (0603 - 1808 Case Sizes)

| | | 0 | Case Size/Series | | | | | | Se | eri | es | s | C0402C | C0603C C0805C | | | | C 1 | 120 |)6C | | | C 1 | 21 | 0C | | C1808C | | | | | | | | | | |
|----------------------|------------|---|------------------|----|----|-----|-------|--------|-----|-----|----|---|--------|---------------|-----|------|----|------------|------|------|-----|-------|------------|-------|-----------|-----|--------|-------|------|------|-----|-----|------|------|------|------|------|
| Conscitones | Сар | | | | Vo | lta | ge | Co | ode | • | | | C | C | В | | D | C | В | D | C | В | D | F | G | C | В | D | F | G | C | В | D | F | G | Z | Η |
| Capacitance | Code | L | R | at | ed | Vo | lta | ige | (V | DC |) | | 500 | 500 | 630 | | | 500 | 630 | 1000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| | | Γ | | (| Ca | pa | ci | tar | ice | 9 | | | | • | | | | F | Prod | uct | Ava | ilabi | lity | and | Chip | Thi | ckne | ess (| Code | es | | | | | | | |
| 1.0 - 9.1 pF* | 109-919* | E | : | С | D | | = 1 0 | | e. | | | ╈ | | 1 | | | | DG | DG | DG | bie | 2 101 | | | | | | ens | | | LB | LB | LB | LB | LB | LB | LB |
| 10 pF - 47pF* | 100 - 470* | | | | | F | : | G | J | K | N | 1 | | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 51 pF | 510 | L | | | | F | | G | J | K | M | 1 | | | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 50 µF 62 nE | 500 620 | L | | | | | | G C | J | ĸ | | | | | | | | | | | | ED | | | ED | FM | FM | FM | FIN | FM | | LD | | LD | | | |
| 68 pF | 680 | Г | T | | | L F | : | G | J | K | N | 4 | | | | Г | | DG | DG | DG | FD | FD | ED | ED FD | FD | FM | FM | FM | FM | FM | I B | IB | IB | IB | IB | LB | IB |
| 75 pF | 750 | L | | | | F | : | G | J | K | N | 1 | | | | | | DG | DG | DG | ED | ED | ED | ED | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 82 pF | 820 | L | | | | F | : | G | J | K | N | 1 | | | | | | DG | DG | DG | ED | ED | ED | ED | EF | FΜ | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 91 pF | 910 | L | | | | F | : | G | J | K | N | 1 | | | | | | DG | DG | DG | ED | ED | ED | ED | EF | FΜ | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 100 pF | 101 | L | 1 | | | F | - | G | J | K | N | 1 | BB | CG | CG | C | G | DG | DG | DG | ED | ED | ED | ED | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LC | LB |
| 110 pF | 111 | L | | | | F | - | G | J | K | N | 4 | BB | CG | CG | 0 | CG | DG | DG | DG | ED | ED | ED | ED | EG | FM | FM | FM | FM | FM | | LB | | LB | LB | LC | LB |
| 120 pF | 121 | L | | | | | | G | J | K | | | BB | | | | | DG | DG | DG | | ED | EU | | EG | FG | FG | FG | FM | FM | | | | | LB | | LB |
| 150 pF 150 nF | 151 | L | | | | | - | G | J | ĸ | | / | BB | | | | | | DG | | | FD | F | | EG | FG | FG | FG | FIN | FM | | | | | | | |
| 160 pF | 161 | L | | | | L F | : | G | J | K | N | Å | BB | CG | CG | | G | DG | DG | DG | ED | ED | ED | EF | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LC | LC | LC |
| 180 pF | 181 | Г | T | | | F | 1 | G | J | K | N | 1 | BB | CG | CG | C | G | DG | DG | DG | ED | ED | ED | EF | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LC | LC | LC |
| 200 pF | 201 | L | | | | F | : | G | J | K | N | 1 | BB | CG | CG | C | G | DG | DG | DG | ED | ED | ED | EF | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LC | LC | |
| 220 pF | 221 | L | | | | F | : | G | J | K | N | 1 | BB | CG | CG | C | G | DG | DG | DG | ED | ED | ED | EG | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LC | LC | |
| 240 pF | 241 | L | | | | F | | G | J | K | N | 4 | BB | CG | CG | | | DG | DG | DG | ED | ED | ED | EG | EG | FG | FG | FG | FM | FM | LA | LA | LA | LB | LC | LC | |
| 270 pF | 2/1 | Ŀ | ł | | _ | | | G | J | K | | 4 | BD | CG | CG | | | DG | DG | DG | ED | ED | ED | EG | EG | FG | FG | FG | FK | FK | LA | LA | LA | LB | LC | LC | |
| 300 µF 330 nF | 301 | L | | | | | - | G | J | ĸ | | | BD | | | | | | | | | ED | FF | EG | | FG | FG | FG | FK | FK | | | | LD | | | |
| 360 pF | 361 | L | | | | L F | : | G | J | ĸ | N | 1 | 66 | CG | CG | | | DG | DG | DN | ED | ED | EF | EG | | FG | FG | FG | FK | FS | LA | LA | LA | LB | LA | LC | |
| 390 pF | 391 | L | | | | F | : | G | J | K | N | 1 | | CG | CG | | | DG | DG | DN | ED | ED | EF | EG | | FG | FG | FG | FK | FS | LA | LA | LA | LB | LA | LC | |
| 430 pF | 431 | | | | | F | : | G | J | K | N | 1 | | CG | CG | | | DG | DG | DP | ED | ED | EF | EG | | FG | FM | FM | FS | FS | LA | LB | LB | LC | LA | | |
| 470 pF | 471 | L | | | | F | : | G | J | K | N | 1 | | CG | CG | | | DG | DG | DP | ED | ED | EG | EG | | FG | FM | FM | FS | FS | LA | LB | LB | LC | LA | | |
| 510 pF | 511 | L | | | | F | | G | J | K | N | 1 | | CG | CG | | | DG | DG | DP | ED | ED | EG | EG | | FG | FM | FM | FS | FS | LA | LB | LB | LC | LB | | |
| 560 pF | 501 | L | | | | | | G | J | K | | | | | | | | DG | DG | DG | | ED | EG | EG | | FG | FM | FM | FS | FS | | LB | | | LB | | |
| 680 nF | 681 | L | | | | | : | G | J | K | N | 1 | | CG | CG | | | DG | DG | DG | FD | FD | FG | | | FG | FM | FM | FS | FS | IB | IB | IB | | | | |
| 750 pF | 751 | h | t | | | F | : | G | J | K | N | 1 | | | | | | DG | DG | DG | ED | EF | EG | | | FG | FM | FM | FM | | LB | LB | LB | LA | | | |
| 820 pF | 821 | L | | | | F | : | G | J | K | N | 1 | | | | | | DG | DG | DG | ED | EF | EG | ; | | FG | FM | FM | FM | | LB | LB | LB | LA | | | |
| 910 pF | 911 | L | | | | F | : | G | J | K | N | 1 | | | | | | DN | DN | | ED | EF | EG | | | FM | FM | FM | FY | | LB | LB | LB | LA | | | |
| 1,000 pF | 102 | L | | | | F | | G | J | K | M | 1 | | | | | | DN | DN | | ED | EF | EG | i | | FM | FM | FM | FY | | LB | LB | LB | LB | | | |
| 1,100 pF | 112 | E | ł | | | L F | | G | J | K | N | 1 | | | | | | DN | DN | | EF | EG | ED | | | FM | FK | FK | FS | | | LC | LC | LB | | | |
| 1,200 pF | 122 | L | | | | | | G C | J | ĸ | | | | | | | | | | | | EG | | | | FM | FN | FN | 15 | | | | | | | | |
| 1,500 pF | 152 | L | | | | F | : | G | J | K | N | 1 | | | | | | DP | DP | | EF | EG | ED | | | FK | FS | FS | | | LC | LC | LC | LC | | | |
| 1,600 pF | 162 | L | | | | F | : | G | J | K | N | 1 | | | | | | DP | DP | | EF | EG | ED | | | FK | FS | FS | | | LC | LC | LC | | | | |
| 1,800 pF | 182 | | | | | F | : | G | J | K | Ν | 1 | | | | | | DG | DG | | EF | EG | EF | | | FK | FS | FS | | | LC | LC | LC | | | | |
| 2,000 pF | 202 | L | | | | F | : | G | J | K | M | 1 | | | | | | DG | DG | | EG | EB | EF | | | FK | FL | FS | | | LC | LA | LB | | | | |
| 2,200 pF | 222 | L | | | | F | | G | J | K | M | 1 | | | | | | DG | DG | | EG | EB | EF | | | FK | FL | FS | | | LC | LA | LB | | | | |
| 2,400 pF | 242 | L | | | | | | G | J | K | | | | | | | | DG | DG | | EG | EB | EG | | | FS | FL | FS | | | | | LB | | | | |
| 2,700 pF 3,000 pF | 302 | L | | | | | : | G | J | K | M | 1 | | | | | | DG | DG | | FR | FR | EG | ' | | FS | FI | FF | | | | | | | | | |
| 3,300 pF | 332 | Г | T | T | | F | | G | J | K | N | 1 | | | | Г | Т | | | | EB | EB | | | | FS | FM | FG | | | LA | LA | LA | | | | |
| 3,600 pF | 362 | L | | | | F | : | G | J | к | N | 1 | | | | | | | | | EC | EC | | | | FL | FM | FG | | | LA | LB | LA | | | | |
| 3,900 pF | 392 | L | | | | F | : | G | J | K | N | 1 | | | | | | | | | EC | EC | | | | FL | FY | FL | | | LA | LB | LA | | | | |
| 4,300 pF | 432 | | | | | F | | G | J | K | M | 1 | | | | | | | | | ED | ED | 1 | | | FM | FY | FL | | | LA | LC | LA | | | | |
| 4,700 pF | 472 | | | | | F | | G | J | K | N | 1 | | | | | | | | | ED | ED | | | | FM | FY | FM | | | LA | | LB | | | | |
| 5,600 pF | 512 | L | | | | F | : | G | J | K | N | 1 | | | | | | | | | EF | EF | | | | FY | FS | FM | | | LA | LD | LC | | | | |
| | | | R | at | ed | Vo | lta | ige | (V | DC |) | T | 500 | 500 | 630 | 0007 | | 500 | 630 | 1000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| Capacitance | Cap Code | Γ | Voltage Code | | | | Ť | C | C | В | 1 | D | C | В | D | C | В | D | F | G | C | В | D | F | G | C | В | D | F | G | Z | Н | | | | | |
| | | | (| Ca | se | Si | ize | e/S | er | ies | | T | C0402C | C | 060 | 3C | ; | C | 0805 | 5C | | C | 120 | 6C | | | C | 121 | OC | | | | С | 180 | 3C | | |

*Capacitance range Includes E24 decade values only (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91.) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions.)

These products are protected under US Patents 7,172,985 and 7,670,981, other patents pending, and any foreign counterparts.



Table 1A – Capacitance Range/Selection Waterfall (0603 – 1808 Case Sizes) cont.

| | | C | as | e S | Siz | ze, | /S | eri | ies | S | C0402C | C |)6(|)3 | C | CO | 80 | 5C | | C | 120 | 60 | } | | C | 121 | 0C | | | | C 1 | 80 | 8C | | |
|-------------|----------|---|-----|-----------|------------|-------------|------------|-----|-------|---|--------|-----|-----|------|-----|-----|------------|--------------|--------------|--------------|----------------|-------------|---------------|---------------|-------------|--------------|--------------|------|-----|-----|------------|------|-----------|------|------|
| | Сар | Г | | Vol | ltag | je (| Cod | е | | Τ | C | C | В | | D | C | В | D | C | В | D | F | G | C | В | D | F | G | С | В | D | F | G | z | н |
| Capacitance | Code | Γ | Rat | ed ' | Vol | tag | e (' | VDO | ;) | T | 500 | 500 | 630 | 0007 | 001 | 500 | 630 | 1000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| | | | | Caj To | pac ple | cita rar | inc ice | е | | | | | | | | I | Proc Se | luct e Ta | Ava ble : | ilab 2 fo | ility or Ch | and ip T | Chip hickr |) Thi Iess | ickn Dim | ess (ens | Code ions | es | | | | | | | |
| 6,200pF | 622 | Γ | | | F | G | J | K | (N | 1 | | | | | | | | | EF | EF | : | | | FY | FE | FY | | | LC | LC | LC | | | | |
| 6,800pF | 682 | | | | F | G | J | K | (N | 1 | | | | | | | | | EG | EG | 3 | | | FY | FE | FY | | | LC | LC | LC | | | | |
| 7,500pF | 752 | | | | F | G | J | K | (N | 1 | | | | | | | | | EG | EG | 3 | | | FS | FF | FS | | | LA | LA | | | | | |
| 8,200 pF | 822 | | | | F | G | J | K | (N | 1 | | 1 | | | | | | | EG | EG | 3 | | | FS | FF | FS | | | LA | LA | | | | | |
| 9,100 pF | 912 | | | | F | G | J | K | (N | 1 | | | | | | | | | EG | EG | 3 | | | FF | FF | FS | | | LA | LA | | | | | |
| 10,000 pF | 103 | | | | F | G | J | K | (N | 1 | | 1 | | | | | | | EH | EH | 1 | | | FG | FG | FS | | | LA | LA | | | | | |
| 12,000 pF | 123 | | | | F | G | J | K | (N | 1 | | 1 | | | | | | | EG | | | | | FG | FG | FM | | | LA | LA | | | | | |
| 15,000 pF | 153 | | | | F | G | J | K | (N | 1 | | | | | | | | | EG | | | | | FΜ | FM | FS | | | LB | LB | | | | | |
| 18,000 pF | 183 | | | | F | G | J | K | ĭ ∣ N | 1 | | | | | | | | | | | | | | FM | FM | FS | | | LC | LC | | | | | |
| 22,000 pF | 223 | | | | F | G | J | K | ĭ ∣ N | 1 | | | | | | | | | | | | | | FY | FY | FS | | | | | | | | | |
| 27,000 pF | 273 | | | | F | G | J | K | ĭ ∣ N | 1 | | | | | | | | | | | | | | FS | FS | | | | | | | | | | |
| 33,000 pF | 333 | | | | F | G | J | K | N | 1 | | | | | | | | | | | | | | FS | FS | | | | | | | | | | |
| | | | Rat | ed ' | Vol | tag | e (' | /DO | ;) | | 500 | 500 | 630 | 0001 | | 500 | 630 | 1000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| Capacitance | Cap Code | | | Vol | ltag | je (| Cod | е | | | C | C | В | | D | C | В | D | C | В | D | F | G | C | В | D | F | G | C | В | D | F | G | z | Н |
| | | | Ca | se | Siz | ze/ | Se | rie | s | T | C0402C | C | 060 | 30 | ; | C | 080 | 5C | | 0 | C120 | 6C | | | C | 121 | 0C | | | | C | 180 | 3C | | |

*Capacitance range Includes E24 decade values only (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91.) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions.)

These products are protected under US Patents 7,172,985 and 7,670,981, other patents pending, and any foreign counterparts.

Table 1B - Capacitance Range/Selection Waterfall (1812 - 2225 Case Sizes)

| | | | Ca | ise Se | e S erio | Siz es | e, | / | | | C | 181 | 2 C | | | | | C 1 | 82 | 5C | | | | | C2 | 222 | 0C | | | | | C2 | 222 | 5C | | |
|---------------|------------|---|------|-----------|-------------|-----------|-------|-------|-----|-----|------|------|------------|------|------|-----|-----|------------|-------|-------|-------|-------|------|-------|------|------------|------|------|------|-----|-----|------|------|------|------|------|
| Capacitance | Сар | | V | olta | ge | Co | de | | С | В | D | F | G | z | н | С | В | D | F | G | z | н | С | В | D | F | G | z | н | С | В | D | F | G | z | Н |
| | Code | R | ated | Vo | lta | ge | (VI |)C) | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| | | | C | apa | cit | and | ce | | | | | | | | | | Pr | odu | ct Av | raila | bilit | y an | d Ch | ip Tl | hick | ness | Co | les | | | | | | | | |
| | | | | Tole | era | nce | 3 | | | | | | | | | | | See | Tabl | e 2 f | or C | hip 1 | Thic | cnes | s Di | <u>men</u> | sion | S | | | | | | | | |
| 10 pF - 47pF* | 100 - 470* | | | F | • | ; . | J | | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 51 pF | 510 | | | F | • | ; . | J | | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 56 pF | 560 | | | F | 0 | j . | J | | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 62 pF | 620 | | | F | 0 | ; . | J | | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 68 pF | 680 | | | F | 0 | ; . | Jł | | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 75 pF | 750 | | | F | 0 | ; . | J P | | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 82 pF | 820 | | | F | 0 | 6 | J | | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 91 pF | 910 | | | F | 0 | 6 | J | | GD | GD | GD | GD | GD | GD | GD | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 100 pF | 101 | | | F | 0 | 6 | J | | GD | GD | GD | GD | GD | GD | GD | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 110 pF | 111 | | | F | G |) . | Jŀ | | GD | GD | GD | GD | GD | GD | GD | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 120 pF | 121 | | | F | G |) J | J | | GD | GD | GD | GD | GD | GD | GD | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 130 pF | 131 | | | F | G |) J | J | | GD | GD | GD | GD | GD | GD | GD | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 150 pF | 151 | | | F | 0 | 3 | I I | | GD | GD | GD | GD | GD | GD | GK | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 160 pF | 161 | | | F | : 0 | 3 . | 1 F | (M | GD | GD | GD | GD | GD | GD | GK | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 180 pF | 181 | | | F | : 0 | 3 | lŀ | | GD | GD | GD | GD | GD | GD | GK | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 200 pF | 201 | | | F | : (| 3 . | J | (M | GD | GD | GD | GD | GD | GD | GM | HE | HE | HE | HE | HE | HE | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| | | R | ated | Vo | Ita | ge | (VI |)C) | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| Capacitance | Cap | | V | olta | ge | Co | de | | C | B | D | F | G | z | H | C | B | D | F | G | z | H | С | B | D | F | G | Z | H | С | B | D | F | G | z | Н |
| | ooue | C | ase | e Si | ze | /Se | eri | es | | | C | 1812 | C | | | | | C | 182 | 5C | | | | | C | 2220 | C | | | | | С | 222 | 5C | | |

*Capacitance range Includes E24 decade values only (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91.) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions.) These products are protected under US Patents 7,172,985 and 7,670,981, other patents pending, and any foreign counterparts.



Table 1B – Capacitance Range/Selection Waterfall (1812 – 2225 Case Sizes) cont.

| | 0 | Case Size/ Series | | | C1 | 81 | 2C | | | | | C1 | 82 | 5C | | | | | C2 | 222 | 0C | | | | | C2 | 22 | 5C | | |
|-------------|------|--------------------------|-----|----------|----------|------|------|------|------|-----|-----|---------------|---------------|----------------|---------------|---------------|--------------|--------------|--------------|-------------|------------|----------|------|----------|----------|----------|------|------|------|-----------|
| Capacitance | Cap | Voltage Code | C | В | D | F | G | z | н | С | В | D | F | G | z | н | C | В | D | F | G | z | н | C | В | D | F | G | z | н |
| | Code | Rated Voltage (VDC) | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| | | Capacitance Tolerance | | | | | | | | | Pro | oduc See 1 | t Av Table | aila e 2 fe | bilit or C | y an hip 1 | d Ch Thic | ip T knes | hick s Di | ness men | Co sion | des s | | | , | | | | | |
| 220 pF | 221 | F G J K M | GB | GB | GB | GB | GB | GD | GM | HE | HE | HE | HE | HE | HE | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 240 pF | 241 | F G J K M | GB | GB | GB | GB | GB | GD | GM | HE | HE | HE | HE | HE | HE | HG | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 270 pF | 271 | F G J K M | GB | GB | GB | GB | GB | GH | GM | HE | HE | HE | HE | HE | HE | HG | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 300 pF | 301 | F G J K M | GB | GB | GB | GB | GB | GH | GM | HE | HE | HE | HE | HE | HE | HG | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 330 pF | 331 | FGJKM | GB | GB | GB | GB | GB | GH | GO | HE | HE | HE | HE | HE | HE | HG | JE | JE | JE | JE | JE | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 360 pF | 361 | F G J K M | GB | GB | GB | GB | GD | GK | GO | HE | HE | HE | HE | HE | HE | HG | JE | JE | JE | JE | JE | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 390 pF | 391 | FGJKM | GB | GB | GB | GB | GD | GK | GO | HE | HE | HE | HE | HE | HE | HG | JE | JE | JE | JE | JE | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 430 pF | 431 | FGJKM | GB | GB | GB | GB | GD | GK | | HE | HE | HE | HE | HE | HE | HJ | JE | JE | JE | JE | JE | JK | JE | KE | KE | KE | KE | KE | KE | KF |
| 4/0 pF | 4/1 | FGJKM | GB | GB | GB | GB | GD | GK | | HE | HE | HE | HE | HE | HE | HJ | JE | JE | JE | JE | JE | JK | JK | KF | KF | KF | KF | KE | KE | KF |
| 510 pF | 511 | FGJKM | GB | GB | GB | GD | GH | GM | | HE | HE | HE | HE | HE | HE | HJ | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KE | KE | KF |
| 560 pF | 501 | FGJKM | GB | GB | GB | GD | GH | GM | | HE | HE | HE | HE | HG | HE | HJ | JK | JK | JK | JK | JK | JK | JL | KF | KF | KF | KF | KE | KE | KF |
| 620 pF | 021 | FGJKM | GB | GB | GB | GD | GH | GM | | HE | HE | HE | HE | HG | HE | HK | JK | JK | JK | JK | JK | JK | JL | KF | | KF | KF | KE | KF | KH |
| 080 pF | 751 | FGJKM | | CP | GB | GD | GH | 60 | | | | | ПЕ | | | | JE | JE | JE | JK | | | JL | | | | | KE | | |
| 750 pF | /51 | FGJKM | GB | GB | GB | GD | GK | | | | HE | | пс | но | HG | | JE | JE | JE | JK | JK | JK | JL | NE VE | KE VE | KE | KF | KE | KF | K TI |
| 020 pF | 021 | | GD | GB | GB | GU | GM | | | | | | | | | | | JE | JE | | | | | | KE | | | KE | | KJ K I |
| 1 000 pF | 102 | FGJKM | GB | GB | GB | СH | GM | | | HE | HE | HE | HG | HG | нс | | IF | IK | IK | IK | IK | IK | | KE | KE | KE | KE | KE | KE | K I |
| 1,000 pr | 112 | F G J K M | GB | GB | GB | GH | GO | | | HE | HE | HE | HG | HG | н | | IF | IK | IK | IK | IK | IK | 514 | KE | KE | KE | KF | KE | KE | NJ |
| 1,100 pr | 12 | F G J K M | GB | GB | GB | GH | GO | | | HE | HE | HE | HG | HG | H.I | | JE | JK | JK | JK | JK | | | KF | KE | KE | KF | KF | KE | |
| 1,200 pT | 132 | F G J K M | GB | GB | GB | GH | GO | | | HF | HE | HE | HG | HF | HJ | _ | JF | JK | JK | JK | JF | JI | | KF | KF | KE | KF | KF | кн | |
| 1.500 pF | 152 | FGJKM | GB | GB | GB | GK | GO | | | HE | HE | HE | HG | HE | нк | | JE | JK | JK | JK | JE | JL | | KE | KE | KE | KF | KF | КН | |
| 1.600 pF | 162 | FGJKM | GB | GD | GD | GK | | | | HE | HG | HG | HG | HG | нк | | JE | JK | JK | JK | JE | JL | | KE | KE | KE | KF | KE | КН | |
| 1.800 pF | 182 | FGJKM | GB | GD | GD | GM | | | | HE | HG | HG | HG | HG | | | JE | JK | JK | JK | JE | JN | | KE | KE | KE | KF | KE | КН | |
| 2,000 pF | 202 | F G J K M | GB | GH | GH | GM | | | | HE | HG | HG | HE | HJ | | | JE | JK | JK | JE | JK | | | KE | KE | KE | KF | KE | KJ | |
| 2,200 pF | 222 | F G J K M | GB | GH | GH | GO | | | | HE | HG | HG | HE | HJ | | | JE | JK | JK | JE | JK | | | KE | KE | KE | KF | KF | KJ | |
| 2,400 pF | 242 | FGJKM | GB | GH | GK | GO | | | | HE | HG | HG | HE | НJ | | | JK | JK | JK | JE | JL | | | KE | KE | KE | KE | кн | | |
| 2,700 pF | 272 | F G J K M | GB | GH | GK | GO | | | | HE | HG | HG | ΗE | нк | | | JK | JK | JK | JE | JL | | | KE | KE | KE | KE | КН | | |
| 3,000 pF | 302 | F G J K M | GB | GH | GK | | | | | HG | HG | HG | ΗE | нк | | | JK | JK | JK | JE | JL | | | KE | KE | KE | KE | КН | | |
| 3,300 pF | 332 | F G J K M | GB | GH | GK | | | | | HG | HG | HG | HG | | | | JK | JK | JK | JK | JN | | | KE | KE | KE | KE | KJ | | |
| 3,600 pF | 362 | F G J K M | GB | GH | GM | | | | | HG | HG | HG | HG | | | | JK | JK | JK | JK | JN | | | KE | KF | KF | KF | KJ | | |
| 3,900 pF | 392 | F G J K M | GB | GH | GM | | | | | HG | HG | HG | HJ | | | | JK | JK | JK | JK | JN | | | KE | KF | KF | KF | KJ | | |
| 4,300 pF | 432 | F G J K M | GH | GH | GO | | | | | HG | HG | HG | HJ | | | | JK | JK | JK | JK | | | | KE | KF | KF | KF | | | |
| 4,700 pF | 472 | F G J K M | GH | GH | GO | | | | | HG | HG | HG | HJ | | | | JK | JK | JK | JL | | | | KE | KF | KF | КН | | | |
| 5,100 pF | 512 | F G J K M | GH | GK | GO | | | | | HG | HE | HG | ΗK | | | | JK | JK | JK | JL | | | | KE | KF | KF | KH | | | |
| 5,600 pF | 562 | F G J K M | GH | GK | GO | | | | | HG | HE | HG | ΗK | | | | JK | JK | JK | JN | | | | KE | KF | KF | КН | | | |
| 6,200pF | 622 | FGJKM | GH | GK | GH | | | | | HG | HE | HG | | | | | JK | JE | JE | JN | | | | KE | KF | KF | KJ | | | |
| 6,800pF | 682 | FGJKM | GH | GM | GH | | | | | HG | HE | HJ | | | | | JK | JE | JK | JN | | | | KE | KF | KF | KJ | | | |
| 7,500pF | /52 | FGJKM | GH | GM | GK | | | | | HG | HE | HJ | | | | | JK | JE | JK | | | | | KF | KE | KF | | | | |
| 8,200 pF | 822 | FGJKM | GK | GO | GK | | | | | HG | HE | HJ | | | | | JK | JE | JL | | | | | KF | KE | KF | | | | |
| 9,100 pF | 912 | | GM | 60 | GM | | | | | HE | HG | HK | | | | | JE | JE | | | | | | | KE | KH | | | | |
| 10,000 pF | 103 | | GM | 00 00 | GM CO | | | | | | по | | | | | | JE | JE | | | | | | | | KH VU | | | | |
| 12,000 pr | 123 | | 60 | C L | 60 | | | | | | по | | | | | | | | | | | | | | | K I | | | | |
| 18 000 pF | 182 | F G J K M | GH | 6H | 00 | | | | | HC | ни | HC | | | | | IF | | JE | | | | | | KH VL | KE | | | | |
| 22 000 pF | 223 | F G I K M | GH | GH | | | | | | HI | HE | HI | | | | | JK | JN | JK | | | | | KE | KI | KE | | | | |
| 27,000 pF | 273 | F G J K M | GK | GK | | | | | | н. | HE | НК | | | | | JL | JN | .11 | | | | | KF | K.I | КН | | | | |
| 33 000 pF | 333 | E G J K M | GM | GM | | | | | | НК | HE | НК | | | | | JN | JE | JN | | | | | КН | KF | КН | | | | |
| 39,000 pF | 393 | FGJKM | GO | GO | | | | | | HE | HE | | | | | | JE | JE | | | | | | КJ | KE | KJ | | | | |
| 47.000 pF | 473 | FGJKM | GO | GO | | | | | | HE | HE | | | | | | JE | JE | | | | | | KE | KE | | | | | |
| 56,000 pF | 563 | F G J K M | | | | | | | | HG | HG | | | | | | JK | JK | | | | | | KE | KE | | | | | |
| | | Rated Voltage (VDC) | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| Capacitance | Cap | Voltage Code | C | B | D | F | G | Z | H | C | B | D | F | G | Z | H | C | В | D | F | G | Z | H | C | В | D | F | G | Z | H |
| | Code | Case Size/Series | | | C | 1812 | 2C | | | | | C | 1825 | 5C | | | | | C | 2220 | DC | | | | | C | 2225 | 5C | | |

*Capacitance range Includes E24 decade values only (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91.) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions.)

These products are protected under US Patents 7,172,985 and 7,670,981, other patents pending, and any foreign counterparts.



Table 1B - Capacitance Range/Selection Waterfall (1812 - 2225 Case Sizes) cont.

| | | (| Cas S | se S Seri | Size es | e/ | | | | C 1 | 181 | 2C | | | | | C 1 | 82 | 5C | | | | | C2 | 222 | 0C | | | | | C2 | 222 | 5C | | |
|-------------|------|-----|-----------|----------------|------------|------|----|-----|-----|------------|------|------|------|------|-----|-----|------------|---------------|----------------|---------------|---------------|---------------|---------------|--------------|-------------|--------------|-----------|------|-----|-----|------|------|------|------|------|
| Capacitance | Сар | | Volt | tage | Code | е | | C | В | D | F | G | z | н | C | В | D | F | G | z | н | С | В | D | F | G | z | н | С | В | D | F | G | z | Н |
| | Code | Rat | ed V | /olta | ige (\ | VDC | ;) | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| | | | Cap To | oacit olera | ance | 9 | | | | | | | | | | Pr | odu See | ct Av Tabl | vaila e 2 f | bilit or C | y an hip 1 | d Ch Thicl | ip Tl knes | hick s Di | ness men | s Co sion | des Is | | | | | | | | |
| 68,000 pF | 683 | | | F | GJ | K | М | | | | | | | | HJ | HJ | | | | | | JL | JL | | | | | | KF | KF | | | | | |
| 82,000 pF | 823 | | | F (| GJ | K | М | | | | | | | | нк | HK | | | | | | JL | JL | | | | | | КН | КН | | | | | |
| 0.1 µF | 104 | | | F (| G J | K | м | | | | | | | | НК | НК | | | | | | JN | JN | | | | | | КН | КН | | | | | |
| 0.12 µF | 124 | | | F | GJ | K | М | | | | | | | | | | | | | | | | | | | | | | KJ | KJ | | | | | |
| | | Rat | ed V | /olta | ige (\ | VDC | ;) | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| Capacitance | Cap | | Volt | tage | Code | e | | C | В | D | F | G | z | Н | C | B | D | F | G | Z | H | C | B | D | F | G | Z | H | С | В | D | F | G | Z | Η |
| | Coue | Ca | ise (| Size | :/Ser | ries | 5 | | | C | 1812 | 20 | | | | | C | 182 | 5C | | | | | C | 222 | 0C | | | | | C | 222 | 5C | | |

*Capacitance range Includes E24 decade values only (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91.) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions.)

These products are protected under US Patents 7,172,985 and 7,670,981, other patents pending, and any foreign counterparts.

Table 1C - Capacitance Range/Selection Waterfall (2824 - 4540 Case Sizes)

| | | Ca | ise Si: Serie: | ze/ | | C | 2824 | 4C | | | C | 304(| C | | | C | 364(| C | | | C | 4540 | C | |
|-------------|------|-------|-------------------|----------|-----|-----|-----------|------|------|-----|-------|-------|---------|--------|--------------|--------|-------|-------|------|-----|-----|------|------|------|
| Canacitance | Сар | Vo | oltage Co | de | C | В | D | F | G | С | В | D | F | G | C | В | D | F | G | С | В | D | F | G |
| oupuontanoe | Code | Vo | Rated Itage (V | DC) | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 |
| | | C | apacitan | ce | | | <u>.</u> | | | P | roduc | t Ava | ilabili | ty an | d Chip |) Thic | kness | s Cod | es | | | | | |
| | | · · · | Toleranc | e | | | | | | | See T | able | 2 for (| Chip 1 | <u>hickr</u> | iess [| Dimen | sions | | | | | | |
| 2,200 pF | 222 | J | K | М | TA | TA | TA | TA | TA | | | | | | | | | | | | | | | |
| 2,700 pF | 272 | J | K | M | TA | TA | TA | TA | TA | | | | | | | | | | | | | | | |
| 3,300 pF | 332 | J | K | M | TA | TA | TA | TA | TA | QB | QB | QB | QB | QB | | | | | | | | | | |
| 3,900 pF | 392 | J | K | M | TA | TA | TA | TA | TB | QB | QB | QB | QB | QB | MA | MA | MA | MA | MA | | | | | |
| 4,700 pF | 472 | J | K | М | TA | TA | TA | TB | TB | QB | QB | QB | QB | QB | MA | MA | MA | MA | MA | SA | SA | SA | SA | SA |
| 5,600 pF | 562 | J | K | M | TA | TA | TA | TB | TC | QB | QB | QB | QB | QB | MA | MA | MA | MA | MA | SA | SA | SA | SA | SA |
| 6,800 pF | 682 | J | K | M | TA | TA | TA | TB | | QB | QB | QB | QB | QC | MA | MA | MA | MA | MA | SA | SA | SA | SA | SA |
| 8,200 pF | 822 | J | K | M | TA | TA | TA | TC | | QB | QB | QB | QC | QC | MA | MA | MA | MA | MB | SA | SA | SA | SA | SA |
| 10,000 pF | 103 | J | K | M | TA | TA | TA | | | QB | QB | QB | QC | QD | MA | MA | MA | MA | MB | SA | SA | SA | SA | SB |
| 12,000 pF | 123 | J | K | M | TA | TA | TA | | | QB | QB | QB | QD | | MA | MA | MA | MB | MB | SA | SA | SA | SA | SB |
| 15,000 pF | 153 | J | K | M | TA | TA | TB | | | QB | QB | QB | QD | | MA | MA | MA | MB | MC | SA | SA | SA | SB | SB |
| 18,000 pF | 183 | J | K | M | TA | TA | TB | | | QB | QB | QB | | | MA | MA | MA | MC | | SA | SA | SA | SB | SC |
| 22,000 pF | 223 | J | K | M | TA | TB | TC | | | QB | QB | QC | | | MA | MA | MA | | | SA | SA | SA | SB | |
| 27,000 pF | 273 | J | K | M | TA | TB | | | | QB | QB | QC | | | MA | MA | MA | | | SA | SA | SA | SC | |
| 33,000 pF | 333 | J | К | М | ТВ | TB | | | | QB | QC | QC | | | MA | MA | MB | | | SA | SA | SA | | |
| 39,000 pF | 393 | J | K | М | ТВ | TC | | | | QB | QC | QD | | | MA | MA | MB | | | SA | SA | SB | | |
| 47,000 pF | 473 | J | К | м | ТВ | | | | | QB | QC | | | | MA | MB | мс | | | SA | SA | SB | | |
| 56,000 pF | 563 | J | к | м | тс | | | | | QC | QD | | | | МА | MB | | | | SA | SA | SB | | |
| 68,000 pF | 683 | J | к | м | | | | | | QC | QD | | | | МВ | мс | | | | SA | SB | sc | | |
| 82,000 pF | 823 | J | к | м | | | | | | QC | - | | | | МВ | | | | | SA | SB | | | |
| 0.1 uF | 104 | J | К | М | | | | | | OD | | | | | мс | | | | | SB | SC | | | |
| 0.12 µF | 124 | J | к | м | | | | | | 1 | | | | | мс | | | | | SB | | | | |
| 0.15 µF | 154 | J | к | м | | | | | | | | | | | | | | | | SC | | | | |
| | | | | ()(D.O.) | • | • | 8 | 8 | 8 | • | 0 | 8 | 8 | 8 | • | • | 8 | 8 | 8 | • | • | 8 | 8 | 8 |
| | | катео | voitaĝe | | 50 | 63 | <u>10</u> | 15 | 20 | 50 | 63 | 10 | 15 | 20 | 50 | 63 | 10 | 15 | 20 | 50 | 63 | 10 | 15 | 20 |
| Capacitance | Cap | Vo | oltage Co | de | C | В | D | F | G | С | В | D | F | G | С | В | D | F | G | C | В | D | F | G |
| • | Coae | Case | e Size/S | eries | | C | 2824 | С | | | C | 3040 | С | | | C | 3640 | С | | | C | 4540 | С | |

*Capacitance range Includes E24 decade values only (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91.) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions.)

These products are protected under US Patents 7,172,985 and 7,670,981, other patents pending, and any foreign counterparts.

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| Thickness | Case | Thickness ± | Paper C |)uantity | Plastic (| Quantity |
|-----------|------|--------------|---------|----------|-----------|----------|
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| BB | 0402 | 0.50 ± 0.05 | 10000 | 50000 | 0 | 0 |
| BD | 0402 | 0.55 ± 0.05 | 10000 | 50000 | 0 | 0 |
| CG | 0603 | 0.80 ± 0.10* | 4,000 | 15,000 | 0 | 0 |
| DN | 0805 | 0.78 ± 0.10* | 4,000 | 15,000 | 0 | 0 |
| DP | 0805 | 0.90 ± 0.10* | 4,000 | 15,000 | 0 | 0 |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EB | 1206 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| EC | 1206 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| ED | 1206 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| EE | 1206 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EG | 1206 | 1.60 ± 0.15 | 0 | 0 | 2,000 | 8,000 |
| EH | 1206 | 1.60 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FE | 1210 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FF | 1210 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FG | 1210 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| FL | 1210 | 1.40 ± 0.15 | 0 | 0 | 2,000 | 8,000 |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FY | 1210 | 2.00 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FK | 1210 | 2.10 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1,000 | 4,000 |
| LA | 1808 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| LB | 1808 | 1.60 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| LC | 1808 | 2.00 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size | Range (mm) | Paper C |)uantity | Plastic | Quantity |

Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

Package quantity based on finished chip thickness specifications.


Table 2 - Chip Thickness/Tape & Reel Packaging Quantities cont.

| Thickness | Case | Thickness ± | Paper C |)uantity | Plastic | Quantity |
|-----------|------|-------------|---------|----------|---------|----------|
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GD | 1812 | 1.25 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GH | 1812 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GK | 1812 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GM | 1812 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| GO | 1812 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| HE | 1825 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| HG | 1825 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| HJ | 1825 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| HK | 1825 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| JE | 2220 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JK | 2220 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| JL | 2220 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| JN | 2220 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| KE | 2225 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| KF | 2225 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| KH | 2225 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| KJ | 2225 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| TA | 2824 | 1.40 ± 0.15 | 0 | 0 | 750 | 1,500 |
| TB | 2824 | 2.00 ± 0.20 | 0 | 0 | 300 | 1,500 |
| TC | 2824 | 2.50 ± 0.20 | 0 | 0 | 300 | 1,500 |
| QB | 3040 | 1.40 ± 0.15 | 0 | 0 | 500 | 1,000 |
| QC | 3040 | 2.00 ± 0.20 | 0 | 0 | 500 | 1,000 |
| QD | 3040 | 2.50 ± 0.20 | 0 | 0 | 350 | 1,000 |
| MA | 3640 | 1.40 ± 0.15 | 0 | 0 | 250 | 1,000 |
| MB | 3640 | 2.00 ± 0.20 | 0 | 0 | 250 | 1,000 |
| MC | 3640 | 2.50 ± 0.20 | 0 | 0 | 250 | 1,000 |
| SA | 4540 | 1.40 ± 0.15 | 0 | 0 | 200 | 1,000 |
| SB | 4540 | 2.00 ± 0.20 | 0 | 0 | 200 | 1,000 |
| SC | 4540 | 2.50 ± 0.20 | 0 | 0 | 200 | 1,000 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size | Range (mm) | Paper C |)uantity | Plastic | Quantity |

Package quantity based on finished chip thickness specifications.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size Code | Metric Size Code | I | Dens Maxi Land Pi | sity Lev mum (I rotrusio | rel A: Most) on (mm |) | I | Dens Media Land Pi | sity Lev an (Nor rotrusio | vel B: ninal) on (mm |) | | Dens Minii Land Pi | sity Lev mum (L rotrusio | vel C: .east) on (mm |) |
|---------------------|------------------------|------|-------------------------|--------------------------------|---------------------------|-------|------|--------------------------|---------------------------------|----------------------------|-------|------|--------------------------|--------------------------------|----------------------------|-------|
| oouc | ooue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 |
| 1825 | 4564 | 2.15 | 1.60 | 6.90 | 6.90 | 7.90 | 2.05 | 1.40 | 6.80 | 6.00 | 7.30 | 1.95 | 1.20 | 6.70 | 5.30 | 7.00 |
| 2220 | 5650 | 2.75 | 1.70 | 5.50 | 8.20 | 6.50 | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | 2.55 | 1.30 | 5.30 | 6.60 | 5.60 |
| 2225 | 5664 | 2.70 | 1.70 | 6.90 | 8.10 | 7.90 | 2.60 | 1.50 | 6.80 | 7.20 | 7.30 | 2.50 | 1.30 | 6.70 | 6.50 | 7.00 |
| 2824 | 7260 | 3.45 | 1.70 | 6.60 | 9.60 | 7.60 | 3.35 | 1.50 | 6.50 | 8.70 | 7.00 | 3.25 | 1.30 | 6.40 | 8.00 | 6.70 |
| 3040 | 7610 | 3.70 | 1.70 | 10.70 | 10.10 | 11.70 | 3.60 | 1.50 | 10.60 | 9.20 | 11.10 | 3.50 | 1.30 | 10.50 | 8.50 | 10.80 |
| 3640 | 9210 | 4.45 | 1.70 | 10.70 | 11.60 | 11.70 | 4.35 | 1.50 | 10.60 | 10.70 | 11.10 | 4.25 | 1.30 | 10.50 | 10.00 | 10.80 |
| 4540 | - | 5.60 | 1.70 | 10.70 | 13.90 | 11.70 | 5.50 | 1.50 | 10.60 | 13.00 | 11.10 | 5.40 | 1.30 | 10.50 | 12.30 | 10.80 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Drofile Feature | Terminat | ion Finish |
|--|-----------------------|-----------------------|
| Fromereature | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate (T_L to T_p) | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T ^L) | 183°C | 217°C |
| Time Above Liquidous (t ^L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T_p to T_L)$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |



Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction



Capacitor Marking (Optional):

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- · EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12, 16 and 24 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punche | d Paper | |
|-------------------|------|---------|--------------------|---------|--------------------|---|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | (W)* | Pitch | (P ₁)* | Pitch | (P ₁)* | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 - | _ |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| 2824 | 16 | 12 | 12 | | | |
| 3040 - 4540 | 24 | 16 | 16 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 & 2220 | 16 | 12 | 12 | | | |
| Array 0508 & 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs
- Double the parts on each reel results in fewer reel changes and increased efficiency
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | |
|-----------|--|----------------------------|----------------------------|----------------------------|---------------------------|----------------------------------|--------------------------------|------------------|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T1 Maximum |
| 8 mm | | | | | 25.0 (0.984) | | | |
| 12 mm | 1.5+0.10/-0.0 (0.059+0.004/-0.0) | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.05 (0.079±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 16 mm | | | | | (1.181) | | | |
| 24 mm | 1.5+0.10/-0.0 (0.059+0.004/-0.0) | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.10 (0.078±0.003) | 30 (1.181) | 5 (0.196) | 0.250 (0.009) | 0.350 (0.013) |
| | | Varial | ble Dimensions | s – Millimeters | (Inches) | | | |
| Tape Size | Pitch | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B ₀ | & K ₀ |
| 8 mm | Single (4 mm) | 6.25 (0.246) | 3.5±0.05 (0.138±0.002) | 4.0±0.10 (0.157±0.004) | 2.5 (0.098) | 8.3 (0.327) | | |
| 12 mm | Single (4 mm) & Double (8 mm) | 10.25 (0.404) | 5.5±0.05 (0.217±0.002) | 8.0±0.10 (0.315±0.004) | 4.6 (0.181) | 12.3 (0.484) | Not | o F |
| 16 mm | Triple (12 mm) | 14.25 (0.561) | 7.5±0.05 (0.138±0.002) | 12.0±0.10 (0.157±0.004) | 4.6 (0.181) | 16.3 (0.642) | NOU | сJ |
| 24 mm | 16 mm | 22.25 (0.875) | 11.5±0.10 (0.452±0.003) | 16.0±0.10 (0.629±0.004) | 3 (0.118) | 24.3 (0.956) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6).

3. If S₁ < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Standard 481 paragraph 4.3 section b).

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{ρ} , B_{ρ} and K_{ρ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3).

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4).

(e) for KPS Series product, A_0 and B_0 are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions — Millimeters (Inches) | | | | | | | | |
|-----------|--|----------------------------|---------------------------|---------------------------|----------------------------|-----------------|-------------------------------|--|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | |
| 8 mm | 1.5+0.10/-0.0 (0.059+0.004/-0.0) | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.05 (0.079±0.002) | 0.10 (0.004) Maximum | 0.75 (0.030) | 2 (0.984) | | |
| | | Variable D | imensions — M | illimeters (Inche | es) | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5±0.05 | 2.0±0.05 (0.079±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138±0.002) | 4.0±0.10 (0.157±0.004) | (0.098) | 8.3 (0.327) | Note 1 | | |

1. The cavity defined by $A_{o'}B_{o}$ and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3).

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4).

e) see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6).



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 Kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |
| 24 mm | 0.1 to 1.6 newton (10 to 160 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ±10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | |
|-----------|--|-------------------------------------|---------------------------------------|----------------------------|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | | |
| 8 mm | 170:0.00 | | | | | | | |
| 12 mm | (7.008 ± 0.008) | 1.5 (0.059) | 13.0+0.5/-0.2 (0.521+0.02/-0.008) | 20.2 (0.795) | | | | |
| 16 mm | or 330±0.20 | | | | | | | |
| 24 mm | (13.000±0.008) | 1.2 (0.047) | 13.0 + -0.2 (0.521 + -0.008) | 21 (0.826) | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | |
| 8 mm | | 8.4+1.5/-0.0 (0.331+0.059/-0.0) | 14.4 (0.567) | | | | | |
| 12 mm | 50 | 12.4+2.0/-0.0 (0.488+0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape | | | | |
| 16 mm | (1.969) | 16.4+2.0/-0.0 (0.646+0.078/-0.0) | 22.4 (0.882) | width without interference | | | | |
| 24 mm | | 25+1.0/-0.0 (0.984+0.039/-0.0) | 27.4+1.0/-1.0 (1.078+0.039/-0.039) | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Application Guide

Solder Fluxes and Cleaning

The use of water-soluble fluxes provides advantages of excellent solderability due to high activation. However, these fluxes contain organic acids that can induce arcing under high DC or AC voltages. Notable problem areas are underneath the MLCC where flux can be trapped between the ceramic material and PCB. It is therefore critical that PCBs are properly cleaned to remove all flux residue to maintain reliability.

Coating for High Voltage MLCCs

For MLCC ratings \geq 1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

| Dielectric | CTE (ppm/°C) |
|----------------------------|--------------|
| Class II BaTiO₃ | 10.7 |
| Class I CaZrO ₃ | 9.8 |

Slits in PCB

It is recommended to apply a slit in the PCB under the MLCC to improve washing of flux residue that may get trapped underneath. In some cases, it is not possible to slit entirely through the PCB due to underlying metal planes. It is also acceptable to apply a recessed slit under the MLCC which will also promote cleaning.

- Recommended for case sizes ≥1206
- The width (w) of the slit should be 1mm
- Length of the slit should be as short as possible to prevent damaging the MLCC due to mechanical stress of the PCB.
- Slits also reduce the risk of solder balls under MLCC which decreased the creepage distance.



Solder Resist

If a slit cannot be applied as above, it is recommended to not use solder resist directly under the MLCC. The use of solder resist material reduces the distance between MLCC ceramic material and PCB thus making it difficult to clean.

Solder Balls

Improper reflow techniques and/or improper washing can induce solder balls under or adjacent to the MLCC. Solder balls reduce the creepage distance between the MLCC terminations and increase the risk of arcing or damage to the ceramic material. To reduce the risk of solder balls:

- Follow KEMET's solder recommendations as outlined in the datasheet.
- If performing a cleaning procedure, properly clean the PCB per KEMET's cleaning recommendations.
- Add slit to the PCB as shown above.





Overview

KEMET's Automotive Grade High Voltage with Flexible Termination (HV FT-CAP) surface mount MLCCs in COG dielectric address the primary failure mode of MLCCs – flex cracks. These devices utilize a pliable and conductive silver epoxy between the base metal and nickel barrier layers of the termination system which inhibits the transfer of board stress to the rigid ceramic body, therefore mitigating flex cracks which can result in low IR or short circuit failures. Flexible termination technology provides superior flex performance over standard termination systems. COG (NPO) dielectric capacitors exhibit no change in capacitance with respect to time and voltage and boasts a negligible change in capacitance with reference to ambient temperature. Capacitance change is limited to ±30ppm/°C from -55°C to +125°C. These devices exhibit low ESR at high frequencies and find conventional use as snubbers or filters in applications such as switching power supplies and lighting ballasts. Whether under-hood or in-cabin, these capacitors are designed to provide reliable performance in mission and safety critical automotive circuits. Stricter testing protocol and inspection criteria have been established for automotive grade products in recognition of potentially harsh environmental conditions. KEMET automotive grade series capacitors meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.

Benefits

- · AEC-Q200 automotive qualified
- Operating temperature range of -55°C to +125°C
- Superior flex performance (up to 5 mm)
- Capacitance offerings ranging from 1 pF to 120 nF
- DC voltage ratings of 500 V, 630 V, 1 KV, 1.5 KV, 2 KV, 2.5 KV and 3 KV
- EIA 0603, 0805, 1206, 1210, 1808, 1812, 1825, 2220 and 2225
- Extremely low ESR and ESL
- High ripple current capability
- · No capacitance shift with voltage
- · Negligible capacitance shift with respect to temperature
- No piezoelectric noise
- · Lead (Pb)-Free, RoHS and REACH compliant

Applications

- · High frequency power converters
- Wide bandgap (WBG), silicon carbide (SiC) and gallium nitride (GaN) systems
- Snubber (high dV/dT)
- Resonant circuits (LLC, Wireless Charging, etc)
- Timing
- Filtering

1





Ordering Information

| С | 2225 | X | 393 | J | С | G | Α | С | AUTO |
|---------|--|-----------------------------|---|---|---|------------|-------------------------|------------------------------------|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance ¹ | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ² | Packaging/Grade (C-Spec) |
| | 0603 0805 1206 1210 1808 1812 1825 2220 2225 | X = Flexible termination | Two significant digits and number of zeros. | $B = \pm 0.10 \text{ pF}$ $C = \pm 0.25 \text{ pF}$ $D = \pm 0.5 \text{ pF}$ $F = \pm 1\%$ $G = \pm 2\%$ $J = \pm 5\%$ $K = \pm 10\%$ $M = \pm 20\%$ | C = 500 B = 630 D = 1,000 F = 1,500 G = 2,000 Z = 2,500 H = 3,000 | G = COG | A = N/A | C = 100% Matte Sn | See "Packaging C-Spec Ordering Options Table" |

¹ Additional capacitance tolerance offerings may be available. Contact KEMET for details.

² Additional termination finish options may be available. Contact KEMET for details.

Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) | | |
|--|---|--|--|
| Commerc | cial Grade ¹ | | |
| Bulk Bag | Not required (Blank) | | |
| 7" Reel/Unmarked | TU | | |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) | | |
| 7" Reel/Unmarked/2mm pitch ² | 7081 | | |
| 13" Reel/Unmarked/2mm pitch ² | 7082 | | |
| Automot | ive Grade ³ | | |
| 7" Reel | AUTO | | |
| 13" Reel/Unmarked | AUT07411 (EIA 0603 and smaller case sizes) AUT07210 (EIA 0805 and larger case sizes) | | |
| 7" Reel/Unmarked/2mm pitch ² | 3190 | | |
| 13" Reel/Unmarked/2mm pitch ² | 3191 | | |

¹ Default packaging is "Bulk Bag." An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain

capacitors that have not been laser marked. The option to laser mark is not available on these devices. For more information see "Capacitor Marking." ² The 2mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2mm pitch option see "Tape & Reel Packaging Information."

³ Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information."

³ For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information."

³ All Automotive packaging C-Specs listed exclude the option to laser mark components. The option to laser mark is not available on these devices. For more information see "Capacitor Marking."



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | tion Due To: | Days Prior To |
|-----------------------------|----------------------------------|---------------|------------------|
| C-Spec | Process/Product change | Obsolescence* | Implementation |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum |
| AUTO | Yes (without approval) | Yes | 90 days minimum |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | | PPAP (Product | Part Approval | Process) Leve | I |
|-----------------------------|---|---------------|---------------|---------------|---|
| C-Spec | 1 | 2 | 3 | 4 | 5 |
| KEMET assigned ¹ | • | • | • | • | • |
| AUTO | | | 0 | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|----------------------------|---------------------------------|
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | |
| 0805 | 2012 | 2.00 (0.079) ±0.30 (0.012) | 1.25 (0.049) ±0.30 (0.012) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave or Solder Reflow |
| 1206 | 3216 | 3.30 (0.130) ±0.40 (0.016) | 1.60 (0.063) ±0.35 (0.013) | | 0.60 (0.024) ±0.25 (0.010) | | |
| 1210 | 3225 | 3.30 (0.130) ±0.40 (0.016) | 2.60 (0.102) ±0.30 (0.012) | | 0.60 (0.024) ±0.25 (0.010) | | |
| 1808 | 4520 | 4.70 (0.185) ±0.50 (0.020) | 2.00 (0.079) ±0.20 (0.008) | See Table 2 for Thickness | 0.70 (0.028) ±0.35 (0.014) | | |
| 1812 | 4532 | 4.50 (0.178) ±0.40 (0.016) | 3.20 (0.126) ±0.30 (0.012) | | 0.70 (0.028) ±0.35 (0.014) | N/A | Solder Reflow |
| 1825 | 4564 | 4.60 (0.181) ±0.40 (0.016) | 6.40 (0.252) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | Only |
| 2220 | 5650 | 5.90 (0.232) ±0.75 (0.030) | 5.00 (0.197) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | |
| 2225 | 5664 | 5.90 (0.232) ±0.75 (0.030) | 6.40 (0.248) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | |



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|--|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±30 ppm/°C |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 0% |
| ¹ Dielectric Withstanding Voltage (DWV) | See Dielectric Withstanding Voltage (DWV) Table (5 ±1 seconds and charge/discharge not exceeding 50 mA) |
| ² Dissipation Factor (DF) Maximum Limit at 25°C | 0.1% |
| ³ Insulation Resistance (IR) Limit at 25°C | 1,000 megohm microfarads or 100 GΩ (500 VDC applied for 120 ±5 seconds at 25°C) |

¹DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

²Capacitance and dissipation factor (DF) measured under the following conditions:

1 MHz ±100 kHz and 1.0 V_{rms} ±0.2 V if capacitance ≤ 1,000 pF

1 kHz ±50 Hz and 1.0 V_{ms} ±0.2 V if capacitance > 1,000 pF

³ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."



Dielectric Withstanding Voltage (DWV)

| EIA Case Size | 500V | 630V | ≥ 1000V |
|---------------|--------------------------|---|--------------------------|
| 0603 | | 130% of rated voltage | |
| 0805 | | < 620pF 150% of rated voltage ≥ 620pF 130% of rated voltage | |
| 1206 | 150% of rated voltage | < 5.1nF 150% of rated voltage ≥ 5.1nF 130% of rated voltage | |
| 1210 | | < 7.5nF 150% of rated voltage ≥ 7.5nF 130% of rated voltage | |
| 1808 | | < 5.1nF 150% of rated voltage ≥ 5.1nF 130% of rated voltage | 120% of rated voltage |
| 1812 | | < 12nF 150% of rated voltage ≥ 12nF 130% of rated voltage | Ĵ |
| 1825 | | < 22nF 150% of rated voltage ≥ 22nF 130% of rated voltage | |
| 2220 | | < 27nF 150% of rated voltage ≥ 27nF 130% of rated voltage | |
| 2225 | | < 33nF 150% of rated voltage ≥ 33nF 130% of rated voltage | |

Post Environmental Limits

| I | High Temperatu | ıre Life, Biased | Humidity, Mois | ture Resistance | | | | | | | | | | |
|---|----------------|------------------|----------------|------------------|-------------------------|--|--|--|--|--|--|--|--|--|
| Dielectric Rated DC Voltage Capacitance Value Dissipation Factor (Maximum %) Capacitance Shift Insulation Resistance | | | | | | | | | | | | | | |
| COG | All | All | 0.5 | 0.3% or ±0.25 pF | 10% of Initial Limit | | | | | | | | | |



Table 1A - Capacitance Range/Selection Waterfall (0603 - 1808 Case Sizes)

| | | Ca | se S | iz | e/S | er | ie | S | C |)60 | 3X | C | 080 | 5X | | C 1 | 120 | 6X | | | C | 1210 | DX | | | | C | 180 | BX | | |
|--------------------|-------------|-----|---|------|-------|------|-----|-----|---------|------|------|-----|------|--------|----------|---------------|----------------|----------|---------|---|----------|----------|------|--------|---------|-----|--------|------|------|--------|-----------|
| | Cap | | Volta | age | e Co | le | | | C | В | D | C | В | D | С | В | D | F | G | С | В | D | F | G | С | В | D | F | G | z | Н |
| Capacitance | Code | Ra | ated V | olta | age (| VD | C) | | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| | | Cap | acitar | ıce | e To | era | anc | е | | I | | | | | Pr | oduc Soo T | t Ava Cable | ailabi | ility a | and C | hip 1 | Thick | ness | Cod | es | I | | | | | |
| 1.0 - 9.1 pF* | 109 - 169* | B C | D | | | | | | | | | DG | DG | DG | | Jee | able | 2 10 | Cill | <u>, , , , , , , , , , , , , , , , , , , </u> | CKIIC | 33 0 | men | 510113 | LB | LB | LB | LB | LB | LB | LB |
| 10 pF | 100 | | | F | G | J | K | М | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 11 pF | 110 | | | | G | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | | | | | | LB | |
| 13 pF | 120 | | | F | G | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 15 pF | 150 | | | F | G | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 16 pF | 160 | | | F | G | J | Κ | М | | | | DG | DG | DG | ES | ES | ES | ES | ES | FΜ | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 18 pF | 180 | | | F | G | J | K | М | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 20 pF | 200 | | | F | G | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | | | | | | LB | LB |
| 22 pF 24 nF | 220 | | | F | G | J | ĸ | M | | | | | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 27 pF | 270 | | | F | G | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 30 pF | 300 | | | F | G | J | К | М | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 33 pF | 330 | | | F | G | J | Κ | М | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 36 pF | 360 | | I | F | G | J | K | М | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 39 pF | 390 | | | | G | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | | | | | LB | | LB |
| 43 pF 47 nF | 430 | | | F | G | J | ĸ | M | | | | DG | DG | DG | FS | FS | FS | FS | FS | FM | FM | FM | FM | FM | IB | IB | IB | IB | IB | I B | LD I B |
| 51 pF | 510 | | | F | G | J | K | М | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 56 pF | 560 | | | F | G | J | Κ | М | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 62 pF | 620 | | | F | G | J | Κ | М | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 68 pF | 680 | | | F | G | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| /5 pF 82 nF | 750 820 | | | | G | J | ĸ | M | | | | | DG | | ES FS | ES ES | ES FS | ES ES | EF | FM | FM | FM | FM | FM | | LB | LB | LB | | LB | |
| 91 pF | 910 | | | F | G | J | K | M | | | | DG | DG | DG | ES | ES | ES | ES | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 100 pF | 101 | | 1 | F | G | J | K | М | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | ES | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LC | LB |
| 110 pF | 111 | | | F | G | J | Κ | М | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | ES | EU | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LC | LB |
| 120 pF | 121 | | | F | G | J | K | М | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | ES | EU | FZ | FZ | FZ | FM | FM | LA | LA | LA | LA | LB | LC | LB |
| 130 pF | 131 | | | F | G | J | K | M | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | ES | EU | FZ | FZ | FZ | FM | FM | | | | | | | |
| 160 pF | 161 | | 1 | F | G | J | ĸ | M | CJ | CJ | CJ | DG | DG | DG | FS | ES | FS | FF | FU | FZ | FZ | FZ | FM | FM | | LA | | LA | | | |
| 180 pF | 181 | | | F | G | J | ĸ | М | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | EF | EU | FZ | FZ | FZ | FM | FM | LA | LA | LA | LA | LC | LC | LC |
| 200 pF | 201 | | | F | G | J | Κ | М | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | EF | EU | FΖ | FZ | FZ | FM | FM | LA | LA | LA | LA | LC | LC | |
| 220 pF | 221 | | | F | G | J | Κ | М | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | EU | EU | FZ | FZ | FZ | FM | FM | LA | LA | LA | LA | LC | LC | |
| 240 pF | 241 | | | F | G | J | K | M | CJ | CJ | | DG | DG | DG | ES | ES | ES | EU | EU | FZ | FZ | FZ | FM | FM | LA | LA | LA | LB | LC | LC | |
| 270 pF 300 nF | 271 | | | F | G | J | ĸ | M | CI | CI | | | | | ES FS | ES FS | ES FF | FII | EU | FZ F7 | FZ F7 | FZ F7 | FK | FK | | | | | | | |
| 330 pF | 331 | | | F | G | J | K | M | CJ | CJ | | DG | DG | DC | ES | ES | EF | EU | | FZ | FZ | FZ | FK | FK | | LA | LA | LB | LC | LC | |
| 360 pF | 361 | | | F | G | J | Κ | М | CJ | CJ | | DG | DG | DC | ES | ES | EF | EU | | FΖ | FZ | FZ | FK | FS | LA | LA | LA | LB | LA | LC | |
| 390 pF | 391 | | | F | G | J | Κ | М | CJ | CJ | | DG | DG | DC | ES | ES | EF | EU | | FΖ | FZ | FZ | FK | FS | LA | LA | LA | LB | LA | LC | |
| 430 pF | 431 | | | F | G | J | K | М | CJ | CJ | | DG | DG | DD | ES | ES | EF | EU | | FZ | FM | FM | FS | FS | LA | LB | LB | LC | LA | | |
| 4/0 pF | 4/1 511 | | | | G | J | K | M | CJ | CJ | | DG | DG | ם ס | ES | ES | EU | EU | | FZ | FM | FM | FS | FS | | | | | | | |
| 560 pF | 561 | | | F | G | J | K | M | CJ | CJ | | DG | DG | DG | ES | ES | EU | EU | | FZ | FM | FM | FS | FS | | LB | LB | LC | LB | | |
| 620 pF | 621 | | | F | G | J | K | М | CJ | CJ | | DG | DG | DG | ES | ES | EU | | | FZ | FM | FM | FS | FS | LA | LB | LB | LA | LC | | |
| 680 pF | 681 | | | F | G | J | Κ | М | CJ | CJ | | DG | DG | DG | ES | ES | EU | | | FΖ | FM | FM | FS | FS | LB | LB | LB | LA | LC | | |
| 750 pF | 751 | | | F | G | J | K | М | | | | DG | DG | DG | ES | EF | EU | | | FZ | FM | FM | FM | | LB | LB | LB | LA | | | |
| 820 pF | 821 | | | F | G | J | K | M | | | | DG | DG | DG | ES | EF | EU | | | FZ | FM | FM | FM | | | | | | | | |
| 910 pF 1 000 nF | 102 | | | F | G | J | ĸ | M | | | | | | | ES FS | FF | FII | | | FM | FM | FM | FV | | | | LB | | | | |
| 1,000 pi | 102 | Ra | F G J K M F G J K M Rated Voltage (VDC) | | | | | 191 | 005 | 330 | 000 | 000 | 330 | 000 | 005 | 330 | 000 | 500 | 000 | 200 | 330 | 000 | 500 | 000 | 002 | 330 | 000 | 500 | 000 | 500 | 000 |
| Capacitance | Cap Code | | Volta | age | Co | le | - | | 2, C | B | | C, | B | - D | C | B | - D | F | G | 2, C | B | D | F | G | 2, C | B | - D | F | G | ∾ Z | е Н |
| | | C | Case S | ize | e/Se | erie | s | | C | 0603 | SX | C | 0805 | 5X | | C | 1206 | X | | | C | 1210 | X | | | | C | 1808 | X | | |

*Capacitance range Includes E24 decade values only (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91.) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions.)



Table 1A – Capacitance Range/Selection Waterfall (0603 – 1808 Case Sizes) cont.

| | | Case | e Siz | ze/ | Se | rie | s | C |)60 | 3X | C |)80 | 5X | | C 1 | 200 | 6X | | | C 1 | 1210 | DX | | | | C | 180 | BX | | |
|-------------|------|---------------------|----------------------------------|------|-------|-----|-----|------|-----|--------|------|-----|------|--------|---------------|---------------|----------------|------------------|----------------|---------------|---------------|--------------|--------------|---------|--------|------|------|--------|--------|--------|
| | Can | \ \ | /oltaç | je C | ode | | | С | В | D | С | В | D | С | В | D | F | G | С | В | D | F | G | C | В | D | F | G | Z | н |
| Capacitance | Code | Rate | d Vol | tage | e (VC | DC) | | 500 | 630 | 1000 | 500 | 630 | 1000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| | | Capac | itanc | e T | oler | anc | e | | | 1 | | | 1 | Pr | oduc See T | t Ava able | ailabi 2 fo | ility a r Chi | and C p Thi | hip 1 ckne | hick ss Di | ness imen | Cod sions | es s | | | | | | |
| 1,100 pF | 112 | | F | G | J | K | М | | | | DC | DC | | EF | EU | ED | | | FM | FK | FK | FS | | LC | LC | LC | LB | | | |
| 1,200 pF | 122 | | F | G | J | K | М | | | | DC | DC | | EF | EU | ED | | | FM | FK | FK | FS | | LC | LC | LC | LC | | | |
| 1,300 pF | 132 | | F | G | J | K | М | | | | DC | DC | | EF | EU | ED | | | FM | FS | FS | | | LC | LC | LC | LC | | | |
| 1,500 pF | 152 | | F | G | J | K | М | | | | DD | DD | | EF | EU | ED | | | FK | FS | FS | | | LC | LC | LC | LC | | | |
| 1,600 pF | 162 | | F | G | J | K | М | | | | DD | DD | | EF | EU | ED | | | FK | FS | FS | | | LC | LC | LC | | | | |
| 1,800 pF | 182 | | F | G | J | K | М | | | | DG | DG | | EF | EU | EF | | | FK | FS | FS | | | LC | LC | LC | | | | |
| 2,000 pF | 202 | | F | G | J | K | м | | | | DG | DG | | EU | EQ | EF | | | FK | FL | FS | | | LC | LA | LB | | | | |
| 2,200 pF | 222 | | F | G | J | К | м | | | | DG | DG | | EU | EQ | EF | | | FK | FL | FS | | | LC | LA | LB | | | | |
| 2,400 pF | 242 | | F | G | J | К | м | | | | DG | DG | | EU | EQ | EU | | | FS | FL | FS | | | LC | LA | LB | | | | |
| 2,700 pF | 272 | | F | G | J | К | м | | | | DG | DG | | EU | EQ | EU | | | FS | FL | FS | | | LC | LA | LC | | | | |
| 3,000 pF | 302 | | F | G | J | K | М | | | | | | | EQ | EQ | | | | FS | FL | FF | | | LA | LA | LA | | | | |
| 3,300 pF | 332 | | F | G | J | К | м | | | | | | | EQ | EQ | | | | FS | FM | FG | | | LA | LA | LA | | | | |
| 3,600 pF | 362 | | F | G | J | К | м | | | | | | | ER | ER | | | | FL | FM | FG | | | LA | LB | LA | | | | |
| 3.900 pF | 392 | | F | G | J | к | м | | | | | | | ER | ER | | | | FL | FY | FL | | | LA | LB | LA | | | | |
| 4.300 pF | 432 | | F | G | J | к | м | | | | | | | ES | ES | | | | FM | FY | FL | | | LA | LC | LA | | | | |
| 4.700 pF | 472 | | F | G | J | К | м | | | | | | | ES | ES | | | | FM | FΥ | FM | | | LA | LC | LB | | | | |
| 5.100 pF | 512 | | F | G | J | к | м | | | | | | | EE | EE | | | | FY | FS | FM | | | LA | LB | LB | | | | |
| 5.200 pF | 562 | | F | G | J | K | M | | | | | | | EF | EF | | | | FY | FS | FM | | | LB | LC | LC | | | | |
| 6.200pF | 622 | | F | G | J | K | M | | | | | | | EF | EF | | | | FY | FE | FY | | | LC | LC | LC | | | | |
| 6.800pF | 682 | | F | G | J | K | M | | | | | | | EU | EU | | | | FY | FE | FY | | | LC | LC | LC | | | | |
| 7 500nF | 752 | | F | G | J | K | M | | | | | | | FU | FU | | | | FS | FF | FS | | | IA | LA | | | | | |
| 8 200 pF | 822 | | F | G | J | ĸ | M | | | | | | | FU | FU | | | | FS | FF | FS | | | | IA | | | | | |
| 9 100 pF | 912 | | F | G | J | ĸ | M | | | | | | | FII | FII | | | | FF | FF | FS | | | | IA | | | | | |
| 10 000 pF | 103 | | F | G | J | ĸ | M | | | | | | | FII | FII | | | | FG | FG | FS | | | | | | | | | |
| 12 000 pF | 123 | | F | G | J | ĸ | M | | | | | | | FII | 20 | | | | FG | FG | FM | | | | | | | | | |
| 15,000 pF | 153 | | Ē | G | | ĸ | M | | | | | | | FII | | | | | FM | FM | FS | | | IR | LB | | | | | |
| 18 000 pF | 183 | | F | G | Ĵ | ĸ | м | | | | | | | | | | | | FM | FM | FS | | | | IC | | | | 1 | |
| 22.000 pF | 223 | | F | G | Ĭ | ĸ | M | | | | | | | | | | | | FV | FV | FS | | | 1 - 0 | | | | | | |
| 27,000 pF | 273 | | F. | G | J | ĸ | м | | | | | | | | | | | | FS | FS | | | | | | | | | 1 | |
| 33.000 pF | 333 | | F. | G | J | ĸ | м | | | | | | | | | | | | FS | FS | | | | | | | | | | |
| | | Rated Voltage (VDC) | | | | | | 500 | 630 | 000 | 500 | 630 | 000 | 200 | 630 | 000 | 500 | 000 | 200 | 630 | 000 | 500 | 000 | 500 | 630 | 000 | 500 | 000 | 500 | 000 |
| Capacitance | Cap | , , | Rated Voltage (VDC) Voltage Code | | | | | C C | В | | c | В | | c . | В | | F | G | c | В | | F | G | с С | В | | F | ∾ G | ∾ 7 | т н |
| | Code | Cas | Voltage Code Case Size/Series | | | | C C | 0603 | X | ů C | 0805 | X X | Ļ | ۔ C | 1206 | <u>.</u> Х | • | Ļ | ت C | 1210 | <u>.</u> Х | | Ļ | - | ت C | 1808 | X | - | | |

*Capacitance range Includes E24 decade values only (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91.) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions.)



Table 1B - Capacitance Range/Selection Waterfall (1812 - 2225 Case Sizes)

| | | Case Size/ Series | | C | 1812 | 2X | | | | | C1 | 82 | 5X | | | | | C2 | 222 | 0X | | | | | C2 | 222 | 5X | | |
|--------------------|-------------|----------------------|------------|-------|----------|------|------|----------|-----|-----|------------------------|----------|------------|------------|-----------|-----------|-------|-------------------------|------------|------------|----------|-----------|------------|-----|------|------|------|------|----------|
| | Сар | Voltage Code | СВ | D | F | G | z | н | С | В | D | F | G | z | н | С | В | D | F | G | z | н | с | В | D | F | G | z | н |
| Сар | Code | Rated Voltage (VDC) | 00 | 00 | 500 | 000 | 500 | 000 | 00 | 30 | 00 | 500 | 000 | 500 | 000 | 8 | 30 | 00 | 500 | 00 | 500 | 000 | 8 | 30 | 000 | 200 | 000 | 200 | 000 |
| | | Capacitance | 5 6 | = | ~ | 5 | 5 | ĕ | ŝ | Pr | ∣ ≍ oduc | ≓ tAv | ~⊼ aila | ة bilit | ୍ଳ van | d Ch | ip Tl | ∣ ≍ hickı | r≓ ness | ⊼ | ন les | ĕ | 5 | • | = | = | 5 | 15 | ĕ |
| | | Tolerance | | | | | | | _ | | See 1 | able | e 2 f | or C | hip 1 | Thic | ines | s Di | men | sion | S | | 1 = | = | | = | | | |
| 10 pF 11 nF | 100 | FGJKM | GB GE | B GB | GB | GB | GB | GB GB | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 12 pF | 120 | F G J K M | GB GE | GB | GB | GB | GB | GB | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 13 pF | 130 | F G J K M | GB GE | GB GB | GB | GB | GB | GB | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 15 pF | 150 | F G J K M | GB GE | GB | GB | GB | GB | GB | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 16 pF 18 nF | 160 | F G J K M | GB GE | GB GB | GB | GB | GB | GB GB | | | | | | | | JK JK | JK | JK JK | JK JK | JK | JK | JK JK | KF | KF | KF | KF | KF | KF | KF |
| 20 pF | 200 | F G J K M | GB GE | GB | GB | GB | GB | GB | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 22 pF | 220 | F G J K M | GB GE | GB | GB | GB | GB | GB | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 24 pF | 240 | F G J K M | GB GE | GB | GB | GB | GB | GB | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 27 pF 30 nF | 300 | FGJKM | GB GF | GB | GB | GB | GB | GB | | | | | | | | JK JK | JK | JK | JK JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 33 pF | 330 | F G J K M | GB GE | GB | GB | GB | GB | GB | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 36 pF | 360 | F G J K M | GB GE | GB | GB | GB | GB | GB | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 39 pF | 390 | F G J K M | GB GE | B GB | GB | GB | GB | GB | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 43 pF 47 nF | 430 | FGJKM | GB GF | GB GB | GB | GB | GB | GB | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 51 pF | 510 | F G J K M | GB GE | GB | GB | GB | GB | GB | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 56 pF | 560 | F G J K M | GB GE | GB GB | GB | GB | GB | GB | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 62 pF | 620 | F G J K M | GB GE | GB | GB | GB | GB | GB | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 68 pF 75 nF | 680 750 | FGJKM | GB GF | GB | GB | GB | GB | GB | | | | | | | | JK .IK | JK | JK | JK | JK | JK | JK .IK | KF | KF | KF | KF | KF | KF | KF |
| 82 pF | 820 | F G J K M | GB GE | GB | GB | GB | GB | GB | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 91 pF | 910 | F G J K M | GD GE | GD | GD | GD | GD | GD | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 100 pF | 101 | F G J K M | GD GE | GD | GD | GD | GD | GD | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 110 pF | 111 | FGJKM | GD GL | GD | GD | GD | GD | GD | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 120 pF 130 pF | 121 | FGJKM | GD GE | GD | GD | GD | GD | GD | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 150 pF | 151 | F G J K M | GD GE | GD | GD | GD | GD | GK | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 160 pF | 161 | F G J K M | GD GI | GD | GD | GD | GD | GK | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 180 pF | 181 | FGJKM | GD GI |) GD | GD | GD | GD | GK | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 200 pF 220 nF | 201 | F G J K M | GB GF | | GB | GD | GD | GM | | | | | | | | JK .IK | JK | JK | JK .IK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 240 pF | 241 | F G J K M | GB GE | GB | GB | GB | GD | GM | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 270 pF | 271 | F G J K M | GB GE | GB GB | GB | GB | GH | GM | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 300 pF | 301 | FGJKM | GB GE | GB | GB | GB | GH | GM | | | | | | | | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 330 pF 360 pF | 331 | FGJKM | | | GB | GB | GH | GU | | | | | | | | JE | JE | JE | JE | JE | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 390 pF | 391 | FGJKM | GB GE | GB | GB | GD | GK | GO | | | | | | | | JE | JE | JE | JE | JE | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 430 pF | 431 | F G J K M | GB GE | GB | GB | GD | GK | | HJ | HJ | HJ | HJ | HJ | HJ | HJ | JE | JE | JE | JE | JE | JK | JE | KE | KE | KE | KE | KE | KE | KF |
| 470 pF | 471 | FGJKM | GB GE | GB | GB | GD | GK | | HJ | HJ | HJ | HJ | HJ | HJ | HJ | JE | JE | JE | JE | JE | JK | JK | KF | KF | KF | KF | KE | KE | KF |
| 510 pF | 511 | FGJKM | GB GE | | GD | GH | GM | | HJ | HJ | HJ | HJ | HJ | HJ | HJ | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KE | KE | KF |
| 620 pF | 621 | FGJKM | GB GE | GB GB | GD | GH | GM | | НК | HK | HK | HK | HK | HK | HK | JK | JK | JK | JK | JK | JK | JL | KF | KF | KF | KF | KE | KE | KH |
| 680 pF | 681 | F G J K M | GB GE | GB GB | GD | GH | GO | | ΗK | HK | HK | ΗK | ΗK | HK | HK | JE | JE | JE | JK | JK | JK | JL | KF | KF | KF | KF | KE | KF | KH |
| 750 pF | 751 | F G J K M | GB GE | 3 GB | GD | GK | | | | | | | | | | JE | JE | JE | JK | JK | JK | JL | KE | KE | KE | KF | KE | KF | KH |
| 820 pF | 821 | FGJKM | GB GE | GB | GD | GK | | | | | | | | | | JE | JE | JE | JK | JK | JK | JN | KE | KE | KE | KF | KE | KF | KJ |
| 910 pF 1 000 nF | 102 | FGJKM | GB GF | GB GB | GH | GM | | | | | | | | | | JE | JK | JK | JK JK | JK | JK | JN | KE | KE | KE | KF | KE | KF | KJ KJ |
| 1,100 pF | 112 | F G J K M | GB GE | GB | GH | GO | | | НJ | HJ | HJ | НJ | НJ | НJ | | JE | JK | JK | JK | JK | JK | | KE | KE | KE | KF | KF | KF | |
| | | Rated Voltage (VDC) | 500 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| Cap | Cap Code | Voltage Code | СВ | D | F | G | Z | H | С | В | D | F | G | z | H | С | В | D | F | G | Z | H | C | В | D | F | G | Z | H |
| | | Case Size/Series | | C | 1812 | X | | | | | C | 1825 | 5X | | | | | C | 2220 | 0X | | | | | C | 2225 | 5X | | |

*Capacitance range Includes E24 decade values only (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91.) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions.)



Table 1B – Capacitance Range/Selection Waterfall (1812 – 2225 Case Sizes) cont.

| | | | Case Size/ Series Voltage Code | | | | | | | | | C1 | 81 : | 2X | | | | | | C 1 | 82 | 5X | | | | | C2 | 222 | OX | | | | | С | 22 | 225 | 5X | | | |
|-----------|-------------|---|--------------------------------------|-----|------|-----|-------|--------------|-------|------|--------------|----------|-------------|------|------|------|---|----------|----------|------------|------|--------------|------|---------------|---------------|------|------|------|------|------|------|-----|-----|------|------|------------|------|-----------|------|------|
| Con | Сар | | | Vo | ltaç | ge | Coc | le | | 0 | B | ; | D | F | G | z | ŀ | 1 | C | B | D | F | G | z | Н | С | В | D | F | G | z | H | С | В | D | | F | G | z | н |
| Cap | Code | L | Rat | ted | Vol | ta | ge (| VD | C) | | 630 | 8 | 8 | 1500 | 2000 | 2500 | | | 500 | 630 | 000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 000 | 1500 | 2000 | 2500 | 000 | 500 | 630 | 000 | | 1200 | 2000 | 2500 | 3000 |
| | | F | | Са | pa | cit | and | ce | | t | | | | • | | | | <u>'</u> | | Pr | oduc | t Av Fabl | aila | bilit or C | y an bin 1 | d Ch | ip T | hick | ness | | des | | | | | | | | | |
| 1 200 nF | 122 | ┢ | | | F | 1 a | ì. | ; | < N | 1 G | 3 G | B | GB | GH | GO | | | Т | НJ | HJ | H.J | HJ | HJ | HJ | iiip | JF | JK | JK | JK | JK | | | KF | KF | K | - к | (F | KF | KF | |
| 1,300 pF | 132 | | | | F | 0 | 3 | | < N | I G | 3 G | B | GB | GH | GO | | | | HE | HE | HE | HE | HE | HJ | | JE | JK | JK | JK | JE | JL | | KE | KE | KE | EK | (F | KF | KH | |
| 1,500 pF | 152 | | | | F | 0 | 3 | 1 H | < N | I GI | 3 G | B | GB | GK | GO | | | | HE | HE | HE | HE | HE | HK | | JE | JK | JK | JK | JE | JL | | KE | KE | KE | ΞİΚ | (F | KF | KH | |
| 1,600 pF | 162 | | | | F | 0 | 3 . | I | < N | I G | 3 G | D | GD | GK | | | | | HG | HG | HG | HG | HG | HK | | JE | JK | JK | JK | JE | JL | | KE | KE | KE | ΞİΚ | (F | KE | KH | |
| 1,800 pF | 182 | | | | F | 0 | 3 | lŀ | < N | I G | 3 G | D | GD | GM | | | | | HG | HG | HG | HG | HG | | | JE | JK | JK | JK | JE | JN | | KE | KE | KE | ΞK | (F | KE | KH | |
| 2,000 pF | 202 | | | | F | 0 | 3 J | + | < N | I G | 3 GI | H I | GH | GΜ | | | | | HE | HE | HE | HE | HJ | | | JE | JK | JK | JE | JK | | | KE | KE | KE | Ξ K | (F | KE | KJ | |
| 2,200 pF | 222 | | | | F | 0 |) J | | | G | 3 GI | H I | GH | GO | | | | | HE | HE | HE | HE | HJ | | | JE | JK | JK | JE | JK | | | KE | KE | KE | EK | (F | KF | KJ | |
| 2,400 pF | 242 | | | | F | 0 | 3 J | ! ! | | G | 3 G | | GK | GO | | | | | HE | HE | HE | HE | HJ | | | JK | JK | JK | JE | JL | | | KE | KE | KE | = K | (E | KH | | |
| 2,700 pF | 2/2 | | | | | | | | | | | | GK | GU | | | | | HE | HE | HE | HE | HK | | | JK | JK | JK | JE | JL | | | KE | KE | | = K | | KH | | |
| 3,000 pF | 302 | | | | F | | | ır ı | | | | | GK | | | | | | HE | HE | HE | HE | HK | | | JK | JK | JK | JE | JL | | | KE | KE | | = K = V | | KH | | |
| 2,500 pF | 352 | | | | | | | | | | | | | | | | | | по | | | | | | | | JK | JK | JK | | | | | | | - r - r | | KJ K I | | |
| 3,000 pr | 392 | | | | F | | | ĺ | | | | - 0 | GM | | | | | | ні | н | нт | ні | | | | IK | IK | IK | IK | | | | KE | KF | | = K | (F | K I | | |
| 4 300 pF | 432 | | | | F | 6 | | | < N | G | H GI | - | GO | | | | | | HJ | HJ | HJ | HJ | | | | JK | JK | JK | JK | | | | KF | KF | KF | = K | (F | nu - | | |
| 4.700 pF | 472 | | | | F | 6 | | | | G | - GI | - 1 | GO | | | | | | HJ | HJ | HJ | HJ | | | | JK | JK | JK | JL | | | | KE | KF | KF | = K | н | | | |
| 5,100 pF | 512 | Г | Г | Г | F | 6 | 3] | | < N | I GI | H G | ĸ | GO | | | | Т | Т | HE | HE | HG | HK | | | _ | JK | JK | JK | JL | | | | KE | KF | KF | = K | (H) | | | |
| 5,600 pF | 562 | | | | F | 0 | 3 | 1 H | κN | I GI | H G | ĸ | GO | | | | | | HE | HE | HG | нк | | | | JK | JK | JK | JN | | | | KE | KF | KF | ×κ | н | | | |
| 6,200 pF | 622 | | | | F | 0 | 3 | | < N | I GI | I G | к I | GH | | | | | | HE | ΗE | HG | | | | | JK | JE | JE | JN | | | | KE | KF | KF | FΙκ | (J | | | i |
| 6,800 pF | 682 | | | | F | 0 | 3 . | 1 H | < N | I GI | I GI | N | GH | | | | | | ΗE | ΗE | HJ | | | | | JK | JE | JK | JN | | | | KE | KF | KF | FΙK | (J | | | |
| 7,500 pF | 752 | | | | F | 0 | 3 | | < N | I GI | I GI | N | GK | | | | | | ΗE | ΗE | HJ | | | | | JK | JE | JK | | | | | KF | KE | KF | = | | | | |
| 8,200 pF | 822 | | | | F | 0 | 3 . | 1 | < N | I G | (G | 0 | GK | | | | | | HE | HE | HJ | | | | | JK | JE | JL | | | | | KF | KE | KF | = | | | | |
| 9,100 pF | 912 | | | | F | 0 | 3 . | | < N | I GI | / G | 0 0 | GM | | | | | | HE | HG | HK | | | | | JE | JE | JL | | | | | KF | KE | K | 1 | | | | |
| 10,000 pF | 103 | | | | F | 0 | 3 . | | < N | I GI | A G | 0 0 | GM | | | | | | HE | HG | нк | | | | | JE | JE | JL | | | | | KF | KE | KF | 1 | | | | |
| 12,000 pF | 123 | | | | F | 0 | 3 . | | < N | I G |) GI | H I | GO | | | | | | HE | HG | HE | | | | | JE | JK | JN | | | | | KE | KE | K | 1 | | | | |
| 15,000 pF | 153 | | | | F | 0 | 3 . | | | I G |) GI | | GO | | | | | | HE | HJ | HE | | | | | JE | JL | JE | | | | | KE | KF | K | J | | | | |
| 18,000 pF | 183 | | | | | 6 | j | ! ! ! | | G | 1 GI | | | | | | | | HG | HK | HG | | | | | JE | JL | JE | | | | | KE | K | | = | | | | |
| 22,000 pF | 223 | | | | | | | | | | 1 6 | | | | | | | | HJ | HE | HJ | | | | | JK | | JK | | | | | KF | KJ | K | | | | | |
| 27,000 pF | 2/3 | | | | | | | | | | | | | | | | | | пJ uv | | | | | | | | | | | | | | | | | 1 | | | | |
| 20,000 pF | 202 | | | | | | | | | | וט ויי כו | n N | | | | | | | | | | | | | | | JE | JIN | | | | | | | | | | | | |
| 47 000 pF | 473 | Ŀ | | | F | 6 | | | | | ן הסיונ | ן ר | | | | | | | HE | HE | | | | | | IF | IE | | | | | | KE | KE | . N. | , | | | | |
| 68 000 pF | 683 | | | | F | | | | | il " | | | | | | | | | H.I | H.I | | | | | | | | | | | | | KF | KE | | | | | | |
| 82.000 pF | 823 | | | | F | 6 | | | < N | | | | | | | | | | НК | НК | | | | | | JL | JL | | | | | | КН | KH | | | | | | |
| 0.1 µF | 104 | | | | F | 0 | 3 | | < N | | | | | | | | | | HK | HK | | | | | | JN | JN | | | | | | КН | KH | | | | | | |
| 0.12 μF | 124 | | | | F | 0 | 3 | I | K N | 1 | | | | | | | | | | | | | | | | | | | | | | | KJ | KJ | | | | | | |
| | | | Rated Voltage (VDC) | | | | | C) | 500 | 200 | 3 | 1000 | 1500 | 2000 | 2500 | 0000 | | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | | 1500 | 2000 | 2500 | 3000 | |
| Cap | Cap Code | F | | Vo | ltaç | ge | Coc | le | | C | E | ; | D | F | G | z | ŀ | i | С | В | D | F | G | z | H | С | В | D | F | G | Z | H | c | B | D | | F | G | Z | H |
| | | | Case Size/Series | | | | | | | C | 1812 | 2X | - | | | | | C | 182 | 5X | | | | | C | 222 | OX | | | | | (| C22 | 225 | x | | | | | |

*Capacitance range Includes E24 decade values only (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91.) KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions.)



Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper C |)uantity | Plastic | Quantity |
|-----------|--------------|------------------------------------|----------|----------|---------|----------|
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| CJ | 603 | 0.80 ± 0.15* | 4,000 | 15,000 | 0 | 0 |
| | 805 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| | 805 | 0.90 ± 0.10 1 25 + 0 15 | | | 4,000 | |
| EO | 1206 | 0.78 ± 0.20 | 0 0 | 0 0 | 4.000 | 10,000 |
| ER | 1206 | 0.90 ± 0.20 | 0 | 0 | 4,000 | 10,000 |
| ED | 1206 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| ES | 1206 | 1.00 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| EE | 1206 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| EF | 1206 | 1.20 ± 0.15 1.60 ± 0.25 | 0 | 0 | 2,500 | |
| F7 | 1200 | 1.00 ± 0.23 1.25 ± 0.20 | 0 | 0 | 2,000 | |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FE | 1210 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FF | 1210 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FG | 1210 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| FL FV | 1210 | 1.40 ± 0.15 | 0 | 0 | 2,000 | 8,000 |
| FI | 1210 | 2.00 ± 0.20 2 10 + 0 20 | | | 2,000 | 8,000 |
| FS | 1210 | 2.50 ± 0.20 | 0 | 0 | 1.000 | 4.000 |
| LA | 1808 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| LB | 1808 | 1.60 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| LC | 1808 | 2.00 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GD | 1812 | 1.25 ± 0.15 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GK | 1812 | 1.40 ± 0.10 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GM | 1812 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| GO | 1812 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| HE | 1825 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| HG | 1825 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| HJ | 1825 | 2.00 ± 0.20 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| | 2220 | 2.30 ± 0.20 1 40 + 0 15 | 0 | 0 | 1 000 | 2,000 |
| JK | 2220 | 1.60 ± 0.20 | Ő | Ő | 1,000 | 4.000 |
| JL | 2220 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| JN | 2220 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| KE | 2225 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| | 2225 | 1.60 ± 0.20 | | | 1,000 | 4,000 |
| K.I | 2225 | 2.00 ± 0.20 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| | 0 | | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Case Size | fhickness ± Range (mm) | Paner (|)uantity | Plastic | l |
| | | | i uper c | | 1 10500 | |

Package quantity based on finished chip thickness specifications.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size | Metric Size | | Dens Maxi Land Pi | sity Lev mum (I rotrusio | rel A: Most) on (mm |) | | Dens Media Land Pi | sity Lev an (Nor rotrusio | vel B: minal) on (mm |) | | Dens Minii Land Pi | sity Lev mum (L rotrusio | vel C: .east) on (mm |) |
|-------------|----------------|------|-------------------------|--------------------------------|---------------------------|------|------|--------------------------|---------------------------------|----------------------------|------|------|--------------------------|--------------------------------|----------------------------|------|
| Coue | Coue | С | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 0.99 | 1.44 | 1.66 | 4.47 | 2.71 | 0.89 | 1.24 | 1.56 | 3.57 | 2.11 | 0.79 | 1.04 | 1.46 | 2.42 | 1.81 |
| 1206 | 3216 | 1.59 | 1.62 | 2.06 | 5.85 | 3.06 | 1.49 | 1.42 | 1.96 | 4.95 | 2.46 | 1.39 | 1.22 | 1.86 | 4.25 | 2.16 |
| 1210 | 3225 | 1.59 | 1.62 | 3.01 | 5.90 | 4.01 | 1.49 | 1.42 | 2.91 | 4.95 | 3.41 | 1.39 | 1.22 | 2.81 | 4.25 | 3.11 |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 |
| 1812 | 4532 | 2.10 | 1.80 | 3.60 | 7.00 | 4.60 | 2.00 | 1.60 | 3.50 | 6.10 | 4.00 | 1.90 | 1.40 | 3.40 | 5.40 | 3.70 |
| 1825 | 4564 | 2.15 | 1.80 | 6.90 | 7.10 | 7.90 | 2.05 | 1.60 | 6.80 | 6.20 | 7.30 | 1.95 | 1.40 | 6.70 | 5.50 | 7.00 |
| 2220 | 5650 | 2.85 | 2.10 | 5.50 | 8.80 | 6.50 | 2.75 | 1.90 | 5.40 | 7.90 | 5.90 | 2.65 | 1.70 | 5.30 | 7.20 | 5.60 |
| 2225 | 5664 | 2.85 | 2.10 | 6.90 | 8.80 | 7.90 | 2.75 | 1.90 | 6.80 | 7.90 | 7.30 | 2.65 | 1.70 | 6.70 | 7.20 | 7.00 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1210 case size.



Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Termination Finish | | | |
|--|-----------------------|-----------------------|--|--|
| Fromereature | SnPb | 100% Matte Sn | | |
| Preheat/Soak | | | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C | | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | | |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds | | |
| Ramp-Up Rate (T_L to T_p) | 3°C/second maximum | 3°C/second maximum | | |
| Liquidous Temperature (T _L) | 183°C | 217°C | | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | | |
| Peak Temperature (T _P) | 235°C | 260°C | | |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum | 30 seconds maximum | | |
| Ramp-Down Rate $(T_p to T_L)$ | 6°C/second maximum | 6°C/second maximum | | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | | |



Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are guite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature-reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.







Construction



Capacitor Marking (Optional):

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- · EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| EIA Case Size | Tape | Embosse | ed Plastic | Punched Paper | | |
|----------------------|------|---------|--------------------|---------------|--------------------|--|
| | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | (W)* | Pitch | (P ₁)* | Pitch | (P ₁)* | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 | |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | |
| Array 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size. 2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- · Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|--|---------------------------------------|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 16 mm | | (0.059) | | | | (1.181) | | | |
| | | , | Variable Dime | ensions – Mil | limeters (Incl | nes) | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | Note 5 | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|---|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-------------------------------|-----------------------|--|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | |
| Tape Size Pitch E2 Minimum F P1 T Maximum W Maximum | | | | | | A ₀ B ₀ | | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | |
| 8 mm Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | |
|--|--------------------------------|---------------------------------------|--|--|--|--|
| Tape Size | Tape SizeAB Minimum | | C | D Minimum | | |
| 8 mm | 178 ±0.20 | | | | | |
| 12 mm | Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 | | |
| 16 mm | 16 mm (13.000 ±0.008) | | X | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | |
| Tape Size | Tape SizeN MinimumW1W2 Maximum | | | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Application Guide

Solder Fluxes and Cleaning

The use of water-soluble fluxes provides advantages of excellent solderability due to high activation. However, these fluxes contain organic acids that can induce arcing under high DC or AC voltages. Notable problem areas are underneath the MLCC where flux can be trapped between the ceramic material and PCB. It is therefore critical that PCBs are properly cleaned to remove all flux residue to maintain reliability.

Coating for High Voltage MLCCs

For MLCC ratings \geq 1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

| Dielectric | CTE (ppm/°C) |
|----------------------------|--------------|
| Class II BaTiO₃ | 10.7 |
| Class I CaZrO ₃ | 9.8 |

Slits in PCB

It is recommended to apply a slit in the PCB under the MLCC to improve washing of flux residue that may get trapped underneath. In some cases, it is not possible to slit entirely through the PCB due to underlying metal planes. It is also acceptable to apply a recessed slit under the MLCC which will also promote cleaning.

- Recommended for case sizes ≥1206
- The width (w) of the slit should be 1mm
- Length of the slit should be as short as possible to prevent damaging the MLCC due to mechanical stress of the PCB.
- Slits also reduce the risk of solder balls under MLCC which decreased the creepage distance.



Solder Resist

If a slit cannot be applied as above, it is recommended to not use solder resist directly under the MLCC. The use of solder resist material reduces the distance between MLCC ceramic material and PCB thus making it difficult to clean.

Solder Balls

Improper reflow techniques and/or improper washing can induce solder balls under or adjacent to the MLCC. Solder balls reduce the creepage distance between the MLCC terminations and increase the risk of arcing or damage to the ceramic material. To reduce the risk of solder balls:

- Follow KEMET's solder recommendations as outlined in the datasheet.
- If performing a cleaning procedure, properly clean the PCB per KEMET's cleaning recommendations.
- Add slit to the PCB as shown above.





Overview

KEMET U2J dielectric features a maximum operating temperature of 125°C and is considered stable. The Electronics Industries Alliance (EIA) characterizes U2J dielectric as a Class I material. Components of this classification are temperature compensating and are suited for resonant circuit applications or those where Q and stability of capacitance characteristics are required. U2J is an extremely stable dielectric material that exhibits a negligible shift in capacitance with respect to voltage and boasts a predictable and linear change in capacitance with reference to ambient temperature with no aging effect. In addition, U2J dielectric extends the available capacitance range of Class I MLCCs to achieve values previously only available using Class II dielectric materials like X7R, X5R, Y5V and Z5U. U2J is not sensitive to DC Bias as compared to Class II dielectric materials and retains over 99% of nominal capacitance at full rated voltage. KEMET automotive grade capacitors meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements. Capacitance change is limited to -750 ±120 ppm/°C from -55°C to +125°C. These devices are lead (Pb)-free, RoHS and REACH compliant without exception and are capable of withstanding multiple passes through a lead (Pb)-free solder reflow profile.

Benefits

- · AEC-Q200 automotive qualified
- Up to 10x increase in capacitance versus COG
- Extremely low effective series resistance (ESR)
- · Extremely low effective series inductance (ESL)
- · High ripple current capability
- · Low noise solution similar to COG
- · Retains over 99% of nominal capacitance at full rated voltage
- Small predictable and linear capacitance change with respect to temperature
- Operating temperature range of -55°C to +125°C
- · Capacitance up to 470 nF
- DC voltage ratings up to 100 V

Applications

- Wireless charging
- Resonant LLC converters
- Power conversion
- Pulse circuits



- High ripple current
- Critical timing
- Decoupling
- · Transient voltage suppression



Ordering Information

| С | 1206 | C | 104 | J | 3 | J | Α | C | TU |
|---------|--|---------------------------------------|--|---|---|------------|-------------------------|---------------------------------|---|
| Ceramic | Case Size (L" x W") | Specification/ Series ¹ | Capacitance Code (pF) | Capacitance Tolerance ² | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ³ | Packaging/ Grade (C-Spec) |
| | 0402 0603 0805 1206 1210 1812 | C = Standard | Two significant digits and number of zeros. | F = ±1% G = ±2% J = ±5% K = ±10% M = ±20% | 8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 | J = U2J | A = N/A | C = 100% Matte Sn | See "Packaging C-Spec Ordering Options Table" |

¹ Flexible termination option is available. Please see FT-CAP product bulletin C1087_U2J_FT-CAP_SMD.

² Additional capacitance tolerance offerings may be available. Contact KEMET for details.

Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) | | |
|---|---|--|--|
| Comme | rcial Grade ¹ | | |
| Bulk Bag/Unmarked | Not required (blank) | | |
| 7" Reel/Unmarked | TU | | |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) | | |
| 7" Reel/Unmarked/2 mm pitch ² | 7081 | | |
| 13" Reel/Unmarked/2 mm pitch ² | 7082 | | |
| Automo | tive Grade ³ | | |
| 7" Reel | AUTO | | |
| 13" Reel/Unmarked | AUTO7411 (EIA 0603 and smaller case sizes) AUTO7210 (EIA 0805 and larger case sizes) | | |
| 7" Reel/Unmarked/2 mm pitch ² | 3190 | | |
| 13" Reel/Unmarked/2 mm pitch ² | 3191 | | |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices. For more information see "Capacitor Marking."

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information."

³ Reeling tape options (paper or plastic) are dependent on capacitor case size (I" x w") and thickness dimensions. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information."

³ For additional information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information."

³ All automotive packaging C-Specs listed exclude the option to laser mark components. The option to laser mark <u>is not available</u> on these devices. For more information see "Capacitor Marking."



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | Days Prior To | |
|-----------------------------|----------------------------------|---------------|------------------|
| C-Spec | Process/Product change | Obsolescence* | Implementation |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum |
| AUTO Yes (without approval) | | Yes | 90 days minimum |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive C-Spec | PPAP (Product Part Approval Process) Level | | | | | | |
|-----------------------------|--|---|---|---|---|--|--|
| | 1 | 2 | 3 | 4 | 5 | | |
| KEMET assigned ¹ | • | • | • | • | • | | |
| AUTO | | | 0 | | | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|---------------------|------------------------|-----------------------------|-----------------------------|------------------------------|-----------------------------|----------------------------|------------------------------------|
| 0402 | 1005 | 1.00 (0.040) ± 0.05 (0.002) | 0.50 (0.020) ± 0.05 (0.002) | See Table 2 for thickness | 0.30 (0.012) ± 0.10 (0.004) | 0.30 (0.012) | Solder reflow only |
| 0603 | 1608 | 1.60 (0.063) ± 0.15 (0.006) | 0.80 (0.032) ± 0.15 (0.006) | | 0.35 (0.014) ± 0.15 (0.006) | 0.70 (0.028) | Solder wave or Solder reflow |
| 0805 | 2012 | 2.00 (0.079) ± 0.20 (0.008) | 1.25 (0.049) ± 0.20 (0.008) | | 0.50 (0.02) ± 0.25 (0.010) | 0.75 (0.030) | |
| 1206 | 3216 | 3.20 (0.126) ± 0.20 (0.008) | 1.60 (0.063) ± 0.20 (0.008) | | 0.50 (0.02) ± 0.25 (0.010) | N/A | |
| 1210 | 3225 | 3.20 (0.126) ± 0.20 (0.008) | 2.50 (0.098) ± 0.20 (0.008) | | 0.50 (0.02) ± 0.25 (0.010) | | Solder reflow only |
| 1812 | 4532 | 4.50 (0.177) ± 0.30 (0.012) | 3.20 (0.126) ± 0.30 (0.012) | | 0.60 (0.024) ± 0.35 (0.014) | | |

Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | -750 ±120 ppm/°C |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 0.1% |
| Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA) |
| Dissipation Factor (DF) Maximum Limit at 25°C | 0.1% |
| Insulation Resistance (IR) Limit at 25°C | 1,000 M Ω μF or 100 G Ω (Rated voltage applied for 120 ±5 seconds at 25°C) |

To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Capacitance and dissipation factor (DF) measured under the following conditions:

1 MHz ±100 kHz and 1.0 ±0.2 V_{rms} if capacitance \leq 1,000 pF

1 kHz ±50 Hz and 1.0 ±0.2 V_{rms} if capacitance > 1,000 pF

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."


Electrical Characteristics (Typical)





Post Environmental Limits

| High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | | | | | |
|---|---------------------|----------------------|-----------------------------------|----------------------|--------------------------|--|--|--|--|--|--|--|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | | | | | | | |
| U2J | All | All | 0.5 | 0.3% or ±0.25 pF | 10% of Initial limit | | | | | | | |



Table 1A – Capacitance Range/Selection Waterfall (0402 – 1812 Case Sizes)

| | 0 | Case Size/ Series | (| C04 | 02C | ; | (| C06 | 030 | • | (| C08 | 050 | ; | | C12 | 060 | ; | | C1210C | | | | C18 | 120 | ; | |
|-------------|-------------|----------------------|----|-----|-----|----|-----|----------|----------|----|------|-------|--------|--------|-------|-------|--------|------|-------|--------|-------|----|-----|-----|-----|-----|----|
| Capacitance | Cap | Voltage Code | 8 | 4 | 3 | 5 | 8 | 4 | 3 | 5 | 8 | 4 | 3 | 5 | 8 | 4 | 3 | 5 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 |
| | Code | Rated Voltage | 10 | 16 | 25 | 50 | 10 | 16 | 25 | 50 | 10 | 16 | 25 | 50 | 5 | 16 | 25 | 50 | 5 | 16 | 25 | 50 | 0 | 5 | 16 | 25 | 50 |
| | | (VDC) Canacitance | - | - | | | - | | | D | rodu | ct Av | ailah | ility | | hin ' | Thick | noco | Cod | | | | - | | | | |
| | | Tolerance | | | | | | | | F | See | Table | e 2 fo | or Chi | p Thi | ickne | ess Di | imen | sions | 63 | | | | | | | |
| 100 pF | 101 | F G J K M | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 110 pF | 111 | F G J K M | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 120 pF | 121 | F G J K M | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 130 pF | 131 | F G J K M | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 150 pF | 151 | F G J K M | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 160 pF | 161 | F G J K M | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 180 pF | 181 | FGJKM | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 200 pF | 201 | FGJKM | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 220 pF | 221 | FGJKM | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 240 pF | 241 | FGJKM | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 270 pF | 271 | FGJKM | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 300 pF | 301 | FGJKM | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 330 pF | 331 | FGJKM | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 360 pF | 361 | FGJKM | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 390 pF | 391 | FGJKM | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 430 pF | 431 | FGJKM | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 470 pF | 471 | FGJKM | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 510 pF | 511 | FGJKM | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 560 pF | 561 | FGJKM | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 620 pF | 621 | FGJKM | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 680 pF | 681 | FGIKM | BB | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 750 pF | 751 | FGIKM | BB | BB | RR | RR | | | | | | | | | | | | | | | | | | | | | |
| 820 pF | 821 | FGIKM | RR | BB | BB | BB | | | | | | | | | | | | | | | | | | | | | |
| 910 pF | 021 | FGIKM | BB | BB | RR | RR | | | | | | | | | | | | | | | | | | | | | |
| 1 000 pF | 102 | FGIKM | BB | BB | BB | BB | CE | CE | CE | CE | | | | | | | | | | | | | | | | | |
| 1,000 pi | 112 | F G J K M | BB | BB | BB | BB | CE | CE | CE | CE | | | | | | | | | | | | | | | | | |
| 1,100 pF | 112 | | | | | | | CF CF | | CE | | | | | | | | | | | | | | | | | |
| 1,200 pF | 122 | | | | | | | CF CF | | | | | | | | | | | | | | | | | | | |
| 1,500 pF | 152 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1,500 pr | 102 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1,000 pF | 102 | | | | DD | DD | | OF | CF CF | CF | | | | | | | | | | | | | | | | | |
| 1,800 pF | 182 | FGJKM | DD | DD | DD | BB | | | | | | | | | | | | | | | | | | | | | |
| 2,000 pF | 202 | FGJKM | BB | RR | BB | | | | | | | | | | | | | | | | | | | | | | |
| 2,200 pF | 222 | FGJKM | BB | RR | RR | | | UF OF | | | | | | | | | | | | | | | | | | | |
| 2,400 pF | 242 | FGJKM | BB | RR | | | | UF OF | UF | | | | | | | | | | | | | | | | | | |
| 2,700 pF | 212 | F G J K M | RR | RR | | | UF. | UF | UF | UF | | | | | | | | | | | | | _ | | | | |
| | | (VDC) | 9 | 16 | 25 | 50 | 10 | 16 | 25 | 50 | 10 | 16 | 25 | 50 | 9 | 16 | 25 | 50 | 9 | 16 | 25 | 50 | 100 | 9 | 16 | 25 | 50 |
| Capacitance | Cap Code | Voltage Code | 8 | 4 | 3 | 5 | 8 | 4 | 3 | 5 | 8 | 4 | 3 | 5 | 8 | 4 | 3 | 5 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 |
| | | Case Size/ Series | | C04 | 02C | | | C06 | 03C | | | C08 | 05C | | | C12 | 06C | | | C | :1210 | С | | | C18 | 12C | |

XX¹ - Commercial Grade Only



Table 1A - Capacitance Range/Selection Waterfall (0402 - 1812 Case Sizes) cont.

| | | Case Size/ Series | | C04 | 020 | ; | | C06 | 030 | ; | | C08 | 050 | ; | | C12 | 06C | ; | | C1210C | | | | | C18 | 12C | |
|-------------|-------------|------------------------|----|-----|-----|----|----|-----|-----|----|------------|-------|--------|-------|-------|-------|--------|------|-------|--------|-------|----|-----|----|-----|-----|--------|
| Capacitance | Cap | Voltage Code | 8 | 4 | 3 | 5 | 8 | 4 | 3 | 5 | 8 | 4 | 3 | 5 | 8 | 4 | 3 | 5 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 |
| | Code | Rated Voltage | 5 | 16 | 25 | 50 | 10 | 16 | 25 | 50 | 10 | 16 | 25 | 50 | 10 | 16 | 25 | 50 | 10 | 16 | 25 | 50 | 00 | 10 | 16 | 25 | 50 |
| | | (VUC) Canacitance | | | | | | | | P | l Produ | ct Av | ailah | ilitv | and (| hin ' | Thick | ness | Cod | P6 | | | - | | | | |
| | | Tolerance | | | | | | | | | See | Table | e 2 fo | r Chi | p Thi | ickne | ess Di | imen | sions | ; | | | | | | | |
| 3,000 pF | 302 | F G J K M | BB | BB | | | CF | CF | CF | CF | | | | | | | | | | | | | | | | | |
| 3,300 pF | 332 | FGJKM | BB | BB | | | CF | CF | CF | CF | | | | | | | | | | | | | | | | | |
| 3,600 pF | 362 | FGJKM | BB | BB | | | CF | CF | CF | CF | | | | | | | | | | | | | | | | | |
| 3,900 pF | 392 | FGJKM | BB | BB | | | CF | CF | CF | CF | | | | | | | | | | | | | | | | | |
| 4,300 pF | 432 | FGJKM | BB | BB | | | CF | CF | CF | CF | | | | | | | | | | | | | | | | | |
| 4,700 pF | 472 | FGJKM | BB | BB | | | CF | CF | CF | CF | DN | DN | DN | DN | | | | | | | | | | | | | |
| 5,100 pF | 512 | F G J K M | | | | | CF | CF | CF | CF | DN | DN | DN | DN | | | | | | | | | | | | | |
| 5,600 pF | 562 | F G J K M | | | | | CF | CF | CF | CF | DN | DN | DN | DN | | | | | | | | | | | | | |
| 6,200 pF | 622 | F G J K M | | | | | CF | CF | CF | CF | DN | DN | DN | DN | | | | | | | | | | | | | |
| 6,800 pF | 682 | F G J K M | | | | | CF | CF | CF | CF | DN | DN | DN | DN | | | | | | | | | | | | | |
| 7,500 pF | 752 | FGJKM | | | | | CF | CF | CF | CF | DN | DN | DN | DN | | | | | | | | | | | | | |
| 8,200 pF | 822 | FGJKM | | | | | CF | CF | CF | CF | DN | DN | DN | DN | | | | | | | | | | | | | |
| 9,100 pF | 912 | FGJKM | | | | | CF | CF | CF | CF | DN | DN | DN | DN | | | | | | | | | | | | | |
| 10,000 pF | 103 | FGJKM | | | | | CF | CF | CF | CF | DN | DN | DN | DN | EB | EB | EB | EB | FB | FB | FB | FB | FB | | | | |
| 12,000 pF | 123 | F G J K M | | | | | CF | CF | CF | | DN | DN | DN | DN | EB | EB | EB | EB | FB | FB | FB | FB | FB | | | | |
| 15,000 pF | 153 | F G J K M | | | | | CF | CF | CF | | DN | DN | DN | DN | EB | EB | EB | EB | FB | FB | FB | FB | FB | | | | |
| 18,000 pF | 183 | F G J K M | | | | | CF | CF | | | DN | DN | DN | DN | EB | EB | EB | EB | FB | FB | FB | FB | FB | | | | |
| 22,000 pF | 223 | F G J K M | | | | | CF | CF | | | DN | DN | DN | DP | EB | EB | EB | EB | FB | FB | FB | FB | FB | | | | |
| 27,000 pF | 273 | F G J K M | | | | | CF | CF | | | DP | DP | DP | DP | EB | EB | EB | EB | FB | FB | FB | FB | FB | | | | |
| 33,000 pF | 333 | F G J K M | | | | | CF | | | | DP | DP | DP | DG | EB | EB | EB | EB | FB | FB | FB | FB | FC | GB | GB | GB | GB |
| 39,000 pF | 393 | F G J K M | | | | | | | | | DG | DG | DG | DG | EB | EB | EB | EB | FB | FB | FB | FB | FC | GB | GB | GB | GB |
| 47,000 pF | 473 | FGJKM | | | | | | | | | DG | DG | DG | DG | EB | EB | EB | EB | FB | FB | FB | FB | FC | GB | GB | GB | GB |
| 56,000 pF | 563 | FGJKM | | | | | | | | | DG | DG | DG | | EB | EB | EB | EC | FB | FB | FB | FB | FE | GB | GB | GB | GB |
| 68,000 pF | 683 | FGJKM | | | | | | | | | DG | DG | | | EC | EC | EC | EC | FB | FB | FB | FB | FG | GB | GB | GB | GB |
| 82,000 pF | 823 | FGJKM | | | | | | | | | DG | DG | | | EC | EC | EC | EE | FB | FB | FB | FB | FG | GB | GB | GB | GB |
| 100,000 pF | 104 | FGJKM | | | | | | | | | DG | DG | | | EC | EC | EC | EF | FB | FB | FB | FC | FG | GB | GB | GB | GB |
| 120,000 pF | 124 | FGJKM | | | | | | | | | | | | | EF | EF | EF | EH | FC | FC | FC | FE | FH | GB | GB | GB | GB |
| 150,000 pF | 154 | F G J K M | | | | | | | | | | | | | EF | EF | EF | EH | FE | FE | FE | FG | FT | GB | GB | GB | GB |
| 180,000 pF | 184 | FGJKM | | | | | | | | | | | | | EH | EH | EH | | FG | FG | FG | FG | FI | GB | GB | GB | GB |
| 220,000 pF | 224 | F G J K M | | | | | | | | | | | | | EH | EH | EH | | FG | FG | FG | FH | | GB | GB | GB | GH |
| 270,000 pF | 274 | FGJKM | | | | | | | | | | | | | | | | | FH | FH | FH | FM | | GB | GB | GB | GH |
| 330,000 pF | 334 | FGJKM | | | | | | | | | | | | | | | | | FM | FM | FM | | | GC | GC | GC | GK |
| 390,000 pF | 394 | FGJKM | | | | | | | | | | | | | | | | | | | | | | GH | GH | GH | GJ |
| 470,000 pF | 474 | FGJKM | | | | | | | | | | | | | | | | | | | | | | GK | GK | GK | GN^1 |
| | | Rated Voltage (VDC) | 10 | 16 | 25 | 50 | 10 | 16 | 25 | 50 | 10 | 16 | 25 | 50 | 10 | 16 | 25 | 50 | 10 | 16 | 25 | 50 | 100 | 10 | 16 | 25 | 50 |
| Capacitance | Cap Code | Voltage Code | 8 | 4 | 3 | 5 | 8 | 4 | 3 | 5 | 8 | 4 | 3 | 5 | 8 | 4 | 3 | 5 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 |
| | | Case Size/ Series | | C04 | 02C | | | C06 | 03C | | | C08 | 05C | | | C12 | 06C | | | C | :1210 | C | - | | C18 | 12C | |

XX¹ - Commercial Grade Only



| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic (| Quantity |
|-----------|-------------------|--------------|---------|----------------------|-----------|----------|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| BB | 0402 | 0.50 ± 0.05 | 10,000 | 50,000 | 0 | 0 |
| CF | 0603 | 0.80 ± 0.07 | 4,000 | 15,000 | 0 | 0 |
| DN | 0805 | 0.78 ± 0.10 | 4,000 | 15,000 | 0 | 0 |
| DP | 0805 | 0.90 ± 0.10 | 4,000 | 15,000 | 0 | 0 |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EB | 1206 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| EC | 1206 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| EE | 1206 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EH | 1206 | 1.60 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FB | 1210 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| FC | 1210 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| FE | 1210 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FG | 1210 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| FH | 1210 | 1.55 ± 0.15 | 0 | 0 | 2,000 | 8,000 |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FT | 1210 | 1.90 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FI | 1210 | 2.10 ± 0.20* | 0 | 0 | 1,500 | 7,000 |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GC | 1812 | 1.10 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GH | 1812 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GK | 1812 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GJ | 1812 | 1.70 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GN | 1812 | 1.70 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic | Quantity |

Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm tape and reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

Table 2B – Bulk Packaging Quantities

| Deekeri | | Loose Pa | ackaging |
|----------|-------------|------------------------|------------------------|
| Раскау | ing rype | Bulk Bag | (default) |
| Packagin | g C-Spec¹ | N/ | Ά ² |
| Case | Size | Packaging Quantities (| pieces/unit packaging) |
| EIA (in) | Metric (mm) | Minimum | Maximum |
| 0402 | 1005 | | |
| 0603 | 1608 | | |
| 0805 | 2012 | 1 | 50,000 |
| 1206 | 3216 | | |
| 1210 | 3225 | | |
| 1812 | 4532 | | 20,000 |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for automotive grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-static bulk bag and automotive grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size | EIAMetricDensity Level A:SizeSizeMaximum (Most)CodeCodeLand Protrusion (mm) | | | | | | | Dens Media Land Pi | sity Lev an (Nor rotrusio | vel B: ninal) on (mm |) | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | |
|-------------------|---|------|------|------|------|------|------|--------------------------|---------------------------------|----------------------------|------|---|------|------|------|------|--|
| Coue | Coue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 | |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 | |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 | |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 | |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 | |
| 1210 ¹ | 3225 | 1.50 | 1.60 | 2.90 | 5.60 | 3.90 | 1.40 | 1.40 | 2.80 | 4.70 | 3.30 | 1.30 | 1.20 | 2.70 | 4.00 | 3.00 | |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 | |

¹ Only for capacitance values \geq 22 μ F

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805, and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations, the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805, and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

The KEMET families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Drofile Feature | Terminat | ion Finish |
|--|-----------------------|-----------------------|
| Trome reduite | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from ${\rm T}_{\rm Smin}$ to ${\rm T}_{\rm Smax}$ | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate (T_L to T_P) | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T_L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T_{P} to T_{L})$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |

Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method | | | | | | | | | | |
|------------------------|------------------------------------|---|---|--|-------------------------------------|----------------|--|--|--|--|--|--|
| | | | | | | | | | | | | |
| | | | Package Size (L" x W") | Force | Duration | | | | | | | |
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: | 0402 | 5 N (0.51 kg) | | | | | | | | |
| | | | 0603 | 10 N (1.02 kg) | 60 seconds | | | | | | | |
| | | | ≥ 0805 | 18 N (1.83 kg) | | | | | | | | |
| Board Flex | JIS-C-6429 | Appendix 2, Note: 3.0 mm | (minimum). | | | | | | | | | |
| | | Magnification 50 X Condit | Agnification 50 X Conditions: | | | | | | | | | |
| Coldorobility | | a) Method B, 4 hour | a) Method B, 4 hours at 155°C, dry heat at 235°C | | | | | | | | | |
| Solderability | J-51D-002 | b) Method B at 215° | °C, category 3 | | | | | | | | | |
| | | c) Method D at 260° | °C, category 3 | | | | | | | | | |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to +12 | 25°C). Measurement at 24 | hours ±4 hours a | after test conclu | usion. | | | | | | |
| | | Load humidity: 1,000 hour Measurement at 24 hours | rs 85°C/85% RH and rated ±4 hours after test conclu | voltage. Add 100 Jsion. |) K ohm resisto | r. | | | | | | |
| Blased Humidity | MIL-STD-202 Method 103 | Low volt humidity: 1,000 h Measurement at 24 hours | ours 85°C/85% RH and 1. +4 hours after test conclu | 5 V. Add 100 K ol Ision | nm resistor. | | | | | | | |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps test conclusion. | 7a and 7b not required. Mo | easurement at 24 | hours ±4 hours | s after | | | | | | |
| Thermal Shock | MIL-STD-202 Method 107 | -55°C/+125°C. Note: Num seconds. Dwell time - 15 | iber of cycles required – 3 minutes, Air – air, | 00. Maximum tra | ansfer time – 20 | <u>כ</u> | | | | | | |
| High Temperature Life | MIL-STD-202 Method 108/EIA -198 | 1,000 hours at 125°C with | 2 X rated voltage applied | | | | | | | | | |
| Storage Life | MIL-STD-202 Method 108 | 125°C, 0 VDC for 1,000 ho | urs. | | | | | | | | | |
| Vibration | MIL-STD-202 Method 204 | 5 G's for 20 minutes, 12 cy 7 secure points on one lor mounted within 2" from a | ycles each of 3 orientation ng side and 2 secure point ny secure point. Test from | ns. Note: Use 8" X is at corners of o 10 – 2,000 Hz. | (5" PCB 0.031" pposite sides. F | thick Parts | | | | | | |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, C | ondition F. | | | | | | | | | |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemi | cal, OKEM clean or equiva | lent. | | | | | | | | |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction



Capacitor Marking (Optional)

Laser marking option is not available on:

- COG, U2J, Ultra Stable X8R, and Y5V dielectric devices
- · EIA 0402 case size devices
- EIA 0603 case size devices with flexible termination option
- KPS commercial and automotive grade stacked devices

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punched Paper | | | |
|----------------------|------|---------|--------------------|---------------|--------------------|--|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | |
| | (W)* | Pitch | (P ₁)* | Pitch | (P ₁)* | | |
| 01005 - 0402 | 8 | | | 2 | 2 | | |
| 0603 | 8 | | | 2/4 | 2/4 | | |
| 0805 | 8 | 4 | 4 | 4 | 4 | | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | | |
| 1805 - 1808 | 12 | 4 | 4 | | | | |
| ≥ 1812 | 12 | 8 | 8 | | | | |
| KPS 1210 | 12 | 8 | 8 | | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | | |
| Array 0612 | 8 | 4 | 4 | | | | |

*Refer to Figures 1 and 2 for W and P₁ carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size. 2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- · Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|--|--|--|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum | | | | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | | | |
| 16 mm | | (0.059) | | | | (1.181) | | | | | | | |
| | | , | Variable Dime | ensions – Mil | limeters (Incl | nes) | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ | | | | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | | | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | te 5 | | | | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_n and B_n are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions — Millimeters (Inches) | | | | | | | | | | | | | |
|-----------|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|--|--|--|--|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | | | | | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | | | | | | |
| | | Variable D | imensions – M | illimeters (Inche | es) | | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | | | | | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | | | | | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | | | | | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | |
|-----------|--|---------------------------------------|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | |
| 8 mm | 178 ±0.20 | | | | | |
| 12 mm | Or 220 10 20 | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | |
| 16 mm | (13.000 ±0.008) | | | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber



KPS "L" Series, High Voltage, SnPb Termination, X7R Dielectric, 500 – 630 VDC (Commercial Grade)



Overview

KEMET Power Solutions (KPS) High Voltage "L" Series with Tin/Lead Termination stacked capacitors utilize a proprietary lead-frame technology to vertically stack one or two multilayer ceramic chip capacitors into a single compact surface mount package. The attached lead-frame mechanically isolates the capacitor's from the printed circuit board, therefore offering advanced mechanical and thermal stress performance. Isolation also addresses concerns for audible, microphonic noise that may occur when a bias voltage is applied. A two chip stack offers up to double the capacitance in the same or smaller design footprint when compared to traditional surface mount MLCC devices. Providing up to 10 mm of board flex capability, KEMET's tin/lead electroplating process is designed to meet a 5% minimum lead content and address concerns for a more robust and reliable lead containing termination system. As the bulk of the electronics industry moves towards RoHS compliance, KEMET continues to provide tin/lead terminated products for military, aerospace and industrial applications and will ensure customers have a stable and long-term source of supply.

KEMET's KPS Series devices in X7R dielectric exhibit a predictable change in capacitance with respect to time and voltage and boast a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to ±15% from -55°C to +125°C. These devices provide lower ESR, ESL and higher ripple current capability when compared to other dielectric solutions.

Conventional uses include both snubbers and filters in applications such as switching power supplies and lighting ballasts. Their exceptional performance at high frequencies has made high voltage ceramic capacitors the preferred dielectric choice of design engineers worldwide. In addition to their use in power supplies, these capacitors are widely used in industries related to automotive (hybrid), telecommunications, medical, military, aerospace, semiconductors and test/diagnostic equipment.



Ordering Information

| С | 2220 | С | 105 | М | C | R | 2 | L | 7186 |
|---------|------------------------|--------------------------|---|---------------------------------------|---------------------------|------------|--|----------------------------------|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance ¹ | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Leadframe Finish ² | Packaging/ Grade (C-Spec) ³ |
| | 2220 | C = Standard | Two Significant Digits and Number of Zeroes | K = ±10% M = ±20 | C = 500 B = 630 | R = X7R | 1 = KPS single chip stack 2 = KPS double chip stack | L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ Double chip stacks ("2" in the 13th character position of the ordering code) are only available in M (\pm 20%) capacitance tolerance. Single chip stacks ("1" in the 13th character position of the ordering code) are available in K (\pm 10%) or M (\pm 20%) tolerances.

² Additional leadframe finish options may be available. Contact KEMET for details.

Built Into Tomorrow



Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) |
|---|---|
| 7" Reel (Embossed Plastic Tape)/Unmarked | 7186 |
| 13" Reel (Embossed Plastic Tape)/Unmarked | 7289 |

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices. For more information see "Capacitor Marking".

Benefits

- Operating temperature range of -55°C to +125°C
- Reliable and robust termination system
- EIA 2220 case size
- DC voltage ratings of 500 V and 630 V
- Capacitance offerings ranging from 0.047 μF up to 1.0 μF
- Available capacitance tolerances of ±10% and ±20%
- · Higher capacitance in the same footprint
- Potential board space savings

- Advanced protection against thermal and mechanical stress
- · Provides up to 10 mm of board flex capability
- Reduces audible, microphonic noise
- · Extremely low ESR and ESL
- SnPb plated termination finish (5% Pb minimum)
- Non-polar device, minimizing installation concerns
- · Film alternative

Applications

Typical applications include switch mode power supplies (input filters, resonators, tank circuits, snubber circuits, output filters), high voltage coupling and DC blocking, lighting ballasts, voltage multiplier circuits, DC/DC converters and coupling capacitors in Ćuk converters. Markets include power supply, LCD fluorescent backlight ballasts, HID lighting, telecommunication equipment, industrial and medical equipment/control, LAN/WAN interface, analog and digital modems, and automotive (electric and hybrid vehicles, charging stations and lighting applications).

Qualification/Certification

Commercial grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance and Reliability.

Environmental Compliance

These devices do not meet RoHS criteria due to the concentration of Lead (Pb) in the termination finish.



Dimensions – Inches (Millimeters)









Single Chip Stack

| Number of Chips | EIA SIZE CODE | METRIC SIZE CODE | L LENGTH | W WIDTH | H HEIGHT | LW LEAD WIDTH | Mounting Technique |
|--------------------|------------------|---------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-----------------------|
| Single | 2220 | 5650 | 6.00 (0.236) ±0.50 (0.020) | 5.00 (0.197) ±0.50 (0.020) | 3.50 (0.138) ±0.30 (0.012) | 1.60 (0.063) ±0.30 (0.012) | Solder Reflow |
| Double | 2220 | 5650 | 6.00 (0.236) ±0.50 (0.020) | 5.00 (0.197) ±0.50 (0.020) | 5.00 (0.197) ±0.50 (0.020) | 1.60 (0.063) ±0.30 (0.012) | Only |

Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|--|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 Vdc Applied (TCC) | ±15% |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| ² Dielectric Withstanding Voltage (DWV) | 150% of rated voltage for voltage rating of < 1000 V 120% of rated voltage for voltage rating of \ge 1000 V (5±1 seconds and charge/discharge not exceeding 50 mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | 2.5% |
| ⁴ Insulation Resistance (IR) Minimum Limit at 25°C | 1,000 megohm microfarads or 100 GΩ (500 VDC applied for 120±5 seconds at 25°C) |

¹ Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours.

² DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

³ Capacitance and dissipation factor (DF) measured under the following conditions:

1 kHz ±50 Hz and 1.0±0.2 Vrms if capacitance \leq 10 μ F

120 Hz ±10 Hz and 0.5±0.1 Vrms if capacitance > 10 μF

⁴ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON".



Post Environmental Limits

| High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | |
|---|---------------------|----------------------|-----------------------------------|----------------------|--------------------------|--|
| Dielectric | Rated DC Voltage | Capacitance Value | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | |
| | > 25 | | 3.0 | | 10% of Initial Limit | |
| X7R | 16/25 | All | 5.0 | ±20% | | |
| | < 16 | | 7.5 | | | |

Table 1 – Capacitance Range/Selection Waterfall (2220 Case Size)

| | | Case Size/Series | | C2220C | | |
|-------------------|-------------|-------------------------|-------------|--|---|--|
| | Capacitance | Voltage Code | | C | В | |
| Capacitance | Code | Rated Vol | age (VDC) | 500 | 630 | |
| | | Capacitanc | e Tolerance | Product Availability and See Table 2 for Chip T | l Chip Thickness Codes hickness Dimensions | |
| Single Chip Stack | | | | | | |
| 0.047 µF | 473 | К | М | JP | JP | |
| 0.10 uF | 104 | К | М | JP | JP | |
| 0.15 uF | 154 | К | М | JP | JP | |
| 0.22 uF | 224 | К | М | JP | JP | |
| 0.33 uF | 334 | К | М | JP | | |
| 0.47 uF | 474 | К | М | JP | | |
| | | Do | uble Chi | p Stack | | |
| 0.10 uF | 104 | | М | JR | JR | |
| 0.22 uF | 224 | | М | JR | JR | |
| 0.33 uF | 334 | | M | JR | JR | |
| 0.47 uF | 474 | | М | JR | JR | |
| 0.68 uF | 684 | | M | JR | | |
| 1.0 uF | 105 | | М | JR | | |
| | | | age (VDC) | 500 | 630 | |
| Capacitance | Capacitance | Voltag | e Code | C | В | |
| | Code | Case Siz | e/Series | C22 | 20C | |



| | - | - | | | | |
|-----------|------|-------------|---------|----------|---------|----------|
| Thickness | Case | Thickness ± | Paper C |)uantity | Plastic | Quantity |
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| JP | 2220 | 3.50 ± 0.30 | 0 | 0 | 300 | 1,300 |
| JR | 2220 | 5.00 ± 0.50 | 0 | 0 | 200 | 800 |

7" Reel

Paper Quantity

0 13" Reel

7" Reel

Plastic Quantity

13" Reel

Table 2 - Chip Thickness/Tape & Reel Packaging Quantities

Package quantity based on finished chip thickness specifications.

Thickness ±

Range (mm)

Case

Size

Thickness

Code

Table 3 – KPS Land Pattern Design Recommendations (mm)

| EIA SIZE | METRIC SIZE | Median (Nominal) Land Protrusion | | | | | |
|----------|----------------|-------------------------------------|------|------|------|------|--|
| CODE | CODE | C | Y | X | V1 | V2 | |
| 2220 | 5650 | 2.69 | 2.08 | 4.78 | 7.70 | 6.00 | |



KEMET's KPS Series land pattern design recommendations have been evaluated through extensive internal testing and validation. KPS lead frames are used to mechanically isolate the MLCC from the PCB and provide stress relief for increased mechanical robustness. The land pattern dimensions for each EIA size code are designed to be encompassed within the end terminations thus regulating solder wicking and maintaining lead frame flexibility. This design is optimized to enable durable solder joint fillets which improve the mechanical integrity and reliability upon placement.



Soldering Process

KEMET's KPS Series devices are compatible with IR reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for IR reflow reflect the profile conditions of the IPC/J-STD-020D standard for moisture sensitivity testing.

To prevent degradation of temperature cycling capability, care must be taken to prevent solder from flowing into the inner side of the lead frames (inner side of "J" lead in contact with the circuit board).

After soldering, the capacitors should be air cooled to room temperature before further processing. Forced air cooling is not recommended.

Hand soldering should be performed with care due to the difficulty in process control. If performed, care should be taken to avoid contact of the soldering iron to the capacitor body. The iron should be used to heat the solder pad, applying solder between the pad and the lead, until reflow occurs. Once reflow occurs, the iron should be removed immediately. (Preheating is required when hand soldering to avoid thermal shock.)

| Profile Feature | SnPb Assembly | Pb-Free Assembly |
|--|---------------------|---------------------|
| Preheat/Soak | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t _s) from T_{min} to T_{max}) | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-up Rate (T_L to T_P) | 3°C/seconds maximum | 3°C/seconds maximum |
| Liquidous Temperature (T_L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _p) | 235°C | 250°C |
| Time within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 10 seconds maximum |
| Ramp-down Rate $(T_p to T_L)$ | 6°C/seconds maximum | 6°C/seconds maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |

Note: All temperatures refer to the center of the package, measured on the package body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method |
|------------------------|------------------------------------|--|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds |
| Board Flex | JIS-C-6429 | Appendix 2, Note: 5.0 mm minimum |
| | | Magnification 50X. Conditions: |
| Coldovahilitu | | a) Method B, 4 hours at 155°C, dry heat at 235°C |
| Solderability | J-51D-002 | b) Method B at 215°C category 3 |
| | | c) Method D, category 3 at 250°C |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 Cycles (-55°C to +125°C), Measurement at 24 hours ± 4 hours after test conclusion. |
| Dissed Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and 200 VDC maximum. Add 100K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. |
| Blased Humidity | | Low Volt Humidity: 1,000 hours 85C°/85%RH and 1.5V. Add 100K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours ±4 hours after test conclusion. |
| Thermal Shock | MIL-STD-202 Method 107 | -55°C/+125°C. Note: Number of cycles required – 300, Maximum transfer time – 20 seconds, Dwell time – 15 minutes. Air – Air. |
| High Temperature Life | MIL-STD-202 Method 108/EIA -198 | 1,000 hours at 125°C with rated voltage applied. |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC, for 1,000 Hours. |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz |
| Mechanical Shock | MIL-STD-202 Method 212 | Figure 1 of Method 213, Condition F. |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add Aqueous wash chemical, OKEM Clean or equivalent. |

Storage & Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. In addition, temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction



Product Marking

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option
- · KPS Commercial and Automotive grade stacked devices

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration – Embossed Plastic (mm)

| EIA Case Size | Tape Size (W)* | Pitch (P ₁)* | | |
|-------------------|----------------|--------------------------|--|--|
| 01005 - 0402 | 8 | 2 | | |
| 0603 - 1210 | 8 | 4 | | |
| 1805 - 1808 | 12 | 4 | | |
| ≥ 1812 | 12 | 8 | | |
| KPS 1210 | 12 | 8 | | |
| KPS 1812 and 2220 | 16 | 12 | | |
| Array 0612 | 8 | 4 | | |

*Refer to Figure 1 for W and P, carrier tape reference locations. *Refer to Table 5 for tolerance specifications.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|---------------------------------|---------------------------|--|--|--|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximim | | | | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | | | | |
| 12 mm | 1.5 +0.10/0.0-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | | | |
| 16 mm | | (0.059) | | | | (1.181) | | | | | | | |
| | | | Variable D | imensions — | Millimeters (| Inches) | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ , B ₀ | , & K ₀ | | | | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | | | | |
| 12 mm | Single (4 mm) and Double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | Note 5 | | | | | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.

2. The tape with or without components shall pass around R without damage (see Figure 5).

3. If S₁ < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Standard 481 paragraph 4.3 section b).

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{α} , B_{α} and K_{α} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 2).

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 3).

(e) for KPS Series product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 2 – Maximum Component Rotation



Figure 3 – Maximum Lateral Movement



Figure 4 – Bending Radius





Figure 5 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 7 – Reel Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | | |
|-----------|--|---------------------------------------|--|---|--|--|--|--|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | | | | | | |
| 8 mm | 178 ±0.20 | | | | | | | | | | | |
| 12 mm | Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | | | | | | |
| 16 mm | (13.000 ±0.008) | | , , , , , , , , , , , , , , , , , , , | | | | | | | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | | | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | | | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | | | | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | | | | | | |



Figure 6 – Tape Leader & Trailer Dimensions



Figure 7 – Maximum Camber





Overview

KEMET Power Solutions (KPS) Commercial "L" with Tin/ Lead Termination stacked capacitors utilize a proprietary lead-frame technology to vertically stack one or two multilayer ceramic chip capacitors into a single compact surface mount package. The attached lead-frame mechanically isolates the capacitor's from the printed circuit board, therefore offering advanced mechanical and thermal stress performance. Isolation also addresses concerns for audible, microphonic noise that may occur when a bias voltage is applied. A two chip stack offers up to double the capacitance in the same or smaller design footprint when compared to traditional surface mount MLCC devices. Providing up to 10 mm of board flex capability, KEMET's tin/lead electroplating process is designed to meet a 5% minimum lead content and address concerns for a more robust and reliable lead containing

termination system. As the bulk of the electronics industry moves towards RoHS compliance, KEMET continues to provide tin/lead terminated products for military, aerospace and industrial applications and will ensure customers have a stable and long-term source of supply. These devices provide lower ESR, ESL and higher ripple current capability when compared to other dielectric solutions.

Combined with the stability of an X7R dielectric, KEMET's KPS devices exhibit a predictable change in capacitance with respect to time and voltage and boast a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to $\pm 15\%$ from -55° C to $\pm 125^{\circ}$ C.

Benefits

- Operating temperature range of -55°C to +125°C
- · Reliable and robust termination system
- EIA 1210 and 2220 case sizes
- DC voltage ratings of 10 V, 16 V, 25 V, 50 V, 63 V, 100 V and 250 V
- \bullet Capacitance offerings ranging from 0.1 up to 47 μF



Ordering Information

| С | 2220 | С | 106 | М | 5 | R | 2 | L | 7186 |
|---------|------------------------|--------------------------|---|---------------------------------------|--|------------|--|----------------------------------|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance ¹ | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Leadframe Finish ² | Packaging/ Grade (C-Spec) |
| | 1210 2220 | C = Standard | Two Significant Digits and Number of Zeroes | K = ±10% M = ±20% | 8 = 10 4 = 16 3 = 25 5 = 50 M = 63 1 = 100 A = 250 | R = X7R | 1 = KPS Single Chip Stack 2 = KPS Double Chip Stack | L = SnPb (5% Pb min.) | See "Packaging C-Spec Ordering Options Table" |

¹ Double chip stacks ("2" in the 13th character position of the ordering code) are only available in M (\pm 20%) capacitance tolerance. Single chip stacks ("1" in the 13th character position of the ordering code) are available in K (\pm 10%) or M (\pm 20%) tolerances.

² Additional leadframe finish options may be available. Contact KEMET for details.

Built Into Tomorrow



Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) |
|---|---|
| 7" Reel (Embossed Plastic Tape)/Unmarked | 7186 |
| 13" Reel (Embossed Plastic Tape)/Unmarked | 7289 |

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices. For more information see "Capacitor Marking."

Benefits cont.

- Available capacitance tolerances of ±10% and ±20%
- · Higher capacitance in the same footprint
- · Potential board space savings
- · Advanced protection against thermal and mechanical stress
- · Provides up to 10mm of board flex capability
- Reduces audible, microphonic noise
- Extremely low ESR and ESL
- SnPb plated termination finish (5% Pb minimum)
- · Non-polar device, minimizing installation concerns
- Tantalum and electrolytic alternative

Applications

Typical applications include smoothing circuits, DC/DC converters, power supplies (input/output filters), noise reduction (piezoelectric/mechanical), circuits with a direct battery or power source connection, critical and safety relevant circuits without (integrated) current limitation, and any application that is subject to high levels of board flexure or temperature cycling. Markets include industrial, aerospace, automotive and telecommunications.



Qualification/Certification

Commercial grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance & Reliability.

Environmental Compliance

These devices do not meet RoHS criteria due to the concentration of Lead (Pb) in the termination finish.

Dimensions – Inches (Millimeters)







| Number of Chips | EIA SIZE CODE | METRIC SIZE CODE | L LENGTH | W WIDTH | H HEIGHT | LW LEAD WIDTH | Mounting Technique |
|--------------------|------------------|---------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-----------------------|
| Cingle | 1210 | 3225 | 3.50 (0.138) ±0.30 (0.012) | 2.60 (0.102) ±0.30 (0.012) | 3.35 (0.132) ±0.10 (0.004) | 0.80 (0.032) ±0.15 (0.006) | |
| Single | 2220 | 5650 | 6.00 (0.236) ±0.50 (0.020) | 5.00 (0.197) ±0.50 (0.020) | 3.50 (0.138) ±0.30 (0.012) | 1.60 (0.063) ±0.30 (0.012) | Solder Reflow |
| Double | 1210 | 3225 | 3.50 (0.138) ±0.30 (0.012) | 2.60 (0.102) ±0.30 (0.012) | 6.15 (0.242) ±0.15 (0.006) | 0.80 (0.031) ±0.15 (0.006) | Only |
| Double | 2220 | 5650 | 6.00 (0.236) ±0.50 (0.020) | 5.00 (0.197) ±0.50 (0.020) | 5.00 (0.197) ±0.50 (0.020) | 1.60 (0.063) ±0.30 (0.012) | |



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 Vdc Applied (TCC) | ±15% |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| ² Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | 5% (10 V), 3.5% (16 V and 25 V) and 2.5%(50 V to 250 V) |
| ⁴ Insulation Resistance (IR) Minimum Limit at 25°C | See Insulation Resistance Limit Table (Rated voltage applied for 120 ±5 seconds at 25°C) |

¹ Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 48 or 1,000 hours. Please refer to a part number specific datasheet for referee time details.

² DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

³ Capacitance and dissipation factor (DF) measured under the following conditions:

1 kHz ±50 Hz and 1.0 ±0.2 V_{rms} if capacitance \leq 10 μ F

120 Hz ±10 Hz and 0.5 ±0.1 $V_{\rm rms}$ if capacitance > 10 μ F

⁴ To obtain IR limit, divide $M\Omega - \mu F$ value by the capacitance and compare to $G\Omega$ limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

Post Environmental Limits

| High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | | | | |
|---|-------|-----|-----|------|-------------------------|--|--|--|--|--|--|
| Dielectric Rated DC Voltage Capacitance Value Dissipation Factor (Maximum %) Capacitance Shift Insulati Resistar | | | | | | | | | | | |
| | > 25 | | 3.0 | | 1 | | | | | | |
| X7R | 16/25 | All | 5.0 | ±20% | 10% of Initial Limit | | | | | | |
| | < 16 | | 7.5 | | | | | | | | |

Insulation Resistance Limit Table

| EIA Case Size | 1,000 Megohm Microfarads or 100 GΩ | 500 Megohm Microfarads or 10 GΩ |
|---------------|---------------------------------------|------------------------------------|
| 1210 | < 0.39 µF | ≥ 0.39 µF |
| 2220 | < 10 µF | ≥ 10 µF |



Electrical Characteristics

Z and ESR C1210C475M5R1L



Z and ESR C2220C476M3R2L



Impedance - 1210, .22 µF, 50 V X7R



Z and ESR C2220C225MAR2L



ESR – 1210, .22 μF , 50 V X7R





Electrical Characteristics cont.

Microphonics - 1210, 4.7 µF, 50 V, X7R



Microphonics - 2220, 47 µF, 25 V, X7R



Competitive Comparision

Microphonics – 1210, 4.7 μF , 50 V, X7R



Microphonics - 2220, 22 µF, 50 V, X7R



Microphonics - 1210, 22 µF, 25 V, X7R



Ripple Current (Arms) 2220, 22 $\mu\text{F},$ 50 V



Note: Refer to Table 4 for test method.



Electrical Characteristics cont.

Board Flex vs. Termination Type



Board Flexure to 10 mm



Board Flex vs. Termination Type





Table 1 – Capacitance Range/Selection Waterfall (1210 & 2220 Case Sizes)

| | | Case Se | Size/ ries | | C1210C | | | | | | | C22 | 20C | | |
|-------------|-------------------|------------|---------------|----|--------|--------|--------------|------------------------|-------------------------|-----------------------|----------------------|----------------|-----|-----|-----|
| o :: | Capacitance | Voltag | je Code | 8 | 4 | 3 | 5 | 1 | A | 4 | 3 | 5 | м | 1 | A |
| Capacitance | Code | Rated Vol | tage (VDC) | 10 | 16 | 25 | 50 | 100 | 250 | 16 | 25 | 50 | 63 | 100 | 250 |
| | | Capacitanc | e Tolerance | | | | Produ See | ct Availa Table 2 f | bility an for Chip 1 | d Chip Tl Thicknes | nickness s Dimens | Codes sions | | | |
| | Single Chip Stack | | | | | | | | | | | | | | |
| 0.10 µF | 104 | K | М | F۷ | FV | FV | FV | FV | FV | JP | JP | JP | JP | JP | JP |
| 0.22 µF | 224 | К | M | FV | FV | FV | FV | FV | | JP | JP | JP | JP | JP | JP |
| 0.47 µF | 474 | К | M | FV | FV | FV | FV | FV | | JP | JP | JP | JP | JP | JP |
| 1.0 μF | 105 | К | M | FV | FV | FV | FV | FV | | JP | JP | JP | JP | JP | JP |
| 2.2 µF | 225 | К | M | FV | FV | FV | FV | | | JP | JP | JP | JP | JP | |
| 3.3 µF | 335 | К | M | FV | FV | FV | FV | | | JP | JP | JP | JP | JP | |
| 4.7 μF | 475 | К | M | FV | FV | FV | FV | | | JP | JP | JP | JP | | |
| 10 µF | 106 | К | M | FV | FV | FV | | | | JP | JP | JP | JP | | |
| 15 µF | 156 | К | M | FV | | | | | | JP | JP | | | | |
| 22 µF | 226 | К | M | FV | | | | | | JP | JP | | | | |
| | | | | | Doubl | e Chip | Stack | | | | | | | | |
| 0.10 µF | 104 | | М | FW | FW | FW | FW | FW | FW | JR | JR | JR | JR | JR | JR |
| 0.22 μF | 224 | | м | FW | FW | FW | FW | FW | FW | JR | JR | JR | JR | JR | JR |
| 0.47 µF | 474 | | М | FW | FW | FW | FW | FW | | JR | JR | JR | JR | JR | JR |
| 1.0 µF | 105 | | М | FW | FW | FW | FW | FW | | JR | JR | JR | JR | JR | JR |
| 2.2 µF | 225 | | М | FW | FW | FW | FW | FW | | JR | JR | JR | JR | JR | JR |
| 3.3 µF | 335 | | м | FW | FW | FW | FW | FW | | JR | JR | JR | JR | JR | |
| 4.7 µF | 475 | | м | FW | FW | FW | FW | | | JR | JR | JR | JR | JR | |
| 10 µF | 106 | | м | FW | FW | FW | FW | | | JR | JR | JR | JR | | |
| 22 µF | 226 | | м | FW | FW | FW | | | | JR | JR | JR | JR | | |
| 33 µF | 336 | | M | FW | | | | | | JR | JR | | | | |
| 47 µF | 476 | | M | FW | | | | | | JR | JR | | | | |
| | | Rated Vol | tage (VDC) | 10 | 16 | 25 | 50 | 100 | 250 | 16 | 25 | 50 | 63 | 100 | 250 |
| Capacitance | Capacitance | Voltag | je Code | 8 | 4 | 3 | 5 | 1 | A | 4 | 3 | 5 | м | 1 | A |
| oupuonunoe | Code | Case Siz | e/Series | | C1210C | | | | C2220C | | | | | | |



| Thickness | Case | Thickness ± | Paper C |)uantity | Plastic | Quantity | |
|----------------------------|------|-------------|---------|----------|------------------|----------|--|
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| FV | 1210 | 3.35 ±0.10 | 0 | 0 | 600 | 2,000 | |
| FW | 1210 | 6.15 ±0.15 | 0 | 0 | 300 | 1,000 | |
| JP | 2220 | 3.50 ±0.30 | 0 | 0 | 300 | 1,300 | |
| JR | 2220 | 5.00 ±0.50 | 0 | 0 0 | | 800 | |
| Thickness Case Thickness ± | | Thickness ± | 7" Reel | 13" Reel | 7" Reel 13" Reel | | |
| Code | Size | Range (mm) | Paper (| Quantity | Plastic | Quantity | |

Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

Package quantity based on finished chip thickness specifications.

Table 3 – KPS Land Pattern Design Recommendations (mm)

| EIA SIZE CODE | METRIC SIZE CODE | Median (Nominal) Land Protrusion | | | | |
|------------------|------------------------|-------------------------------------|------|------|------|------|
| | | C | Y | X | V1 | V2 |
| 1210 | 3225 | 1.50 | 1.14 | 1.75 | 5.05 | 3.40 |
| 2220 | 5650 | 2.69 | 2.08 | 4.78 | 7.70 | 6.00 |

Image at right based on an EIA 1210 case size.



KEMET's KPS Series land pattern design recommendations have been evaluated through extensive internal testing and validation. KPS lead frames are used to mechanically isolate the MLCC from the PCB and provide stress relief for increased mechanical robustness. The land pattern dimensions for each EIA size code are designed to be encompassed within the end terminations thus regulating solder wicking and maintaining lead frame flexibility. This design is optimized to enable durable solder joint fillets which improve the mechanical integrity and reliability upon placement.


Soldering Process

KEMET's KPS devices are compatible with IR reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for IR reflow reflect the profile conditions of the IPC/J-STD-020D standard for moisture sensitivety testing.

To prevent degradation of temperature cycling capability, care must be taken to prevent solder from flowing into the inner side of the lead frames (inner side of "J" lead in contact with the circuit board).

After soldering, the capacitors should be air cooled to room temperature before further processing. Forced air cooling is not recommended.

Hand soldering should be performed with care due to the difficulty in process control. If performed, care should be taken to avoid contact of the soldering iron to the capacitor body. The iron should be used to heat the solder pad, applying solder between the pad and the lead, until reflow occurs. Once reflow occurs, the iron should be removed immediately. (Preheating is required when hand soldering to avoid thermal shock.)

| Profile Feature | SnPb Assembly | Pb-Free Assembly |
|--|---------------------|---------------------|
| Preheat/Soak | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t _s) from T_{min} to T_{max}) | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-up Rate (T_L to T_P) | 3°C/seconds maximum | 3°C/seconds maximum |
| Liquidous Temperature (T_L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _p) | 235°C | 250°C |
| Time within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum | 10 seconds maximum |
| Ramp-down Rate $(T_p to T_L)$ | 6°C/seconds maximum | 6°C/seconds maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |

Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods & Conditions

| Stress | Reference | Test or Inspection Method |
|------------------------|------------------------|--|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8kg for 60 seconds |
| Board Flex | JIS-C-6429 | Appendix 2, Note: 5.0 mm minimum |
| | | Magnification 50X. Conditions: |
| Colderahilitu | | a) Method B, 4 hours at 155°C, dry heat at 235°C |
| Solderability | J-51D-002 | b) Method B at 215°C category 3 |
| | | c) Method D, category 3 at 250°C |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 Cycles (-55°C to +125°C), measurement at 24 hours ± 4 hours after test conclusion. |
| Discod Uumiditu | | Load Humidity: 1,000 hours 85°C/85% RH and rated voltage. Add 100K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. |
| Blased Humidity | MIL-STD-202 Method 103 | Low Volt Humidity: 1,000 hours 85C°/85%RH and 1.5V. Add 100K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours ±4 hours after test conclusion. |
| Thermal Shock | MIL-STD-202 Method 107 | -55°C/+125°C. Note: Number of cycles required – 300, maximum transfer time – 20 seconds, dwell time – 15 minutes. Air – air. |
| High Temperature Life | MIL-STD-202 Method 108 | 1,000 hours at 125°C with 1.5X rated voltage applied. |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC, for 1,000 hours. |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Condition F. |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical – OKEM clean or equivalent. |

Storage & Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. In addition, temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction



Product Marking

Laser marking option is not available on:

- COG, Ultra-Stable X8R and Y5V dielectric devices
- EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option
- · KPS Commercial and Automotive grade stacked devices

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration – Embossed Plastic (mm)

| EIA Case Size | Tape Size (W)* | Pitch (P ₁)* |
|-------------------|----------------|--------------------------|
| 01005 - 0402 | 8 | 2 |
| 0603 - 1210 | 8 | 4 |
| 1805 - 1808 | 12 | 4 |
| ≥ 1812 | 12 | 8 |
| KPS 1210 | 12 | 8 |
| KPS 1812 and 2220 | 16 | 12 |
| Array 0612 | 8 | 4 |

*Refer to Figure 1 for W and P, carrier tape reference locations. *Refer to Table 5 for tolerance specifications.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|---------------------------------|---------------------------|--|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximim | | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | | |
| 12 mm | 1.5 +0.10/0.0-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | |
| 16 mm | | (0.059) | | | | (1.181) | | | | | |
| | | | Variable D | imensions — | Millimeters (| Inches) | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ , B ₀ | , & K ₀ | | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | | |
| 12 mm | Single (4 mm) and Double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | Not | e 5 | | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.

2. The tape with or without components shall pass around R without damage (see Figure 5).

3. If S₁ < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Standard 481 paragraph 4.3 section b).

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{α} , B_{α} and K_{α} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 2).

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 3).

(e) for KPS Series product, A_n and B_n are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 2 – Maximum Component Rotation



Figure 3 – Maximum Lateral Movement



Figure 4 – Bending Radius





Figure 5 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 7 – Reel Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|-----------|--|---------------------------------------|--|--|--|--|--|--|--|--|--|
| Tape Size | Tape Size A B Minimum C | | | | | | | | | | |
| 8 mm | 178 ±0.20 | | | | | | | | | | |
| 12 mm | Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0 521 +0 02/-0 008) | 20.2 (0.795) | | | | | | | |
| 16 mm | (13.000 ±0.008) | (0.001) | , , , , , , , , , , , , , , , , , , , | | | | | | | | |
| | Variable | Dimensions — Millimete | rs (Inches) | | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | | | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | | | | | |



Figure 6 – Tape Leader & Trailer Dimensions



Figure 7 – Maximum Camber





Overview

The KEMET electrostatic discharge (ESD) rated commercial and automotive grade surface mount capacitors in X7R dielectric are suited for a variety of applications where electrostatic discharge (ESD) events during assembly or operation could damage the capacitor or the circuit. These ESD rated capacitors provide the ability to design within a given ESD criteria per the human body model (HBM) AEC Q200–002 criteria. The KEMET automotive grade capacitors also meet the other demanding Automotive Electronics Council's AEC–Q200 qualification requirements. The X7R dielectric features a 125°C maximum operating temperature and is considered "temperature stable." The Electronics Industries Alliance (EIA) characterizes X7R dielectric as a Class II material. Components of this classification are fixed, ceramic dielectric capacitors, suited for bypass and decoupling applications and for frequency discriminating circuits, where Q and stability of capacitance characteristics are not critical. The X7R dielectric exhibits a predictable change in capacitance with respect to time and voltage, and boasts a minimal change in capacitance compared to its value at 25°C. Capacitance change is limited to $\pm 15\%$ from -55°C to $\pm 125°C$.

Benefits

- · AEC-Q200 automotive qualified
- ESD qualified per HBM AEC Q200-002
- Available in package size EIA 0402, 0603, 0805, 1206
- DC Voltage ratings of 16 V, 25 V, 50 V, 63 V, 100 V, 200 V and 250 V
- Capacitance range from 1 nF to 2.2 μF
- -55°C to +125°C operating temperature range
- Lead (Pb)-free, RoHS and REACH compliant
- Available capacitance tolerances of ±5%, ±10% and ±20%
- 100% pure matte tin-plated termination finish allowing for excellent solderability
- · Non-polar devices, minimizing installation concerns
- · Flexible termination option available



Typical applications include: electrostatic discharge (ESD), integrated circuit (IC) protection, radio frequency (RF) filtering function, input and output automotive applications such as controllers, navigation systems, airbags and keyless systems.

1





Ordering Information

| С | 0603 | C | 104 | J | 3 | R | E | C | AUTO |
|---------|------------------------------|---|--|---------------------------------|---|------------|-------------------------|------------------------------------|--|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ² | Packaging/ Grade (C-Spec) |
| | 0402 0603 0805 1206 | C = Standard X = Flexible Termination | Two significant digits and number of zeros | J = ±5% K = ±10% M = ±20% | 4 = 16 3 = 25 5 = 50 M = 63 1 = 100 2 = 200 A = 250 | R = X7R | E = ESD | C = 100% Matte Sn | See "Packaging C-Spec Ordering Options Table" |

¹ The flexible termination option is not available on EIA 0402 case size product. "C" must be used in the 6th character position when ordering this case size.

² Additional termination finish options may be available. Contact KEMET for details. Applications

Table 1A – Capacitance Range/Selection Waterfall

| | | Case Size/ Series | C | C0402C | | C0603C | | | | | | |
|-------------|----------|----------------------|-------|--------|------|---------|----------|--------|-------|-------|-------|--|
| Canacitance | Can Code | Rated Voltage (VDC) | 16 | 25 | 50 | 16 | 25 | 50 | 63 | 100 | 200 | |
| oupuonunee | | Voltage Code | 4 | 3 | 5 | 4 | 3 | 5 | м | 1 | 2 | |
| | | Cap Tolerance | | | I | ESD Lev | el per A | EC-Q20 | 0 | | | |
| 1.0 nF | 102 | | 2 kV | 2 kV | 2 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | |
| 1.5 nF | 152 | | 4 kV | 4 kV | 4 kV | 12 kV | 12 kV | 12 kV | 12 kV | 12 kV | 12 kV | |
| 2.2 nF | 222 | | 6 kV | 6 kV | 6 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | |
| 3.3 nF | 332 | | 8 kV | 8 kV | 8 kV | 12 kV | 12 kV | 12 kV | 12 kV | 12 kV | 12 kV | |
| 4.7 nF | 472 | | 8 kV | 8 kV | 8 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV | |
| 6.8 nF | 682 | | 4 kV | 4 kV | 4 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | |
| 10 nF | 103 | J = ±5% | 6 kV | 6 kV | 6 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | |
| 15 nF | 153 | K = ±10% | 6 kV | 6 kV | 6 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV | | |
| 22 nF | 223 | M = ±20% | 8 kV | 8 kV | 8 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV | | |
| 33 nF | 333 | | 8 kV | 8 kV | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | | |
| 47 nF | 473 | | 12 kV | 12 kV | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | | |
| 68 nF | 683 | | 12 kV | | | 25 kV | 25 kV | 25 kV | | | | |
| 100 nF | 104 | | 16 kV | | | 25 kV | 25 kV | 25 kV | | | | |
| 150 nF | 154 | | | | | 25 kV | 25 kV | 25 kV | | | | |
| 220 nF | 224 | | | | | 25 kV | 25 kV | | | | | |

DC (Direct Contact Discharged) for Values $\leq 8kV$

AC (Air Discharched) for Values $\geq 12kV$



Table 1A - Capacitance Range/Selection Waterfall (cont.)

| | Case Size/ Series | | C0805C | | | | C1206C | | | | | | | | | |
|-------------|----------------------|---------------------|--------|-------|-------|-------|--------|--------|---------|--------|-------|-------|-------|-------|-------|-------|
| Consoitones | Con Codo | Rated Voltage (VDC) | 16 | 25 | 50 | 63 | 100 | 200 | 250 | 16 | 25 | 50 | 63 | 100 | 200 | 250 |
| Capacitance | Cap Coue | Voltage Code | 4 | 3 | 5 | м | 1 | 2 | A | 4 | 3 | 5 | м | 1 | 2 | A |
| | | Cap Tolerance | | | | | | ESD Lo | evel pe | er AEC | -Q200 |) | | | | |
| 1.0 nF | 102 | | 12 kV | 12 kV | 12 kV | 12 kV | 12 kV | 12 kV | 12 kV | 4 kV | 4 kV | 4 kV | 4 kV | 4 kV | 4 kV | 4 kV |
| 1.5 nF | 152 | | 4 kV | 4 kV | 4 kV | 4 kV | 4 kV | 4 kV | 4 kV | 6 kV | 6 kV | 6 kV | 6 kV | 6 kV | 6 kV | 6 kV |
| 2.2 nF | 222 | | 4 kV | 4 kV | 4 kV | 4 kV | 4 kV | 4 kV | 4 kV | 8 kV | 8 kV | 8 kV | 8 kV | 8 kV | 8 kV | 8 kV |
| 3.3 nF | 332 | | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV |
| 4.7 nF | 472 | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV |
| 6.8 nF | 682 | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV |
| 10 nF | 103 | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV |
| 15 nF | 153 | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV |
| 22 nF | 223 | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV |
| 33 nF | 333 | J = ±5% | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV |
| 47 nF | 473 | K = ±10% | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV |
| 68 nF | 683 | M = ±20% | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV |
| 100 nF | 104 | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV |
| 150 nF | 154 | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | |
| 220 nF | 224 | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | | |
| 330 nF | 334 | | 25 kV | 25 kV | 25 kV | | | | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | | |
| 470 nF | 474 | | 25 kV | 25 kV | 25 kV | | | | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | | |
| 680 nF | 684 | | 25 kV | 25 kV | 25 kV | | | | | 25 kV | 25 kV | 25 kV | | | | |
| 1.0 μF | 105 | | 25 kV | 25 kV | | | | | | 25 kV | 25 kV | 25 kV | | | | |
| 1.5 μF | 155 | | 25 kV | | | | | | | 25 kV | 25 kV | 25 kV | | | | |
| 2.2 µF | 225 | | 25 kV | | | | | | | 25 kV | 25 kV | 25 kV | | | | |

DC (Direct Contact Discharged) for Values $\leq 8kV$

AC (Air Discharched) for Values ≥ 12kV

Packaging C-Spec Ordering Options Table

| Packaging Type | Packaging/Grade Ordering Code (C-Spec) | | | |
|---|---|--|--|--|
| Commerc | ial Grade ¹ | | | |
| Bulk Bag | Not required (blank) | | | |
| 7" Reel/Unmarked | TU | | | |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) | | | |
| 7" Reel/Unmarked/2 mm pitch ² | 7081 | | | |
| 13" Reel/Unmarked/2 mm pitch ² | 7082 | | | |
| Automoti | ve Grade ³ | | | |
| 7" Reel | AUTO | | | |
| 13" Reel/Unmarked | AUTO7411 (EIA 0603 and smaller case sizes) AUTO7210 (EIA 0805 and larger case sizes) | | | |
| 7" Reel/Unmarked/2 mm pitch ² | 3190 | | | |
| 13" Reel/Unmarked/2 mm pitch ² | 3191 | | | |

¹ Default packaging is "Bulk Bag." An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices. For more information see "Capacitor Marking."

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information."

³ Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information."

³ For additional information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information."

³ All automotive packaging C-Specs listed exclude the option to laser mark components. The option to laser mark is not available on these devices. For more information see "Capacitor Marking."

3



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | tion Due To: | Days Prior To | |
|-----------------------------|----------------------------------|----------------|------------------|--|
| C-Spec | Process/Product change | Implementation | | |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum | |
| AUTO | Yes (without approval) | Yes | 90 days minimum | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive C-Spec | | PPAP (Product Part Approval Process) Level | | | | | | | | |
|-----------------------------|---|--|---|---|---|--|--|--|--|--|
| | 1 | 2 | 3 | 4 | 5 | | | | | |
| KEMET assigned ¹ | • | • | • | • | • | | | | | |
| AUTO | | | 0 | | | | | | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only

Δ



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|----------------------------|------------------------------------|
| | | | Without Flexib | le Termination | | | |
| 0402 | 1005 | 1.00 (0.040) ±0.05 (0.002) | 0.50 (0.020) ±0.05 (0.002) | | 0.30 (0.012) ±0.10 (0.004) | 0.30 (0.012) | Solder reflow only |
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | See Table 2 for | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | |
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | Thickness | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder wave or Solder reflow |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | - | 0.50 (0.02) ±0.25 (0.010) | N/A | |
| | | | With Flexible | e Termination | | | |
| 0603 | 1608 | 1.60 (0.063) ±0.17 (0.007) | 0.80 (0.032) ±0.15 (0.006) | | 0.45 (0.018) ±0.15 (0.006) | 0.58 (0.023) | |
| 0805 | 2012 | 2.00 (0.079) ±0.30 (0.012) | 1.25 (0.049) ±0.30 (0.012) | See Table 2 for Thickness | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder wave or Solder reflow |
| 1206 | 3216 | 3.30 (0.130) ±0.40 (0.016) | 1.60 (0.063) ±0.35 (0.013) | | 0.60 (0.024) ±0.25 (0.010) | N/A | |



Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions.

Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±15% |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| ² Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | See Dissipation Factor Limit table |
| ^₄ Insulation Resistance (IR) Minimum Limit at 25°C | See Insulation Resistance Limit table (Rated voltage applied for 120 ±5 seconds at 25°C) |

¹ Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 48 or 1,000 hours. Please refer to a part number specific datasheet for referee time details

²DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

³ Capacitance and dissipation factor (DF) measured under the following conditions:

1 kHz ± 50 Hz and 1.0 ± 0.2 $V_{\rm rms}$ if capacitance \leq 10 μF

120 Hz ± 10 Hz and 0.5 ± 0.1 V_{rms} if capacitance > 10 μ F

⁴ To obtain IR limit, divide $M\Omega - \mu F$ value by the capacitance and compare to $G\Omega$ limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."



Post Environmental Limits

| | Post Environmental Limits | | | | | | | | | | | | | |
|---------------|---------------------------|-------------|-----------------------------------|----------------------|--------------------------|--|--|--|--|--|--|--|--|--|
| EIA Case Size | Rated DC Voltage | Capacitance | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | | | | | | | | | |
| | < 16 | | 7.5 | | | | | | | | | | | |
| All | 16/25 | All | 5.0 | ±20% | 10% of Initial limit | | | | | | | | | |
| | > 25 | | 3.0 | | | | | | | | | | | |

Dissipation Factor Limit Table

| EIA Case Size | Rated DC Voltage | Capacitance | Dissipation Factor (Maximum %) |
|---------------|------------------|-------------|-----------------------------------|
| A 11 | 16/25 | A 11 | 3.5 |
| All | > 25 | All | 2.5 |

Insulation Resistance (IR) Limits Table

| EIA Case Size | 1,000 megohm microfarads or 100 GΩ | 500 megohm microfarads or 10 GΩ |
|---------------|---------------------------------------|------------------------------------|
| 0402 | < .012 µF | ≥ .012 µF |
| 0603 | < .047 µF | ≥ .047 µF |
| 0805 | < 0.15 µF | ≥ 0.15 µF |
| 1206 | < 0.47 µF | ≥ 0.47 µF |



Table 1B – Product Availability and Chip Thickness Waterfall – Standard Termination

| | | Case Size/ Series | C | C0402 | 2C C0603C | | | | | | |
|-------------|----------|----------------------|------|---------|--------------------|---------------------|--------------------|--------------------|---------------------|---------|-------|
| Canacitance | Can Code | Rated Voltage (VDC) | 16 | 25 | 50 | 16 | 25 | 50 | 63 | 100 | 200 |
| oupacitance | | Voltage Code | 4 | 3 | 5 | 4 | 3 | 5 | м | 1 | 2 |
| | | Cap Tolerance | Prod | uct Ava | ilability Specs | and Chi for Chip | p Thick Thickne | ness Co ess Dim | des – Se ensions | e Packa | aging |
| 1.0 nF | 102 | | BB | BB | BB | CF | CF | CF | CF | CF | CF |
| 1.5 nF | 152 | | BB | BB | BB | CF | CF | CF | CF | CF | CF |
| 2.2 nF | 222 | | BB | BB | BB | CF | CF | CF | CF | CF | CF |
| 3.3 nF | 332 | | BB | BB | BB | CF | CF | CF | CF | CF | CF |
| 4.7 nF | 472 | | BB | BB | BB | CF | CF | CF | CF | CF | CF |
| 6.8 nF | 682 | | BB | BB | BB | CF | CF | CF | CF | CF | CF |
| 10 nF | 103 | J = ±5% | BB | BB | BB | CF | CF | CF | CF | CF | CF |
| 15 nF | 153 | K = ±10% | BB | BB | BB | CF | CF | CF | CF | CF | |
| 22 nF | 223 | M = ±20% | BB | BB | BB | CF | CF | CF | CF | CF | |
| 33 nF | 333 | | BB | BB | | CF | CF | CF | CF | CF | |
| 47 nF | 473 | | BB | BB | | CF | CF | CF | CF | CF | |
| 68 nF | 683 | | BB | | | CF | CF | CF | | | |
| 100 nF | 104 | | BB | | | CF | CF | CF | | | |
| 150 nF | 154 | | | | | CF | CF | CF | | | |
| 220 nF | 224 | | | | | CF | CF | | | | |

| | | Case Size/ Series | C0805C | | | | | C1206C | | | | | | | | |
|-------------|----------|----------------------|--------|--------|---------|----------|-------|------------------|-----------------|-----------------|-----------------|--------|--------|------|---------|-----|
| Canacitance | Can Code | Rated Voltage (VDC) | 16 | 25 | 50 | 63 | 100 | 200 | 250 | 16 | 25 | 50 | 63 | 100 | 200 | 250 |
| Capacitance | Cap Coue | Voltage Code | 4 | 3 | 5 | м | 1 | 2 | A | 4 | 3 | 5 | м | 1 | 2 | A |
| | | Cap Tolerance | Pro | duct / | Availal | oility a | nd Ch | ip Thio Thicl | ckness (ness | s Code Dimen | s – Se sions | e Pacl | kaging | Spec | s for C | hip |
| 1.0 nF | 102 | | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 1.5 nF | 152 | | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 2.2 nF | 222 | | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 3.3 nF | 332 | | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 4.7 nF | 472 | | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 6.8 nF | 682 | | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 10 nF | 103 | | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 15 nF | 153 | | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 22 nF | 223 | | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 33 nF | 333 | J = ±5% | DE | DE | DE | DE | DE | DE | | EB | EB | EB | EB | EB | EB | EB |
| 47 nF | 473 | K = ±10% | DG | DG | DG | DG | DG | DG | | ED | ED | ED | ED | ED | ED | ED |
| 68 nF | 683 | M = ±20% | DE | DE | DE | DE | DE | | | ED | ED | ED | ED | ED | ED | ED |
| 100 nF | 104 | | DE | DE | DE | DE | DE | | | EM | EM | EM | EM | EM | EM | EM |
| 150 nF | 154 | | DG | DG | DG | DG | DG | | | EG | EG | EG | EG | EG | EG | |
| 220 nF | 224 | | DG | DG | DG | DG | DG | | | EC | EC | EC | EC | EC | | |
| 330 nF | 334 | | DP | DP | DP | | | | | EM | EM | EM | EM | EM | | |
| 470 nF | 474 | | DE | DE | DE | | | | | EH | EH | EH | EH | EH | | |
| 680 nF | 684 | | DG | DG | DG | | | | | ED | ED | ED | | | | |
| 1.0 µF | 105 | | DG | DG | | | | | | ED | ED | ED | | | | |
| 1.5 μF | 155 | | DG | | | | | | | EH | EH | EH | | | | |
| 2.2 µF | 225 | | DG | | | | | | | EH | EH | EH | | | | |



Table 1C – Product Availability and Chip Thickness Waterfall – Flexible Termination

| | | Case Size/ Series | | | | | | |
|-------------|----------|---------------------|--|------------------------|-------------------------|------------------------|----------------------|--------------------|
| Canacitance | Can Code | Rated Voltage (VDC) | C) 16 25 4 3 Product Availabilit Packaging Specs CJ CJ CJ CJ CJ CJ | 50 | 63 | 100 | 200 | |
| Capacitance | oup oode | Voltage Code | 4 | 3 | 5 | м | 1 | 2 |
| | | Cap Tolerance | Product Packa | Availabil Iging Spe | lity and C cs for Ch | hip Thick ip Thickn | ness Cod ess Dime | es – See nsions |
| 1.0 nF | 102 | | CJ | CJ | CJ | CJ | CJ | CJ |
| 1.5 nF | 152 | | CJ | CJ | CJ | CJ | CJ | CJ |
| 2.2 nF | 222 | | CJ | CJ | CJ | CJ | CJ | CJ |
| 3.3 nF | 332 | | CJ | CJ | CJ | CJ | CJ | CJ |
| 4.7 nF | 472 | | CJ | CJ | CJ | CJ | CJ | CJ |
| 6.8 nF | 682 | | CJ | CJ | CJ | CJ | CJ | CJ |
| 10 nF | 103 | J = ±5% | CJ | CJ | CJ | CJ | CJ | CJ |
| 15 nF | 153 | K = ±10% | CJ | CJ | CJ | CJ | CJ | |
| 22 nF | 223 | M = ±20% | CJ | CJ | CJ | CJ | CJ | |
| 33 nF | 333 | | CJ | CJ | CJ | CJ | CJ | |
| 47 nF | 473 | | CJ | CJ | CJ | CJ | CJ | |
| 68 nF | 683 | | CJ | CJ | CJ | | | |
| 100 nF | 104 | | CJ | CJ | CJ | | | |
| 150 nF | 154 | | CJ | CJ | CJ | | | |
| 220 nF | 224 | | CJ | CJ | | | | |

| | | Case Size/ Series | | | C | 0805 | C | | | | | C1206C | | | | |
|-------------|----------|----------------------|-----|--------|---------|----------|-------|------------------|-----------------|-----------------|-----------------|--------|--------|--------|--|-----|
| Canacitance | Can Code | Rated Voltage (VDC) | 16 | 25 | 50 | 63 | 100 | 200 | 250 | 16 | 25 | 50 | 63 | 100 | 200 | 250 |
| Capacitance | Cap Coue | Voltage Code | 4 | 3 | 5 | м | 1 | 2 | A | 4 | 3 | 5 | м | 1 | 2 | A |
| | | Cap Tolerance | Pro | duct / | Availal | oility a | nd Ch | ip Thio Thicl | ckness (ness | s Code Dimen | s – Se sions | e Pac | kaging | l Sbec | 200 2 :s for C EQ EQ EQ EQ EQ EQ EQ EQ EQ ES ES EM EU | hip |
| 1.0 nF | 102 | | DR | DR | DR | DR | DR | DR | DC | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 1.5 nF | 152 | | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 2.2 nF | 222 | | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 3.3 nF | 332 | | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 4.7 nF | 472 | | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 6.8 nF | 682 | | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 10 nF | 103 | | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 15 nF | 153 | | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 22 nF | 223 | | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 33 nF | 333 | J = ±5% | DS | DS | DS | DS | DS | DS | | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 47 nF | 473 | K = ±10% | DH | DH | DH | DH | DH | DH | | ES | ES | ES | ES | ES | ES | ES |
| 68 nF | 683 | M = ±20% | DS | DS | DS | DS | DS | | | ES | ES | ES | ES | ES | ES | ES |
| 100 nF | 104 | | DE | DE | DE | DE | DE | | | EM | EM | EM | EM | EM | EM | EM |
| 150 nF | 154 | | DG | DG | DG | DG | DG | | | EU | EU | EU | EU | EU | EU | |
| 220 nF | 224 | | DG | DG | DG | DG | DG | | | ER | ER | ER | ER | ER | | |
| 330 nF | 334 | | DD | DD | DD | | | | | EM | EM | EM | EM | EM | | |
| 470 nF | 474 | | DS | DS | DS | | | | | EU | EU | EU | EU | EU | | |
| 680 nF | 684 | | DG | DG | DG | | | | | ES | ES | ES | | | | |
| 1.0 μF | 105 | | DG | DG | | | | | | ES | ES | ES | | | | |
| 1.5 μF | 155 | | DG | | | | | | | EU | EU | EU | | | | |
| 2.2 μF | 225 | | DG | | | | | | | EU | EU | EU | | | | |



Table 2 - Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic Quantity | | | |
|-----------|-------------------|-------------|---------|----------------------|------------------|----------|--|--|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | |
| BB | 0402 | 0.50 ± 0.05 | 10,000 | 50,000 | 0 | 0 | | |
| CF | 0603 | 0.80 ± 0.07 | 4,000 | 15,000 | 0 | 0 | | |
| DN | 0805 | 0.78 ± 0.10 | 4,000 | 15,000 | 0 | 0 | | |
| DP | 0805 | 0.90 ± 0.10 | 4,000 | 15,000 | 0 | 0 | | |
| DE | 0805 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 | | |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | | |
| EB | 1206 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 | | |
| EC | 1206 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 | | |
| ED | 1206 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 | | |
| EM | 1206 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | | |
| EG | 1206 | 1.60 ± 0.15 | 0 | 0 | 2,000 | 8,000 | | |
| EH | 1206 | 1.60 ± 0.20 | 0 | 0 | 2,000 | 8,000 | | |

Table 3 – Bulk Packaging Quantities

| Dookog | ing Tuno | Loose Pa | ackaging | | | | | |
|----------|------------------------|------------------------|------------------------|--|--|--|--|--|
| Раскау | ing type | Bulk Bag | (default) | | | | | |
| Packagir | ng C-Spec ¹ | N/A ² | | | | | | |
| Case | e Size | Packaging Quantities (| pieces/unit packaging) | | | | | |
| EIA (in) | Metric (mm) | Minimum | Maximum | | | | | |
| 0402 | 1005 | | | | | | | |
| 0603 | 1608 | | | | | | | |
| 0805 | 2012 | | 50,000 | | | | | |
| 1206 | 3216 | | | | | | | |
| 1210 | 3225 | 1 | | | | | | |
| 1808 | 4520 | | | | | | | |
| 1812 | 4532 | | | | | | | |
| 1825 | 4564 | | 20,000 | | | | | |
| 2220 | 5650 | | | | | | | |
| 2225 | 5664 | | | | | | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for automotive grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and automotive grade products). The 15th through 22nd character positions of the ordering code should be left blank. All products ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 4 – Land Pattern Design Recommendations per IPC-7351

| EIA Size | Metric Size | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | | | Dens Media Land Pi | sity Lev an (Nor rotrusio | vel B: ninal) on (mm |) | | Dens Minii Land Pi | sity Lev mum (L rotrusio | rel C: .east) on (mm |) |
|-------------|----------------|--|------|------|------|-------|-----------|--------------------------|---------------------------------|----------------------------|------|------|--------------------------|--------------------------------|----------------------------|------|
| Coue | Coue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| | | | | | | Witho | out Flexi | ble Term | ination | | | | | | | |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| | | | | | | Wit | h Flexibl | e Termir | nation | | | | | | | |
| 0603 | 1608 | 0.85 | 1.25 | 1.10 | 4.00 | 2.10 | 0.75 | 1.05 | 1.00 | 3.10 | 1.50 | 0.65 | 0.85 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 0.99 | 1.44 | 1.66 | 4.47 | 2.71 | 0.89 | 1.24 | 1.56 | 3.57 | 2.11 | 0.79 | 1.04 | 1.46 | 2.42 | 1.81 |
| 1206 | 3216 | 1.59 | 1.62 | 2.06 | 5.85 | 3.06 | 1.49 | 1.42 | 1.96 | 4.95 | 2.46 | 1.39 | 1.22 | 1.86 | 4.25 | 2.16 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).





Soldering Process

Recommended Soldering Technique

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile

The KEMET families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Termination Finish | | | | | |
|--|--------------------|--|--|--|--|--|
| Tomereature | 100% Matte (Sn) | | | | | |
| Preheat/Soak | | | | | | |
| Temperature minimum (T _{smin}) | 150°C | | | | | |
| Temperature maximum (T _{smax}) | 200°C | | | | | |
| Time (t _s) from T _{Smin} to T _{Smax} | 60 – 120 seconds | | | | | |
| Ramp-up rate $(T_L to T_P)$ | 3°C/second maximum | | | | | |
| Liquidous temperature (T_L) | 217°C | | | | | |
| Time above liquidous (t _L) | 60 – 150 seconds | | | | | |
| Peak temperature (T _P) | 260°C | | | | | |
| Time within 5°C of maximum peak temperature (t _p) | 30 seconds maximum | | | | | |
| Ramp-down rate $(T_{P} to T_{L})$ | 6°C/second maximum | | | | | |
| Time 25°C to peak temperature | 8 minutes maximum | | | | | |

Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 5 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | | Test or Inspection Me | ethod | | | | | | | | | |
|------------------------|---------------------------|--|--|---|--------------|--|--|--|--|--|--|--|--|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1 | .8 kg for 60 seconds. | | | | | | | | | | |
| Board Flex | JIS-C-6429 | Appendix 2, Note: Standard COG. Flexible termination sy | termination system – 2.0 m stem – 3.0 mm (minimum). | m (minimum) for all except 3 | mm for | | | | | | | | |
| | | Magnification 50 X. Conditions: | | | | | | | | | | | |
| 0-1dhilber | | a) Method B, 4 hours at 155°C, dry heat at 235°C | | | | | | | | | | | |
| Solderability | J-SID-002 | b) Method B at 215°C, | category 3 | | | | | | | | | | |
| | | c) Method D, at 260°C, | category 3 | | | | | | | | | | |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 Cycles (-55°C to +125 | 1,000 Cycles (-55°C to +125°C). Measurement at 24 hours \pm 4 hours after test conclusion. | | | | | | | | | | |
| _ | MIL-STD-202 | Load humidity: 1,000 hours Measurement at 24 hours +4 | 85°C/85% RH and rated volt hours after test conclusion | age. Add 100 K ohm resistor. 1. | | | | | | | | | |
| Biased Humidity | Method 103 | Low volt humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. | | | | | | | | | | | |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours ±4 hours after test conclusion. | | | | | | | | | | | |
| Thermal Shock | MIL-STD-202 Method 107 | -55°C/+125°C. Note: Numbe seconds. Dwell time - 15 minutes. Air | er of cycles required – 300. – Air. | Maximum transfer time – 20 | | | | | | | | | |
| | | 1,000 hours at 125°C with 2 X rated voltage applied excluding the following: | | | | | | | | | | | |
| | MIL-STD-202 | Case Size | Capacitance | Applied Voltage | | | | | | | | | |
| High Temperature Life | Method 108/EIA-198 | 0603 and 0805 | ≥ 1.0 µF | 1 E V | | | | | | | | | |
| | | 1206 and 1210 | ≥ 10 µF | 1.5 A | | | | | | | | | |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC for 1,000 hour | S. | | | | | | | | | | |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycl 7 secure points on one long mounted within 2" from any | es each of 3 orientations. N side and 2 secure points at secure point. Test from 10 - | ote: use 8" X 5" PCB 0.031" th corners of opposite sides. Pa - 2,000 Hz | nick arts | | | | | | | | |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Con | dition F. | | | | | | | | | | |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemica | l, OKEM Clean or equivalent | | | | | | | | | | |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction – Standard Termination



Construction – Flexible Termination





Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a "K" to identify KEMET, followed by two characters (per EIA–198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the "K" character only.

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.
- X7R dielectric products in capacitance values outlined below.

| EIA Case Size | Metric Size Code | Capacitance |
|---------------|------------------|-------------|
| 0603 | 1608 | ≤ 170 pF |
| 0805 | 2012 | ≤ 150 pF |
| 1206 | 3216 | ≤ 910 pF |
| 1210 | 3225 | ≤ 2,000 pF |
| 1808 | 4520 | ≤ 3,900 pF |
| 1812 | 4532 | ≤ 6,700 pF |
| 1825 | 4564 | ≤ 0.018 µF |
| 2220 | 5650 | ≤ 0.027 µF |
| 2225 | 5664 | ≤ 0.033 µF |

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 μ F. Orientation of marking is vendor optional.





Capacitor Marking (Optional) cont.

| | C | apacita | ance (p | F) For \ | /arious | Alpha/ | Numera | al Identif | fiers | | | | |
|-----------|------|---------|---------|----------|---------|---------|---------|------------|------------|----------------|--|--|--|
| Alaba | | | | | | Numera | d I | | | | | | |
| Alplia | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | |
| Character | | | | | Capa | citance | e (pF) | | | | | | |
| A | 0.10 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 | | | |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 | | | |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 | | | |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 | | | |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 | | | |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 | | | |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 | | | |
| Н | 0.20 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 | | | |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 | | | |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 | | | |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 | | | |
| М | 0.30 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 | | | |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 | | | |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 | | | |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 | | | |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 | | | |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 | | | |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 | | | |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 | | | |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 | | | |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 | | | |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 | | | |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 | | | |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 | | | |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 | | | |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 | | | |
| d | 0.40 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 | | | |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 | | | |
| f | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 | | | |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 | | | |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 | | | |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 00 800,000,000 | | | |
| у | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 | | | |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 6 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punche | d Paper | | | |
|----------------------|------|---------|--------------------|--------------------------|----------|--|--|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | | |
| | (W)* | Pitch | (P ₁)* | Pitch (P ₁)* | | | | |
| 01005 - 0402 | 8 | | | 2 | 2 | | | |
| 0603 | 8 | | | 2/4 | 2/4 | | | |
| 0805 | 8 | 4 | 4 | 4 | 4 | | | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | | | |
| 1805 - 1808 | 12 | 4 | 4 | | | | | |
| ≥ 1812 | 12 | 8 | 8 | | | | | |
| KPS 1210 | 12 | 8 | 8 | | | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | | | |
| Array 0612 | 8 | 4 | 4 | | | | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size. 2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- · Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 7 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|--|--|--|--|--|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum | | | | | | |
| 8 mm | | 1.0 (0.039) | 1.0 (0.039) | | | 25.0 (0.984) | | | | | | | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | | | | | |
| 16 mm | | (0.059) | | | | (1.181) | | | | | | | | | |
| | | , | Variable Dime | ensions – Mil | limeters (Incl | nes) | | | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ | | | | | | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | | | | | | |
| 12 mm | Single (4 mm) and Double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | Note 5 | | | | | | | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | | | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{α} , B_{α} and K_{α} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes, and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape, and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_a and B_a are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 8 - Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | | | | | |
|-----------|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|--|--|--|--|--|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | | | | | | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | | | | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | | | | | | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | | | | | | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | | | | | | | |

1. The cavity defined by A_{ρ} , B_{ρ} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius



Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs) ESD, X7R Dielectric, 16 – 250 VDC (Commercial & Automotive Grade)



Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 9 – Reel Dimensions

Metric will govern

| | Constant | Dimensions — Millimete | rs (Inches) | | | | |
|-----------|-----------------|--|--|---|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | |
| 8 mm | 178 ±0.20 | | | | | | |
| 12 mm | Or 220 10 20 | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | |
| 16 mm | (13.000 ±0.008) | | | | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | |
| 12 mm | 50 (1.969) | 50 12.4 +2.0/-0.0 (1.969) (0.488 +0.078/-0.0) | | Shall accommodate tape width without interference | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber



ESD, COG Dielectric, 25 – 250 VDC (Commercial & Automotive Grade)



Overview

The KEMET electrostatic discharge (ESD) rated commercial and automotive grade surface mount capacitors in COG dielectric are suited for a variety of applications where electrostatic discharge (ESD) events during assembly or operation could damage the capacitor or the circuit. These ESD rated capacitors provide the ability to design within a given ESD criteria per the human body model (HBM) AEC Q200–002 criteria. The KEMET automotive grade capacitors also meet the other demanding Automotive Electronics Council's AEC–Q200 qualification requirements. The COG dielectric features a 125°C maximum operating temperature and is considered "stable." The Electronics Industries Alliance (EIA) characterizes COG dielectric as a Class I material. Components of this classification are temperature compensating and are suited for resonant circuit applications, as well as those where Q and stability of capacitance characteristics are required. The COG dielectric exhibits no change in capacitance with respect to time and voltage, and boasts a negligible change in capacitance compared to its value at 25°C. Capacitance change is limited to ± 30 ppm/°C from -55°C to $\pm 125°C$.

Benefits

- · AEC-Q200 automotive qualified
- ESD qualified per HBM AEC Q200-002
- Available in package size EIA 0402, 0603, 0805, 1206
- + DC Voltage ratings of 25 V, 50 V, 63 V, 100 V, 200 V and 250 V
- Capacitance range from 1 nF to 100 nF
- -55°C to +125°C operating temperature range
- Lead (Pb)-free, RoHS and REACH compliant
- Available capacitance tolerances of ±1%, ±2%, ±5%, ±10%, and ±20%
- No piezoelectric noise
- Extremely low ESR and ESL
- High thermal stability
- High ripple current capability
- Preferred capacitance solution at line frequencies and into the MHz range
- No capacitance changes with respect to applied DC voltage
- Negligible capacitance change with respect to temperature from -55°C to +125°C
- No capacitance decay with time
- Non-polar devices, minimizing installation concerns
- · 100% pure matte tin-plated termination finish allowing for excellent solderability
- Flexible Termination option available

Applications

Typical applications include: electrostatic discharge (ESD), integrated circuit (IC) protection, radio frequency (RF) filtering function, input and output automotive applications such as controllers, navigation systems, airbags and keyless systems.





Ordering Information

| С | 0603 | C | 103 | J | 3 | G | E | С | AUTO |
|---------|------------------------------|---|--|---|---|------------|-------------------------|------------------------------------|--|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance ² | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ² | Packaging/ Grade (C-Spec) |
| | 0402 0603 0805 1206 | C = Standard X = Flexible Termination | Two significant digits and number of zeros | F = ±1% G = ±2% J = ±5% K = ±10% M = ±20% | 3 = 25 5 = 50 M = 63 1 = 100 2 = 200 A = 250 | G = COG | E = ESD | C = 100% Matte Sn | See "Packaging C-Spec Ordering Options Table" |

¹ Additional capacitance tolerance offerings may be available. Contact KEMET for details.

²Additional capacitance tolerance offerings and termination finish options may be available. Contact KEMET for details.Benefits (cont'd)

Table 1A – Capacitance Range/Selection Waterfall

| | | Case Size/ Series | C0402C | | | | C0603C | | | | C0805C | | | | | C1206C | | | | | | | |
|--------------------|----------|------------------------|--------|------|------|------|--------|-------|-------|-------|--------|---------|-------|-------|-------|--------|-------|-------|-------|-------|-------|-------|-------|
| Capacitance Cap Co | Cap Code | Rated Voltage (VDC) | 25 | 50 | 63 | 100 | 25 | 50 | 63 | 100 | 200 | 25 | 50 | 63 | 100 | 200 | 250 | 25 | 50 | 63 | 100 | 200 | 250 |
| | | Voltage Code | 3 | 5 | м | 1 | 3 | 5 | м | 1 | 2 | 3 | 5 | М | 1 | 2 | A | 3 | 5 | М | 1 | 2 | A |
| | | Cap Tolerance | | | | | | | | | ESD | Leve | per / | AEC- | Q200 | | | - | | | | | |
| 1.0 nF | 102 | | 4 kV | 4 kV | 4 kV | 4 kV | 6 kV | 6 kV | 6 kV | 6 kV | 6 kV | 8 kV | 8 kV | 8 kV | 8 kV | 8 kV | 8 kV | 12 kV | 12 kV | 12 kV | 12 kV | 12 kV | 12 kV |
| 1.5 nF | 152 | | 6 kV | 6 kV | | | 8 kV | 8 kV | 8 kV | 8 kV | 8 kV | 8 kV | 8 kV | 8 kV | 8 kV | 8 kV | 8 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV |
| 2.2 nF | 222 | | 6 kV | | | | 12 kV | 12 kV | 12 kV | 12 kV | 12 kV | / 12 kV | 12 kV | 12 kV | 12 kV | 12 kV | 12 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV |
| 3.3 nF | 332 | | | | | | 16 kV | 16 kV | 16 kV | 16 kV | ' | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV | 16 kV |
| 4.7 nF | 472 | F = ±1% | | | | | 16 kV | 16 kV | 16 kV | 16 kV | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV |
| 6.8 nF | 682 | G = ±2% | | | | | 25 kV | 25 kV | | | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV |
| 10 nF | 103 | J = ±5% | | | | | 25 kV | | | | | 25 kV | 25 kV | 25 kV | 25 kV | | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV |
| 15 nF | 153 | K = ±10% | | | | | 25 kV | | | | | 25 kV | 25 kV | 25 kV | 25 kV | | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV |
| 22 nF | 223 | M = ±20% | 1 | | | | 1 | | | | | 25 kV | 25 kV | ' | | | | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV | 25 kV |
| 33 nF | 333 | | | | | | | | | | | 25 kV | | | | | | 25 kV | 25 kV | 25 kV | 25 kV | | |
| 47 nF | 473 | | | | | | | | | | | 25 kV | | | | | | 25 kV | 25 kV | 25 kV | 25 kV | | |
| 68 nF | 683 | | | | | | | | | | | | | | | | | 25 kV | 25 kV | | | | |
| 100 nF | 104 | | | | | | | | | | | | | | | | | 25 kV | | | | | |

DC (Direct Contact Discharged) for Values $\leq 8kV$ AC (Air Discharched) for Values $\geq 12kV$



Packaging C-Spec Ordering Options Table

| Packaging Type | Packaging/Grade Ordering Code (C-Spec) | | | | |
|---|---|--|--|--|--|
| Commercial Grade ¹ | | | | | |
| Bulk Bag | Not required (blank) | | | | |
| 7" Reel/Unmarked | TU | | | | |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) | | | | |
| 7" Reel/Unmarked/2 mm pitch ² | 7081 | | | | |
| 13" Reel/Unmarked/2 mm pitch ² | 7082 | | | | |
| Automotive Grade ³ | | | | | |
| 7" Reel | AUTO | | | | |
| 13" Reel/Unmarked | AUT07411 (EIA 0603 and smaller case sizes) AUT07210 (EIA 0805 and larger case sizes) | | | | |
| 7" Reel/Unmarked/2 mm pitch ² | 3190 | | | | |
| 13" Reel/Unmarked/2 mm pitch ² | 3191 | | | | |

¹ Default packaging is "Bulk Bag." An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices. For more information see "Capacitor Marking."

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

³ Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information."

³ For additional information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information."

³ All automotive packaging C-Specs listed exclude the option to laser mark components. The option to laser mark is not available on these devices. For more information see "Capacitor Marking."



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | Days Prior To | |
|-----------------------------|----------------------------------|---------------|------------------|
| C-Spec | Process/Product change | Obsolescence* | Implementation |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum |
| AUTO | Yes (without approval) | Yes | 90 days minimum |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive C-Spec | PPAP (Product Part Approval Process) Level | | | | |
|-----------------------------|--|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| KEMET assigned ¹ | • | • | • | • | • |
| AUTO | | | 0 | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only

Δ



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique | | |
|------------------|------------------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|----------------------------|------------------------------------|--|--|
| | Without Flexible Termination | | | | | | | | |
| 0402 | 1005 | 1.00 (0.040) ±0.05 (0.002) | 0.50 (0.020) ±0.05 (0.002) | See Table 2 for Thickness | 0.30 (0.012) ±0.10 (0.004) | 0.30 (0.012) | Solder reflow only | | |
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | | | |
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder wave or Solder reflow | | |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | - | 0.50 (0.02) ±0.25 (0.010) | N/A | | | |
| | With Flexible Termination | | | | | | | | |
| 0603 | 1608 | 1.60 (0.063) ±0.17 (0.007) | 0.80 (0.032) ±0.15 (0.006) | See Table 2 for Thickness | 0.45 (0.018) ±0.15 (0.006) | 0.58 (0.023) | | | |
| 0805 | 2012 | 2.00 (0.079) ±0.30 (0.012) | 1.25 (0.049) ±0.30 (0.012) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder wave or Solder reflow | | |
| 1206 | 3216 | 3.30 (0.130) ±0.40 (0.016) | 1.60 (0.063) ±0.35 (0.013) | | 0.60 (0.024) ±0.25 (0.010) | N/A | | | |



Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions.

Electrical Parameters/Characteristics

| Item | Parameters/Characteristics | | |
|---|--|--|--|
| Operating Temperature Range | -55°C to +125°C | | |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±30 ppm/°C | | |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 0% | | |
| ¹ Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA) | | |
| ² Dissipation Factor (DF) Maximum Limit at 25°C | 0.1% | | |
| ³ Insulation Resistance (IR) Minimum Limit at 25°C | 1,000 MΩ μF or 100 GΩ (Rated voltage applied for 120 ±5 seconds at 25°C) | | |

¹ DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

² Capacitance and dissipation factor (DF) measured under the following conditions:

1 MHz ±100 kHz and 1.0 ±0.2 V_{rms} if capacitance \leq 1,000 pF

1 kHz \pm 50 Hz and 1.0 \pm 0.2 V_{rms} if capacitance > 1,000 pF

³ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance, it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as automatic level control (ALC). The ALC feature should be switched to "ON."

Post Environmental Limits

| Post Environmental Limits | | | | | |
|---------------------------|---------------------|-------------|-----------------------------------|----------------------|--------------------------|
| Dielectric | Rated DC Voltage | Capacitance | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance |
| COG | All | All | 0.5 | 0.3% or ±0.25 pf | 10% of Initial limit |


Table 1B – Product Availability and Chip Thickness Waterfall – Standard Termination

| | | Case Size/ Series | | C0402C | | | C0603C | | | | C0805C | | | | | C1206C | | | | | | | |
|-------------|----------|------------------------|----|--------|--------|--------|---------|-------|-------|-------|--------|-------|-------|-------|-------|--------|---------|--------|--------------|--------|-------|-------|-----|
| Capacitance | Cap Code | Rated Voltage (VDC) | 25 | 50 | 63 | 100 | 25 | 50 | 63 | 100 | 200 | 25 | 50 | 63 | 100 | 200 | 250 | 25 | 50 | 63 | 100 | 200 | 250 |
| | | Voltage Code | 3 | 5 | м | 1 | 3 | 5 | м | 1 | 2 | 3 | 5 | м | 1 | 2 | A | 3 | 5 | м | 1 | 2 | A |
| | | Cap Tolerance | | Produ | uct Av | vailab | ility a | nd Ch | ip Th | ickne | ess Co | des - | - See | Packa | aging | Spec | s for (| Chip T | Thick | ness I | Dimen | sions | ; |
| 1.0 nF | 102 | | BB | BB | BB | BB | CF | CF | CF | CF | CF | DD | DD | DD | DD | DD | DD | EQ | EQ | EQ | EQ | EQ | EQ |
| 1.5 nF | 152 | | BB | BB | | | CF | CF | CF | CF | CF | DR | DR | DR | DR | DR | DR | ER | ER | ER | ER | ER | ER |
| 2.2 nF | 222 | | BB | | | | CF | CF | CF | CF | CF | DR | DR | DR | DR | DR | DR | ET | ET | ET | ET | ET | ET |
| 3.3 nF | 332 | | | | | | CF | CF | CF | CF | | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ |
| 4.7 nF | 472 | F = ±1% | | | | | CF | CF | CF | CF | | DD | DD | DD | DD | DD | DD | EQ | EQ | EQ | EQ | EQ | EQ |
| 6.8 nF | 682 | G = ±2% | | | | | CF | CF | | | | DG | DG | DG | DG | DG | DG | EQ | EQ | EQ | EQ | EQ | EQ |
| 10 nF | 103 | J = ±5% | | | | | CF | | | | | DD | DD | DD | DD | | | ER | ER | ER | ER | ER | ER |
| 15 nF | 153 | K = ±10% | | | | | CF | | | | | DG | DG | DG | DG | | | EF | EF | EF | EF | EF | EF |
| 22 nF | 223 | M = ±20% | | | | | | | | | | DF | DF | | | | | EH | EH | EH | EH | EH | EH |
| 33 nF | 333 | | | | | | | | | | | DG | | | | | | EF | EF | EF | EF | | |
| 47 nF | 473 | | | | | | | | | | | DG | | | | | | EH | EH | EH | EH | | |
| 68 nF | 683 | | | | | | | | | | | | | | | | | EH | EH | | | | |
| 100 nF | 104 | | | | | | | | | | | | | | | | | EH | | | | | |

Table 1C – Product Availability and Chip Thickness Waterfall – Flexible Termination

| | Case Siz Series | | C0603C | | | | C0805C | | | | | | C1206C | | | | | | |
|-------------|--------------------|------------------------|--------|---------|--------|---------|--------|-------|--------|--------|---------|--------|---------|---------|---------|-------|--------|--------|------|
| Capacitance | Cap Code | Rated Voltage (VDC) | 25 | 50 | 63 | 100 | 200 | 25 | 50 | 63 | 100 | 200 | 250 | 25 | 50 | 63 | 100 | 200 | 250 |
| | | Voltage Code | 3 | 5 | м | 1 | 2 | 3 | 5 | м | 1 | 2 | A | 3 | 5 | м | 1 | 2 | A |
| | | Cap Tolerance | Prod | luct Av | ailabi | lity an | d Chip | Thick | ness C | odes · | - See I | Packag | jing Sp | becs fo | or Chip | Thick | ness D | Dimens | ions |
| 1.0 nF | 102 | | CJ | CJ | CJ | CJ | CJ | DD | DD | DD | DD | DD | DD | EQ | EQ | EQ | EQ | EQ | EQ |
| 1.5 nF | 152 | | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | ER | ER | ER | ER | ER | ER |
| 2.2 nF | 222 | | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | ET | ET | ET | ET | ET | ET |
| 3.3 nF | 332 | | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ |
| 4.7 nF | 472 | F = ±1% | CJ | CJ | CJ | CJ | | DD | DD | DD | DD | DD | DD | EQ | EQ | EQ | EQ | EQ | EQ |
| 6.8 nF | 682 | G = ±2% | CJ | CJ | | | | DG | DG | DG | DG | DG | DG | EQ | EQ | EQ | EQ | EQ | EQ |
| 10 nF | 103 | J = ±5% | CJ | | | | | DD | DD | DD | DD | | | ER | ER | ER | ER | ER | ER |
| 15 nF | 153 | K = ±10% | CJ | | | | | DG | DG | DG | DG | | | EF | EF | EF | EF | EF | EF |
| 22 nF | 223 | M = ±20% | | | | | | DF | DF | | | | | EH | EH | EH | EH | EH | EH |
| 33 nF | 333 | | | | | | | DG | | | | | | EF | EF | EF | EF | | |
| 47 nF | 473 | | | | | | | DG | | | | | | EH | EH | EH | EH | | |
| 68 nF | 683 | | | | | | | | | | | | | EH | EH | | | | |
| 100 nF | 104 | | | | | | | | | | | | | EH | | | | | |

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| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic (| Quantity |
|-----------|-------------------|-------------|---------|----------------------|-----------|----------|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| BB | 0402 | 0.50 ± 0.05 | 10,000 | 50,000 | 0 | 0 |
| CF | 0603 | 0.80 ± 0.07 | 4,000 | 15,000 | 0 | 0 |
| DN | 0805 | 0.78 ± 0.10 | 4,000 | 15,000 | 0 | 0 |
| DP | 0805 | 0.90 ± 0.10 | 4,000 | 15,000 | 0 | 0 |
| DF | 0805 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EB | 1206 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| EC | 1206 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| EE | 1206 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EH | 1206 | 1.60 ± 0.20 | 0 | 0 | 2,000 | 8,000 |

Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

Table 3 – Bulk Packaging Quantities

| Dookogi | | Loose Pa | ackaging | | | |
|----------|-----------------------|--|-----------|--|--|--|
| Packayi | iig iype | Bulk Bag | (default) | | | |
| Packagin | g C-Spec ¹ | N/A² | | | | |
| Case | Size | Packaging Quantities (pieces/unit packagin | | | | |
| EIA (in) | Metric (mm) | Minimum | Maximum | | | |
| 0402 | 1005 | | | | | |
| 0603 | 1608 | | | | | |
| 0805 | 2012 | | 50,000 | | | |
| 1206 | 3216 | | | | | |
| 1210 | 3225 | 1 | | | | |
| 1808 | 4520 | | | | | |
| 1812 | 4532 | | | | | |
| 1825 | 4564 | | 20,000 | | | |
| 2220 | 5650 |] | | | | |
| 2225 | 5664 | | | | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for automotive grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and automotive grade products.) The 15th through 22nd character positions of the ordering code should be left blank. All products ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.

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Table 4 – Land Pattern Design Recommendations per IPC-7351

| EIA Size | EIA Metric Size Size ode Code Density Level A: Maximum (Most) Land Protrusion (mm) | | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | |
|-------------|--|------|------|------|--|------|-----------|----------|--------|---|------|------|------|------|------|------|
| Coue | Coue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| | Without Flexible Termination | | | | | | | | | | | | | | | |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| | | | | | | Wit | h Flexibl | e Termir | nation | | | | | | | |
| 0603 | 1608 | 0.85 | 1.25 | 1.10 | 4.00 | 2.10 | 0.75 | 1.05 | 1.00 | 3.10 | 1.50 | 0.65 | 0.85 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 0.99 | 1.44 | 1.66 | 4.47 | 2.71 | 0.89 | 1.24 | 1.56 | 3.57 | 2.11 | 0.79 | 1.04 | 1.46 | 2.42 | 1.81 |
| 1206 | 3216 | 1.59 | 1.62 | 2.06 | 5.85 | 3.06 | 1.49 | 1.42 | 1.96 | 4.95 | 2.46 | 1.39 | 1.22 | 1.86 | 4.25 | 2.16 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).





Soldering Process

Recommended Soldering Technique

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile

The KEMET families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Termination Finish |
|--|--------------------|
| Fromereature | 100% Matte Sn |
| Preheat/Soak | |
| Temperature minimum (T _{smin}) | 150°C |
| Temperature maximum (T _{smax}) | 200°C |
| Time (t _s) from T _{Smin} to T _{Smax} | 60 – 120 seconds |
| Ramp-up rate $(T_L to T_P)$ | 3°C/second maximum |
| Liquidous temperature (T_L) | 217°C |
| Time above liquidous (t _L) | 60 – 150 seconds |
| Peak temperature (T _P) | 260°C |
| Time within 5°C of maximum peak temperature (t _p) | 30 seconds maximum |
| Ramp-down rate $(T_{P} to T_{L})$ | 6°C/second maximum |
| Time 25°C to peak temperature | 8 minutes maximum |

Note : All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 5 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method |
|------------------------|-----------------------------------|--|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds. |
| Board Flex | JIS-C-6429 | Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm for COG. Flexible termination system – 3.0 mm (minimum). |
| | | Magnification 50 X. Conditions: |
| Caldarability | | a) Method B, 4 hours at 155°C, dry heat at 235°C |
| Solderability | J-51D-002 | b) Method B at 215°C, category 3 |
| | | c) Method D at 260°C, category 3 |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 Cycles (-55°C to +125°C). Measurement at 24 hours ±4 hours after test conclusion. |
| - | MIL-STD-202 | Load humidity: 1,000 hours 85°C/85% RH and rated voltage. Add 100 K ohm resistor. Measurement at 24 hours +4 hours after test conclusion. |
| Blased Humidity | Method 103 | Low volt humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion. |
| Moisture Resistance | MIL-STD-202 Method 106 | t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours ±4 hours after test conclusion. |
| Thermal Shock | MIL-STD-202 Method 107 | -55°C/+125°C. Note: Number of cycles required – 300. Maximum transfer time – 20 seconds. Dwell time – 15 minutes. Air – Air. |
| High Temperature Life | MIL-STD-202 Method 108/EIA-198 | 1,000 hours at 125°C (85°C for X5R, Z5U and Y5V) with 2 X rated voltage applied. |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC for 1,000 hours. |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Note: use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Condition F. |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction – Standard Termination



Construction – Flexible Termination





Capacitor Marking (Optional)

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices
- EIA 0402 case size devices
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 6 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punche | d Paper | |
|----------------------|------|---------|--------------------|--------------------------|----------|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | (W)* | Pitch | (P ₁)* | Pitch (P ₁)* | | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 | |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | |
| Array 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size. 2 mm pitch reel for 0805 EIA case size under development.

2 mm pitch reel for U805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 7 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | | (| Constant Dim | ensions – Mil | limeters (Inc | hes) | | | |
|-----------|---------------------------------------|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 16 mm | | (0.059) | | | | (1.181) | | | |
| | | , | Variable Dime | ensions – Mil | limeters (Incl | nes) | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | |
| 12 mm | Single (4 mm) and Double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | te 5 |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{α} , B_{α} and K_{α} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes, and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape, and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_a and B_a are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 8 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | | Constant [|)imensions — M | lillimeters (Inch | es) | | |
|-----------|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|
| Tape Size | D _o | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) |
| | Variable Dimensions – Millimeters (Inches) | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius



Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs) ESD, COG Dielectric, 25 – 250 VDC (Commercial & Automotive Grade)



Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 9 – Reel Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | |
|--|-----------------|---------------------------------------|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | |
| 8 mm | 178 ±0.20 | | | | |
| 12 mm | 0r | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | |
| 16 mm | (13.000 ±0.008) | | · · · / | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Overview

KEMET Power Solutions - Military Case Code (KPS-MCC) High Temperature SMPS Ceramic Stacked Capacitors combine a robust and proprietary COG/NPO base metal electrode (BME) dielectric system with a durable leadframe technology for high temperature and high power SMPS applications. These devices are specifically designed to withstand the demands of harsh industrial environments such as down-hole oil exploration and automotive/avionics engine compartment circuitry.

The KPS-MCC is constructed with large chip multilayer ceramic capacitors (MLCCs), horizontally stacked and secured to a lead-frame termination system, using a high melting point (HMP) solder alloy. The lead-frame isolates the MLCCs from the printed circuit board (PCB), while establishing a parallel circuit configuration. Mechanically isolating the capacitors from the PCB improves mechanical and thermal stress performance, while the parallel circuit configuration allows for bulk capacitance in the same or smaller design footprint.

KEMET's high temperature COG capacitors are temperaturecompensating and are well suited for resonant circuit applications, or for those where Q and stability of capacitance characteristics are required. They exhibit no change in capacitance with respect to time and voltage, and boast a negligible change in capacitance with reference to ambient temperature. Capacitance change is limited to ±30 ppm/°C from -55°C to +200°C. In addition, these capacitors exhibit high insulation resistance with low dissipation factor at elevated temperatures up to +200°C. They also exhibit low ESR at high frequencies and offer greater volumetric efficiency over competitive high temperature BME ceramic capacitor devices.

Benefits

- · Straight Pin lead wires for "through-hole" mounting
- Formed "J" and "L" lead wires for surface mounting
- Operating temperature range of -55° to +200°C
- Military-style case codes (MCC) 3, 4, and 5
- DC voltage ratings of 50 2,000 V
- Capacitance offerings ranging from 4.7 nF 2.0 μF
- Industrial grade
- High frequency performance and bulk capacitance in a reduced footprint
- Low ESR and ESL
- High thermal stability
- · High ripple current capability



Built Into Tomorrow

1



Applications

- Industrial
- Down-hole
- Defense and aerospace
- Hybrid and Electric Vehicles (HEVs, BEVs)

- SMPS
- Input and output filtering on power supplies, often found on "capacitor banks"
- Snubber circuits and DC link
- Resonator circuits

Ordering Information

| L1 | G | N | 30 | С | 106 | K | Α | 02 |
|----------------|---|--|----------------------------------|---|--|--------------------------|--|--------------------|
| Product Family | Dielectric Classification/ Characteristic | Lead Configuration ¹ | Case Size/ Case Code (CC) | Rated Voltage (DC) | Capacitance Code (pF) | Capacitance Tolerance | Lead/ Termination Finish | Number of Chips |
| L1 | G = 200°C COG (BME) | N = Straight pin L = Formed "L" J = Formed "J" | 30 = CC3 40 = CC4 50 = CC5 | 5 = 50 V 1 = 100 V 2 = 200 V C = 500 V B = 630 V D = 1,000 V F = 1,500 V G = 2,000 V | Two Significant Digits and number of zeros | J = ±5% K = ±10% | A = Silver H = Solder Coated (60/40) | 01 - 10 |

¹ Lead configuration and dimension details are outlined in the "Dimensions" section of this document. Additional lead configurations may be available. Contact KEMET for details.

Lead Configurations – Inches (Millimeters)

| Lead Style Symbol | Lead Style | L Lead Length |
|----------------------|--------------|------------------------------|
| Ν | (N) Straight | 0.250 minimum (6.35) |
| L | (L) Formed | 0.055 ±0.005 (1.4 ±0.127) |
| J | (J) Formed | 0.055 ±0.005 (1.4 ±0.127) |

Additional lead configurations may be available. Contact KEMET for details.



Dimensions – Inches (Millimeters)



| Case Code | C Lead Spacing ² ±0.025 (0.635) | E Length | D Width ±0.025 (0.635) | A Height Maximum | B Height Maximum | H Lead Pitch | K Lead Width | F Seating Plane ¹ ±0.010 (0.250) | Number of Leads Per Side | Mounting Technique |
|--------------|--|---|------------------------------|--|--|--------------------|--------------------|---|--------------------------------|-----------------------|
| 3 | 0.450 (11.43) | For straight lead (N) and (J) lead: E = 0.5 (12.7) maximum For (L) lead: E = 0.54 (13.7) ±0.035 | 1.01 (25.64) | | For straight lead (N), add | | | For straight lead | 10 | |
| 4 | 0.400 (10.16) | For straight lead (N) and (J) lead: E = 0.44 (11.18) maximum For (L) lead: E = 0.49 (12.45) ±0.035 | 0.40 (10.16) | Refer to Product Ordering Table 1 | 0.07 inch to dimension "A" For (L) and (J) lead add | 0.1 (2.54) | 0.02 (0.5) | (N), seating plane is 0.055 For (L) and (J) lead, seating plane is | 4 | Solder reflow only |
| 5 | 0.250 (6.35) | For straight lead (N) and (J) lead: E = 0.3 (7.62) maximum For (L) lead: E = 0.34 (8.64) ±0.035 | 0.25 (6.35) | | 0.08 inches to dimension "A" | | | 0.070 | 3 | |

¹ Seating plane is the distance between the circuit board and the bottom of the lowest capacitor in the stack.

² Lead spacing dimension from outside of lead frame.

3



Environmental Compliance

KPS-MCC part types \ge 500 V with silver (Ag) plating are RoHS compliant with exemption 7a.

Electrical Parameters/Performance Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +200°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±30 ppm/°C (up to 200°C) |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 0% |
| Dielectric Withstanding Voltage (DWV) ¹ | 250% of rated voltage for voltage rating of < 500 V 130% of rated voltage for voltage rating of \ge 500 to < 1,000 V 120% of rated voltage for voltage rating of \ge 1,000 V (5 ±1 seconds and charge/discharge not exceeding 50 mA) |
| Dissipation Factor (DF) Maximum Limit at 25°C ² | 0.1% |
| Insulation Resistance (IR) Minimum Limit at 25°C ³ | 1,000 M Ω μF or 100 G Ω (Rated voltage applied for 120 ± 5 seconds at 25°C) |

¹ DWV is the voltage a capacitor can withstand for a short period of time. It exceeds the nominal and continuous working voltage of a capacitor.

 $^{\rm 2}$ Capacitance and dissipation factor (DF) measured under the following conditions:

1 MHz ±100 kHz and 1.0 ±0.2 V_{rms} if capacitance \leq 1,000 pF.

1 kHz \pm 50 Hz and 1.0 \pm 0.2 V_{rms} if capacitance > 1,000 pF.

³ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to $G\Omega$ limit. Select the lower of the two limits.

Note: When measuring capacitance, it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

4



Table 1 - Product Ordering Codes & Ratings

| KEMET Part Number ¹ | Capacitance (μF) ^{2,3} | Case Code | Number of Chips | Height A Inch (mm) Maximum | RoHS Compliance |
|--|------------------------------------|-----------|-----------------|----------------------------------|-------------------|
| | | 50 |) V | | |
| L1G(1)505304(2)(3)01 | 0.3 | 5 | 1 | 0.11 (2.79) | No |
| L1G(1)505604(2)(3)02 | 0.6 | 5 | 2 | 0.21 (5.3) | NO |
| L1G(1)505904(2)(3)03 | 1.2 | 5 | 3 4 | 0.32 (0.13) | No |
| L1G(1)505155(2)(3)05 | 1.5 | 5 | 5 | 0.53 (13.46) | No |
| | | 10 | 0 V | | |
| L1G(1)501304(2)(3)01 | 0.3 | 5 | 1 | 0.11 (2.79) | No |
| L1G(1)401334(2)(3)01 | 0.33 | 4 | 1 | 0.11 (2.79) | No |
| L1G(1)501604(2)(3)02 | 0.6 | 5 | 2 | 0.21 (5.3) | No |
| L1G(1)401684(2)(3)02 | 0.68 | 4 | 2 | 0.21 (5.3) | No |
| L1G(1)501904(2)(3)03 | 0.9 | 5 | 3 | 0.32 (8.13) | No |
| LIG(1)401105(2)(3)03 | I.U 1.0 | 4 | 3 | 0.32 (8.13) | NO |
| L1G(1)501125(2)(3)04 L1G(1)401125(2)(3)04 | 1.2 | 5 | 4 | 0.42 (10.67) | NO |
| L1G(1)401135(2)(3)04 | 1.5 | 4 | 4 | 0.42 (10.07) | No |
| L1G(1)401175(2)(3)05 | 1.7 | 4 | 5 | 0.53 (13.46) | No |
| | | 20 | 0 V | | |
| L1G(1)502114(2)(3)01 | 0.11 | 5 | 1 | 0.11 (2.79) | No |
| L1G(1)502224(2)(3)02 | 0.22 | 5 | 2 | 0.21 (5.3) | No |
| L1G(1)502334(2)(3)03 | 0.33 | 5 | 3 | 0.32 (8.13) | No |
| L1G(1)402334(2)(3)01 | 0.33 | 4 | 1 | 0.11 (2.79) | No |
| L1G(1)302404(2)(3)02 | 0.4 | 3 | 2 | 0.11 (2.79) | No |
| L1G(1)502444(2)(3)04 | 0.44 | 5 | 4 | 0.42 (10.67) | No |
| L1G(1)502554(2)(3)05 | 0.55 | 5 | 5 | 0.53 (13.46) | No |
| L1G(1)402684(2)(3)02 | 0.68 | 4 | 2 | 0.21 (5.3) | No |
| LIG(1)302804(2)(3)04 | U.8 1.0 | 3 | 4 | 0.21 (5.3) | NO |
| L1G(1)402103(2)(3)05 | 1.0 | 4 | 6 | 0.32 (0.13) | No |
| 116(1)402135(2)(3)04 | 1.2 | 4 | 4 | 0.42 (10.67) | No |
| L1G(1)302165(2)(3)08 | 1.6 | 3 | 8 | 0.42 (10.67) | No |
| L1G(1)402175(2)(3)05 | 1.7 | 4 | 5 | 0.53 (13.46) | No |
| L1G(1)302205(2)(3)10 | 2.0 | 3 | 10 | 0.53 (13.46) | No |
| | | 50 | 0 V | | |
| L1G(1)50C473(2)(3)01 | 0.047 | 5 | 1 | 0.11 (2.79) | |
| L1G(1)50C923(2)(3)02 | 0.092 | 5 | 2 | 0.21 (5.3) | |
| L1G(1)40C124(2)(3)01 | 0.12 | 4 | 1 | 0.11 (2.79) | |
| L1G(1)50C144(2)(3)03 | 0.15 | 5 | 3 | 0.32 (8.13) | |
| L1G(1)50C194(2)(3)04 | 0.19 | 5 | 4 | 0.42 (10.67) | |
| LIG(1)40C244(2)(3)02 | 0.24 | 4 | 2 | 0.21 (5.3) | |
| L1G(1)30C234(2)(3)05 | 0.20 | 5 | 2 | 0.33 (13.40) | Ves (see note 1) |
| 11G(1)30C404(2)(3)03 | 0.30 | 3 | 2 | 0.11 (2.79) | 100 (300 11010 4) |
| L1G(1)40C474(2)(3)04 | 0.47 | 4 | 4 | 0.42 (10.67) | |
| L1G(1)40C604(2)(3)05 | 0.6 | 4 | 5 | 0.53 (13.46) | |
| L1G(1)30C804(2)(3)04 | 0.8 | 3 | 4 | 0.21 (5.3) | |
| L1G(1)30C125(2)(3)06 | 1.2 | 3 | 6 | 0.32 (8.13) | |
| L1G(1)30C165(2)(3)08 | 1.6 | 3 | 8 | 0.42 (10.67) | |
| L1G(1)30C205(2)(3)10 | 2.0 | 3 | 10 | 0.53 (13.46) | |
| KEMET Part Number ¹ | Capacitance (µF) ^{2,3} | Case Code | Number of Chips | Height A Inch (mm) Maximum | RoHS Compliance |

¹ Complete part number equires additional characters in the numbered positions provided in order to indicate lead configuration, capacitance tolerance and lead finish. For each numbered position, available options are as follows:

 (a) Lead style character "N," "L," or "J."
 (b) Capacitance tolerance character "J" or "K."
 (c) Lead finish character "A" for 100% Ag, "H" for solder coated.

² Capacitance values listed are for stacked components and do not follow E12, E24 format defined by BS 2488 standard. Please contact factory to indicate a planet of standard.

inquire about capacitance values not listed.

³ Identical capacitance values may be listed for the same voltage rating. User can select which case size and chip count is desired for the given capacitance value.

⁴ KPS-MCC Stacked Capacitors ≥ 500 V with Ag plating are RoHS compliant by exemption 7a.



Table 1 - Product Ordering Codes & Ratings cont.

| KEMET Part Number ¹ | Capacitance (μF) ^{2,3} | Case Code | Number of Chips | Height A Inch (mm) Maximum | RoHS Compliance |
|--|---|--|---|---|------------------|
| | | 63 | 0 V | | |
| L1G(1)50B283(2)(3)01 L1G(1)50B563(2)(3)02 L1G(1)40B823(2)(3)01 L1G(1)50B843(2)(3)03 L1G(1)50B114(2)(3)04 L1G(1)50B154(2)(3)05 | 0.028 0.056 0.082 0.084 0.11 0.15 | 5 5 4 5 5 5 5 | 1 2 1 3 4 5 | 0.11 (2.79) 0.21 (5.3) 0.11 (2.79) 0.32 (8.13) 0.42 (10.67) 0.53 (13.46) | |
| L1G(1)40B774(2)(3)02 L1G(1)40B254(2)(3)03 L1G(1)30B254(2)(3)02 L1G(1)40B334(2)(3)04 L1G(1)40B424(2)(3)05 L1G(1)30B504(2)(3)04 L1G(1)30B754(2)(3)06 L1G(1)30B105(2)(3)08 | 0.17 0.25 0.25 0.33 0.42 0.5 0.75 1.0 | 4 4 3 4 3 3 3 3 | 2 3 2 4 5 4 6 8 | 0.21 (5.3) 0.32 (8.13) 0.11 (2.79) 0.42 (10.67) 0.53 (13.46) 0.21 (5.3) 0.32 (8.13) 0.42 (10.67) | Yes (see note 4) |
| L1G(1)30B125(2)(3)10 | 1.2 | 3 | 10 | 0.53 (13.46) | |
| | | 1,0 | 00 V | | |
| L1G(1)50D183(2)(3)01 L1G(1)50D543(2)(3)02 L1G(1)50D543(2)(3)03 L1G(1)40D563(2)(3)01 L1G(1)50D723(2)(3)04 L1G(1)50D723(2)(3)05 L1G(1)40D124(2)(3)02 L1G(1)40D174(2)(3)03 L1G(1)40D274(2)(3)04 L1G(1)40D274(2)(3)04 L1G(1)30D334(2)(3)04 L1G(1)30D474(2)(3)06 L1G(1)30D534(2)(3)08 L1G(1)30D534(2)(3)08 L1G(1)30D534(2)(3)08 | 0.018 0.036 0.054 0.056 0.072 0.092 0.12 0.16 0.17 0.22 0.27 0.33 0.47 0.63 0.82 | 5 5 4 5 4 3 4 4 4 4 3 3 3 3 3 3 3 3 3 | 1 2 3 1 4 5 2 2 2 3 4 5 4 6 8 10 | $\begin{array}{c} 0.11 \ (2.79) \\ 0.21 \ (5.3) \\ 0.32 \ (8.13) \\ 0.11 \ (2.79) \\ 0.42 \ (10.67) \\ 0.53 \ (13.46) \\ 0.21 \ (5.3) \\ 0.11 \ (2.79) \\ 0.32 \ (8.13) \\ 0.42 \ (10.67) \\ 0.53 \ (13.46) \\ 0.21 \ (5.3) \\ 0.42 \ (10.67) \\ 0.53 \ (13.46) \\ 0.21 \ (5.3) \\ 0.32 \ (8.13) \\ 0.42 \ (10.67) \\ 0.53 \ (13.46) \end{array}$ | Yes (see note 4) |
| | | 1,50 | 00 V | | |
| L1G(1)50F682(2)(3)01 L1G(1)50F133(2)(3)02 L1G(1)50F203(2)(3)03 L1G(1)40F223(2)(3)01 L1G(1)50F273(2)(3)04 L1G(1)50F333(2)(3)05 L1G(1)40F443(2)(3)02 L1G(1)40F663(2)(3)02 L1G(1)40F663(2)(3)02 L1G(1)40F883(2)(3)04 L1G(1)40F114(2)(3)05 L1G(1)30F134(2)(3)04 L1G(1)30F204(2)(3)06 L1G(1)30F274(2)(3)08 L1G(1)30F334(2)(3)10 | 0.0068 0.013 0.02 0.022 0.027 0.033 0.044 0.066 0.066 0.088 0.11 0.13 0.2 0.27 0.33 | 5 5 5 4 5 5 4 4 3 4 4 3 4 4 3 3 3 3 3 3 | 1 2 3 1 4 5 2 3 2 4 5 4 6 8 10 | 0.11 (2.79) 0.21 (5.3) 0.32 (8.13) 0.11 (2.79) 0.42 (10.67) 0.53 (13.46) 0.21 (5.3) 0.32 (8.13) 0.11 (2.79) 0.42 (10.67) 0.53 (13.46) 0.21 (5.3) 0.32 (8.13) 0.42 (10.67) 0.53 (13.46) Height A lack (mm) | Yes (see note 4) |
| KEMET Part Number ¹ | Capacitance (µF) ^{2,3} | Case Code | Number of Chips | Maximum | RoHS Compliance |

¹ Complete part number requires additional characters in the numbered positions provided in order to indicate lead configuration, capacitance tolerance and lead finish. For each numbered position, available options are as follows:

 (a) Lead style character "N," "L," or "J."
 (b) Capacitance tolerance character "J" or "K."
 (c) Lead finish character "A" for 100% Ag, "H" for solder coated.

² Capacitance values listed are for stacked components and do not follow E12, E24 format defined by BS 2488 standard. Please contact factory to inquire about capacitance values not listed.

³ Identical capacitance values may be listed for the same voltage rating. User can select which case size and chip count is desired for the given capacitance values

capacitance value.

⁴ KPS-MCC Stacked Capacitors ≥ 500 V with Ag plating are RoHS compliant by exemption 7a.



Table 1 - Product Ordering Codes & Ratings cont.

| KEMET Part Number ¹ | Capacitance (μF) ^{2,3} | Case Code | Number of Chips | Height A Inch (mm) Maximum | RoHS Compliance | |
|-----------------------------------|------------------------------------|-----------|-----------------|----------------------------------|------------------|--|
| 2,000 V | | | | | | |
| L1G(1)50G472(2)(3)01 | 0.0047 | 5 | 1 | 0.11 (2.79) | | |
| L1G(1)50G922(2)(3)02 | 0.0092 | 5 | 2 | 0.21 (5.3) | | |
| L1G(1)50G153(2)(3)03 | 0.015 | 5 | 3 | 0.32 (8.13) | | |
| L1G(1)40G153(2)(3)01 | 0.015 | 4 | 1 | 0.11 (2.79) | | |
| L1G(1)50G193(2)(3)04 | 0.019 | 5 | 4 | 0.42 (10.67) | | |
| L1G(1)50G253(2)(3)05 | 0.025 | 5 | 5 | 0.53 (13.46) | | |
| L1G(1)40G293(2)(3)02 | 0.029 | 4 | 2 | 0.21 (5.3) | | |
| L1G(1)30G403(2)(3)02 | 0.04 | 3 | 2 | 0.11 (2.79) | Yes (see note 4) | |
| L1G(1)40G423(2)(3)03 | 0.042 | 4 | 3 | 0.32 (8.13) | | |
| L1G(1)40G563(2)(3)04 | 0.056 | 4 | 4 | 0.42 (10.67) | | |
| L1G(1)40G723(2)(3)05 | 0.072 | 4 | 5 | 0.53 (13.46) | | |
| L1G(1)30G803(2)(3)04 | 0.08 | 3 | 4 | 0.21 (5.3) | | |
| L1G(1)30G124(2)(3)06 | 0.12 | 3 | 6 | 0.32 (8.13) | | |
| L1G(1)30G164(2)(3)08 | 0.16 | 3 | 8 | 0.42 (10.67) | | |
| L1G(1)30G204(2)(3)10 | 0.2 | 3 | 10 | 0.53 (13.46) | | |
| KEMET Part Number ¹ | Capacitance (µF) ^{2,3} | Case Code | Number of Chips | Height A Inch (mm) Maximum | RoHS Compliance | |

¹ Complete part number requires additional characters in the numbered positions provided in order to indicate lead configuration, capacitance tolerance and lead finish. For each numbered position, available options are as follows:

 (a) Lead style character "N," "L," or "J."
 (b) Capacitance tolerance character "J" or "K."
 (c) Lead finish character "A" for 100% Ag, "H" for solder coated.

² Capacitance values listed are for stacked components and do not follow E12, E24 format defined by BS 2488 standard. Please contact factory to inquire about capacitance values not listed.

³ Identical capacitance values may be listed for the same voltage rating. User can select which case size and chip count is desired for the given capacitance values

capacitance value.

⁴ KPS-MCC Stacked Capacitors ≥ 500 V with Ag plating are RoHS compliant by exemption 7a.



Soldering Process

The capacitors and assemblies outlined in this specification sheet are susceptible to thermal shock damage due to their large ceramic mass. Temperature profiles used should provide adequate temperature rise and cool-down time to prevent damage from thermal shock. In general, KEMET recommends against hand-soldering for these types of large ceramic devices, but if hand-soldering cannot be avoided, refer to hand-soldering section below.

Recommended Soldering Technique:

· Solder reflow

Recommended Reflow Soldering Profile:



| | m | 0 |
|---|---|----|
| | | С. |
| - | | - |

| Profile Feature | Sn-Pb | Pb-Free |
|---|-----------------|------------------|
| Preheat/Soak | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from T_{smin} to T_{smax}) | 60 – 90 seconds | 60 - 120 seconds |
| Ramp-up rate $(T_L \text{ to } T_P)$ | 2°C/second | 3°C/second |
| Liquidous temperature (T_L) | 183°C | 217°C |
| Time above liquidous (t_L) | 95 seconds | 95 seconds |
| Peak temperature (T _P) | 240°C | 260°C |
| Time within 5°C of maximum peak temperature (t _P) | 5 seconds | 5 seconds |
| Ramp-down rate $(T_P to T_L)$ | 2°C/second | 2°C/second |
| Time 25°C to peak temperature | 3.5 minutes | 3.5 minutes |

Note: All temperatures refer to the center of the package, measured on the package body surface that is facing up during assembly reflow.

Preheating and Reflow Profile Notes:

Due to the differences in the coefficient of the thermal expansion for the different materials of construction, it is critical to monitor and control the heating and cooling rates during the soldering process. To ensure optimal component reliability, KEMET's recommended heating and cooling rate is 2°C/second. After soldering, the capacitors should be air cooled to room temperature before further processing. Forced air cooling is not recommended.

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Soldering Process cont.

Recommendations for Hand-Soldering:

Care should be taken when hand-soldering large ceramic stacks. Excessive thermal shock on the ceramic material can lead to cracking and reliability issues. To reduce risk of thermal shock, KEMET recommends solder reflow, but if hand soldering cannot be avoided, please see recommended guidelines below.

Pre-Heating

Stacks should be preheated to a temperature within 50°C of reflow temperature. KEMET recommends a ramp rate of 2°C/ second to avoid thermal shock during the pre-heating process.

Hand-Soldering

When using a solder iron, keep tip of the iron as far away from ceramic body to avoid excessive heating.

Cool Down

After reflow, stacks should be allowed to cool at a preferable rate of 2°C/second until room temperature is reached.

Storage & Handling

Ceramic capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature-reels and may soften or warp, and tape peel force may increase. KEMET recommends that maximum storage temperature does not exceed 40°C and maximum storage humidity does not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts. Atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.

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Table 2 - Performance & Reliability: Test Methods & Conditions

| Inspection | Test Method | Test Conditions | | | |
|--|---------------------------------|--|--|--|--|
| | Reliability/Environmental Tests | | | | |
| High Temperature Life | MIL-STD-202, Method 108 | 200°C, rated voltage, 1,000 hours | | | |
| Temperature Cycling | JESD22, Method JA-104 | -55°C to +200°C, 300 cycles | | | |
| Thermal Shock | MIL-STD-202, Method 107 | -55°C to +200°C, 20 seconds transfer, 15 minutes dwell, 20 cycles | | | |
| Moisture Resistance | MIL-STD-202, Method 106 | 20 cycles, no voltage applied | | | |
| Physical, Mechanical and Process Tests | | | | | |
| Vibration | MIL-STD-202, Method 204 | Condition D per MIL–PRF–49470, simple harmonic, 20 g peak, 10 – 2,000 Hz, 20 minute sweep, 12 sweeps per axis | | | |
| Resistance to Soldering Heat | MIL-STD-202, Method 210 | Condition B, 260°C, 10 seconds | | | |
| Terminal Strength | MIL-STD-202, Method 202 | Condition A | | | |
| Immersion | MIL-STD-202, Method 104 | Condition B | | | |
| Solderability | J-STD-002C | Category 3 For Sn-Pb solder alloy: Method A, 245°C, 5 seconds Method S, 220°C peak For Pb-Free solder alloy: Method A1, 260°C, 5 seconds Method S1, 245°C peak | | | |



Construction



Packaging

| Waffle Packaging Quantities | | | | | |
|-----------------------------|------------|-----------------------------|--------------------------------------|--|--|
| Case Code | Lead Style | Number of Chips in Stack | Waffle Pack Quantity ¹ | | |
| 3 | L/J/N | 2, 4, 6, 8, 10 | 25 | | |
| 4 | 1 /N | 1, 2, 3 | 50 | | |
| | L/N | 4, 5 | 25 | | |
| | J | 1, 2, 3, 4, 5 | 50 | | |
| 5 | N | 1, 2, 3 | 50 | | |
| | IN | 4, 5 | 25 | | |
| | L/J | 1, 2, 3, 4, 5 | 50 | | |

¹ Minimum order value applies. Contact KEMET for details.

High Reliability Surface Mount Capacitors, MIL-PRF-32535, 4 – 200 VDC (COG and BP Dielectrics)

Overview

The KEMET MIL-PRF-32535 COG and BP surface mount capacitors are designed, tested and screened to meet demanding high reliability defense and aerospace applications. MIL-PRF-32535 is Defense Logistics Agency's (DLA) first capacitor specification for defense and aerospace that capitalizes on industry leading base metal electrode (BME) technology. Qualified under performance specification MIL-PRF-32535 and QPL listed, this series meets or exceeds the requirements outlined by DLA and is currently available in M (standard reliability) and T (high reliability) product levels. Driven by the demand for higher capacitance and smaller case size MLCCs in high reliability applications, KEMET's MIL-PRF-32535 COG and BP provides over an 18-fold increase in capacitance over MIL-PRF-55681 and MIL-PRF-123, allowing for reduced board space and continuing the trend for miniaturization.

In addition to being the first BME COG and BP dielectric qualified for use in defense and aerospace applications, MIL-PRF-32535 is the first DLA specification to recognize a flexible termination option. KEMET's flexible termination utilizes a pliable and conductive silver epoxy between the base metal and nickel barrier layers of the termination system. The addition of this epoxy layer inhibits the transfer of board stress to the rigid ceramic body, therefore mitigating flex cracks, which can result in a low IR or short circuit failures..

Benefits

- Patented BME technology
- Qualified per MIL-PRF-32535 (QPL)
- Standard reliability (M Level)
- High reliability (T Level)
- Flexible termination option available
- EIA 0402, 0603, 0805, 1206, 1210, 1812, 2220 case sizes
- DC voltage ratings of 4 V, 6.3 V, 10 V, 16 V, 25 V, 50 V, 100 V and 200 V
- · Capacitance offerings ranging from 1.0 pF up to 180 nF
- Available capacitance tolerances of ± 0.10 pF, ± 0.25 pF, ± 0.5 pF, $\pm 1\%,$ $\pm 2\%,$ $\pm 5\%,$ and 10%
- No piezoelectric noise
- Extremely low ESR and ESL
- · High ripple current capability
- Preferred capacitance solution at line frequencies and into the MHz range
- No capacitance change with respect to applied rated DC voltage
- Negligible capacitance change with respect to temperature from -55°C to +125°C
- No capacitance decay with time
- · Non-polar device, minimizing installation concerns







Applications

- Critical timing
- Tuning
- Circuits requiring low loss
- Circuits with pulse
- High current

- Decoupling
- Bypass
- Filtering
- Transient voltage suppression
- Blocking

| MIL-PRF-32535 | Ordering | Information | |
|---------------|----------|-------------|--|
|---------------|----------|-------------|--|

| M32535 | 04 | E1 | Z | 103 | J | Z | Μ | В |
|------------|---|-------------------------------|--|---|--|--|----------------------------|-----------|
| MIL Prefix | Slash Sheet | Characteristic/ Dielectric | Rated Voltage (VDC) | Capacitance Code (pF) | Capacitance Tolerance | Termination ^{1, 2} | Product Level | Electrode |
| | 02 = 0402 03 = 0603 04 = 0805 05 = 1206 06 = 1210 07 = 1812 08 = 2220 | E1 = COG BP = BP | V = 4 W = 6.3 X = 10 Y = 16 Z = 25 A = 50 B = 100 C = 200 | Two significant digits and number of zeros. Use R as decimal for 1.0 – 9.9 pF e.g., 2.2 pF = 2R2 | $B = \pm 0.1 \text{ pF}$ C = ±0.25 pF D = ±0.5 pF F = ±1% G = ±2% J = ±5% K = ±10% | D = Sn/Pb solder dipped G = Nickel gold-plating R = Flexible termination with solder plating V = Flexible termination with nickel gold-plating Z = Sn/Pb solder plated | M = M Level T = T Level | B = BME |

¹ Termination options D, R, and V are not available in EIA 0402 case size.

² Termination option D is not available in EIA 0603 case size.

KEMET Part Number Equivalent (For Reference Only)

(Do not use this ordering code if a QPL MIL-SPEC part type is required. Please order using MIL-SPEC ordering code. Details regarding MIL-PRF-32535 QPL ordering information is outlined above.)

| С | 0805 | K | 104 | J | 3 | G | Μ | L | - |
|---------|--|--------------------------|--|--|--|-------------------|--|--|--|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance ² | Rated Voltage (VDC) | Dielectric | Product Level | Termination Finish | Packaging/ Grade (C-Spec) |
| | 0402 0603 0805 1206 1210 1812 2220 | K = MIL-PRF-32535 | Two significant digits and number of zeros. Use 9 for 1.0 – 9.9 pF e.g., 2.2 pF = 229 | $B = \pm 0.1 \text{ pF}$ C = ±0.25 pF D = ±0.5 pF F = ±1% G = ±2% J = ±5% K = ±10% | 7 = 4 9 = 6.3 8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 2 = 200 | E = COG G = BP | M = M Level, standard termination N = M Level, flexible termination T = T Level, standard termination V = T Level, flexible termination | L = Sn/Pb solder plated H = Sn/Pb solder dipped G = Nickel gold-plating | See "Packaging C-Spec Ordering Options Table" |



Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) |
|----------------------------------|---|
| Standard Packaging (Waffle Tray) | Not required (blank) |
| 7" Tape & Reel | Contact Sales |

¹ Default packaging with no C-Spec is "Waffle Tray," and is recommended for order quantities of less than 250 pieces. See Waffle Tray packaging information section for additional details.

¹ See Tape & Reel Packaging information section of the datasheet for additional details.

Dimensions per MIL-PRF-32535 – Inches (Millimeters)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness (Max) | B Bandwidth | Maximum Part Weight (mg) ³ | Mounting Technique |
|------------------|---------------------|-------------|-------------|-------------------------|----------------|---|-----------------------|
| 0402 | 1005 | 0.040±0.004 | 0.020±0.004 | 0.024 | 0.004 (0.100) | 1.6 | Solder reflow |
| | | (1.02±0.10) | (0.51±0.10) | (0.61) | minimum | | only |
| 0603 | 1608 | 0.063±0.006 | 0.032±0.006 | 0.039 | 0.016±0.008 | 63 | |
| 0003 | 1000 | (1.60±0.15) | (0.81±0.15) | (0.99) | (0.41±0.20) | 0.5 | |
| 00051 | 2012 | 0.079±0.010 | 0.050±0.010 | 0.060 | 0.020±0.010 | 20 | Solder wave or |
| 0005 | 2012 | (2.01±0.25) | (1.27±0.25) | (1.52) | (0.51±0.25) | 20 | solder reflow |
| 10062 | 2016 | 0.126±0.010 | 0.063±0.010 | 0.070 | 0.020±0.014 | E7 | |
| 1200- | 3210 | (3.20±0.25) | (1.60±0.25) | (1.78) | (0.51±0.36) | 57 | |
| 10102 | 2225 | 0.126±0.010 | 0.098±0.010 | 0.110 | 0.020±0.014 | 100 | |
| 12104 | 3225 | (3.20±0.25) | (2.49±0.25) | (2.79) | (0.51±0.36) | 108 | |
| 10102 | 4500 | 0.178±0.012 | 0.126±0.012 | 0.110 | 0.024±0.018 | 016 | Solder reflow |
| 1012 | 403Z | (4.52±0.30) | (3.20±0.30) | (2.79) | (0.61±0.46) | 210 | only |
| 00002 | | 0.224±0.016 | 0.197±0.016 | 0.110 | 0.025±0.018 | 400 | |
| 22202 | 5050 | (5 69+0 41) | (5.00+0.41) | (2 79) | (0 64+0 46) | 430 | |

¹ For EIA 0805 solder dipped termination finish, add 0.020 (0.51) to the positive length tolerance and 0.015 (0.38) to the positive width and thickness tolerance.

² For EIA 1206, 1210, 1812 and 2220 solder dipped termination finishes, add 0.025 (0.64) to the positive length tolerance and 0.015 (0.38) to the positive width and thickness tolerance.

³ Maximum Part Weight represents the maximum weight in the given case size for all voltages.



Environmental Compliance

These devices are RoHS compliant only if ordered with gold (Au) termination finish.

Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|--|
| Operating temperature range | -55°C to +125°C |
| Capacitance change with reference to +25°C and 0 VDC applied (TCC) | ±30 ppm/°C |
| Aging rate (maximum % capacitance loss/decade hour) | 0% |
| ¹ Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA) |
| ² Dissipation Factor (DF) maximum limit at 25°C | Cap < 10 pF: 0.25% Cap ≥ 10 pF: 0.15% |
| ³ Insulation Resistance (IR) minimum limit at 25°C | Rated voltage < 25 V 500 M Ω µFs or 100 G Ω , whichever is less Rated voltage ≥ 25 V 1,000 M Ω µF or 100 G Ω , whichever is less (Rated voltage applied for 120 seconds maximum at 25°C) |

¹ DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

² Capacitance and dissipation factor (DF) measured under the following conditions:

1 MHz ±100 kHz and 1.0 $V_{\rm rms}$ ±0.2 V if capacitance \leq 1,000 pF

1 kHz \pm 50 Hz and 1.0 V_{rms} \pm 0.2 V if capacitance > 1,000 pF

³ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Capacitance and dissipation factor (DF) measured under the following conditions:

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as automatic level control (ALC). The ALC feature should be switched to "ON."



Table 1A - Capacitance Range/Selection Waterfall (0402 - 0805 Case Sizes)

| | Can | | | C | as | e S | Siz | е | | | | | 040 | 2 | | | | | | 06 | 03 | | | | | | | 08 | 05 | | | |
|----------------|-------------------------|------------|----|--------|--------|-------|-------|-------|--------|---|-----|---|-----|----|----|-----|----|-----|----|------|-------|-------|------|-----|----------|------------|---|------------|----|----------------|--------------|-----|
| | Code | Cap | ١ | /olt | age | Cod | le (I | MIL) | | v | w | X | Y | z | A | B | v | W | X | Y | z | A | В | C | ۷ | w | X | Y | z | A | В | C |
| Canacitance | (MIL- | (KEMET | ٧o | ltag | je C | ode | (KE | ME | т) | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 2 |
| Capacitanice | PRF-32535 | Part | ╞ | - * 0 | - 1.1. | | | 100 | | - | ņ | | 9 | 2 | | 0 | | m | | 9 | 2 | • | 9 | 9 | ╞ | | • | 5 | 2 | - | 0 | 9 |
| | Number) | Number) | | ale | 0 Vu | ltaų | je (| VDC. | ' | 4 | و | 7 | Ē | 2 | S | 5 | 4 | ف | 7 | Ē | 6 | ò | 5 | 20 | 4 | و. | 7 | - | 0 | ũ | 2 | 20 |
| | in an in a start of the | | Ca | pac | itan | ice ' | Tole | erano | ce | | | | | | | | | | Pr | oduc | t Ava | ilabi | lity | | <u> </u> | . <u> </u> | | . <u> </u> | | | , | |
| 1 pF 1 5 pF | 1R0 1R5 | 109 159 | B | C C | D | | | | | | | | | | | | | | | : | | | • | | 1: | | | | | | | |
| 2.2 pF | 2R2 | 229 | В | c | D | | | | | | | | | | | | • | • | • | • | • | • | • | • | • | | • | • | • | · • / | · · | • |
| 2.7 pF | 2R7 | 279 | В | С | D | | | | | | | | | | | | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 3.3 pF | 3R3 | 339 | В | С | D | | | | | | | | | | | | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 3.9 pF | 3R9 | 399 | В | С | D | | | | | | | | | | | | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 4.7 pF | 4R7 | 479 | В | С | D | | | | | | | | | | | | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 5.6 pF | 5R6 | 569 | В | С | D | | | | | | | | | | | | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 6.8 pF | 6R8 | 689 | В | С | D | | | | | | | | | | | | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 8.2 pF | 8R2 | 829 | В | С | D | - | 2 | | | | | | | | | | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 10 pF | 100 | 100 | | | | F | G | J | K | • | • | • | • | • | • | • | ! | • | • | • | • | • | • | • | ! | • | | • | • | 1.1 | • ! | • |
| 12 pr | 120 | 120 | | | | F | 6 | J | K V | • | • | | | | | | !: | | | | | | | | !: | | | | | 1.1 | 1.1 | |
| 10 µr 19 nF | 130 | 150 | | | | | G | J | ĸ | | | | | | | | 1. | | | | | | | | 1. | | | | | 1.1 | 1. | |
| 20 nF | 200 | 200 | | | | F | G | .1 | ĸ | - | | - | - | - | - | - | | | | | | | | | Ĭ. | | | | | 1. | 1. | |
| 20 p. | 220 | 220 | | | | F | G | J | ĸ | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 27 pF | 270 | 270 | | | | F | G | J | ĸ | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 33 pF | 330 | 330 | | | | F | G | J | К | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 39 pF | 390 | 390 | | | | F | G | J | К | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 47 pF | 470 | 470 | | | | F | G | J | К | • | ٠ | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 56 pF | 560 | 560 | | | | F | G | J | Κ | ٠ | ٠ | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 68 pF | 680 | 680 | | | | F | G | J | К | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 82 pF | 820 | 820 | | | | F | G | J | K | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 100 pF | 101 | 101 | | | | F | G | J | K | • | • | • | • | • | • | • | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | • |
| 120 pF | 121 | 121 | | | | F | G | J | Κ | • | • | • | • | • | • | • | • | • | • | • | • | • | • | | • | • | • | • | • | | | • |
| 150 pr | 151 | 151 | | | | F | 6 | J | K | • | | | | | | | | | | | | | | | | | | | | | | |
| 220 nF | 221 | 221 | | | | F | G | J | ĸ | | | | | | | | | | | | | | | | | | | | | | | |
| 270 pF | 271 | 271 | | | | F | G | .1 | ĸ | | | | | | | | | | | | | | | | | | | | | | | |
| 330 pF | 331 | 331 | | | | F | G | J | ĸ | | | | | | | | | | | | | | | | | | | | | • | • | |
| 390 pF | 391 | 391 | | | | F | G | J | ĸ | • | • | • | • | • | • | | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | • |
| 470 pF | 471 | 471 | | | | F | G | J | к | • | • | • | • | • | • | | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | • |
| 560 pF | 561 | 561 | | | | F | G | J | К | • | • | • | • | • | • | | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | |
| 680 pF | 681 | 681 | | | | F | G | J | К | • | • | • | • | • | • | | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | |
| 820 pF | 821 | 821 | | | | F | G | J | К | • | • | • | • | • | | | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | |
| 1,000 pF | 102 | 102 | | | | F | G | J | К | • | • | • | • | • | | | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | |
| 1,200 pF | 122 | 122 | | | | F | G | J | K | | | | | | | | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | |
| 1,500 pF | 152 | 152 | | | | F | G | J | K | | | | | | | | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | |
| 1,800 pF | 182 | 182 | | | | F | 6 | J | K | | | | | | | | | | | | | | | | | | | | | | | |
| 2,000 pr | 202 | 202 | | | | F | G | J | ĸ | | | | | | | | | | | | | | | | | | | | | | | |
| 2,200 pr | 272 | 272 | | | | F | G | .1 | ĸ | | | | | | | | | | | | | | | | Ĭ. | | | | | 1. | 1. | |
| 3.300 pF | 332 | 332 | | | | F | G | Ĵ | ĸ | | | | | | | | | • | • | • | • | • | | | | | | | | 1. | | |
| 3.900 pF | 392 | 392 | | | | F | G | J | ĸ | | | | | | | | • | • | • | • | • | • | | | • | | • | | • | 1. | | |
| 4,700 pF | 472 | 472 | | | | F | G | J | к | | | | | | | | • | • | • | • | • | | | | • | • | • | • | • | • | • | |
| 5,600 pF | 562 | 562 | | | | F | G | J | Κ | | | | | | | | • | • | • | • | • | | | | • | • | • | • | • | • | • | |
| 6,800 pF | 682 | 682 | | | | F | G | J | Κ | | | | | | | | | | | | | | | | • | • | • | • | • | • | • | |
| 8,200 pF | 822 | 822 | | | | F | G | J | К | | | | | | | | | | | | | | | | • | • | • | • | • | • | • | |
| 10,000 pF | 103 | 103 | | | | F | G | J | Κ | | | | | | | | | | | | | | | | • | • | • | • | • | | \square | |
| | Cap Code | Cap Code | R | ate | d Vo | olta | je (| VDC |) | 4 | 6.3 | 9 | 16 | 25 | 50 | 100 | 4 | 6.3 | 9 | 16 | 25 | 20 | 100 | 200 | 4 | 6.3 | 9 | 16 | 25 | 50 | 100 | 200 |
| Capacitance | PRF-32535 | Part | | ۷ | olta | ige | Cod | e | | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 2 |
| | Part Number) | Number) | (| Cas | e S | ize, | Se | ries | | | | | 040 | 2 | | | | | | 06 | 603 | | | | | | | 08 | 05 | | | |



Table 1B - Capacitance Range/Selection Waterfall (1206 - 1210 Case Sizes)

| | | | | Cas | e Siz | e. | | | | 12 | 06 | | | | | | | 12 | 10 | | | |
|-------------|--------------------------------|---------------------|-----|---------|---------|-------|---|-----|----|---------|-----------------|------------------|-------------------|-----------------|------------------|----------------|---------------|----------------|----------|----|-----|-----|
| | Con Codo | Con Codo | V | oltage | Code (| MIL) | ۷ | w | Х | Y | z | A | В | C | v | w | X | Y | z | A | В | C |
| Canacitance | | (KEMET Dart | Vol | tage Co | ode (K | EMET) | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 2 |
| Capacitance | (MIL-PKF-52555 Dart Number) | (REWEI Palt | | | | , | | | - | | | | _ | - | | ~ | | | | | _ | |
| | Fart Nulliber) | Nulliber) | Ra | ted Vo | ltage (| VDC) | 4 | 6.3 | 10 | 16 | 25 | 50 | 10(| 20(| 4 | <u>ن</u> | 9 | 16 | 25 | 50 | 10(| 20(|
| | | | | | | | | | | Pr S | oduci See Ta | t Avai able 2 | labili ? for C | ty an Chip 1 | d Chij Thicki | o Thio ness | cknes Dime | s Coo nsion | les s | | | |
| 560 pF | 561 | 561 | F | G | J | K | • | • | • | • | • | • | • | • | | | | | | | | |
| 680 pF | 681 | 681 | F | G | J | K | • | • | • | • | • | • | • | • | | | | | | | | |
| 820 pF | 821 | 821 | F | G | J | K | • | • | • | • | • | • | • | • | | | | | | | ' | |
| 1,000 pF | 102 | 102 | F | G | J | K | • | • | • | • | • | • | • | • | | | | | | | | |
| 1,200 pF | 122 | 122 | F | G | J | K | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 1,500 pF | 152 | 152 | F | G | J | K | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 1,800 pF | 182 | 182 | F | G | J | K | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 2,000 pF | 202 | 202 | F | G | J | K | | | | | | | | | • | • | • | • | • | • | • | • |
| 2,200 pF | 222 | 222 | F | G | J | K | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | • |
| 2,700 pF | 272 | 272 | F | G | J | K | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | • |
| 3,300 pF | 332 | 332 | F | G | J | K | • | • | • | • | • | • | • | | • | • | • | • | • | • | • • | • |
| 3,900 pF | 392 | 392 | F | G | J | K | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | |
| 4,700 pF | 472 | 472 | F | G | J | K | • | • | • | • | • | • | • | | • | • | • | • | • | • | • • | |
| 5,600 pF | 562 | 562 | F | G | J | K | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | |
| 6,800 pF | 682 | 682 | F | G | J | K | ٠ | • | ٠ | • | • | • | • | | • | • | • | • | • | • | • | |
| 8,200 pF | 822 | 822 | F | G | J | K | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | |
| 10,000 pF | 103 | 103 | F | G | J | K | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | |
| 12,000 pF | 123 | 123 | F | G | J | K | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | |
| 15,000 pF | 153 | 153 | F | G | J | K | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | |
| 18,000 pF | 183 | 183 | F | G | J | K | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | |
| 22,000 pF | 223 | 223 | F | G | J | K | • | • | • | • | • | | | | • | • | • | • | • | • | • | |
| 27,000 pF | 273 | 273 | F | G | J | K | • | • | • | • | • | | | | • | • | • | • | • | • | • | |
| 33,000 pF | 333 | 333 | F | G | J | K | | | | | | | | | • | • | • | • | • | • | • | |
| 39,000 pF | 393 | 393 | F | G | J | K | | | | | | | | | • | • | • | • | • | | | |
| 47,000 pF | 473 | 473 | F | G | J | K | | | | | | | | | • | • | • | • | • | | | |
| | Cap Code | Can Code | Ra | ted Vo | ltage (| VDC) | 4 | 6.3 | 10 | 16 | 25 | 20 | 100 | 200 | 4 | 6.3 | 9 | 16 | 25 | 20 | 100 | 200 |
| Capacitance | (MIL-PRF-32535 Part Number) | (KEMET Part Number) | | Volta | ge Coo | le | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 2 |
| | rait Nullivel) | | C | ase Si | ze/Se | ries | | | | 12 | 06 | | | | | | | 12 | 10 | | | |



Table 1C - Capacitance Range/Selection Waterfall (1812 - 2220 Case Sizes)

| | | | | Cas | e Siz | e. | | | | 18 | 12 | | | | | | | 22 | 20 | | | |
|-------------|--------------------------------|---------------------|--------------|--------|---------|--------|---|-----|---|----------|----|----|------|-------|-------|---------------|---|----------|----|----|-----|-----|
| | Con Codo | Con Codo | Vo | oltage | Code (| MIL) | v | w | X | Y | z | A | В | C | v | w | X | Y | z | A | В | C |
| Canacitance | (MIL-PRF-32535 | (KEMET Part | Volt | age Co | ode (K | EMET) | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 2 |
| oupuortanoe | Part Number) | Number) | Da | | | | _ | m | _ | <u>.</u> | 6 | | • | 9 | - | e | _ | <u>.</u> | ы | | • | 0 |
| | , | | ка | | itage (| VDC) | • | ف | - | Ē | 2 | 5 | 10 | 20 | • | ف | - | ÷ | 2 | 2 | 9 | 20 |
| | | | Cap | acitan | ce Tol | erance | | | | | | | Prod | uct A | vaila | bility | | | | | | |
| 1,000 pF | 102 | 102 | F | G | J | K | • | • | • | • | • | • | • | • | • | • | • | • | • | ٠ | ٠ | • |
| 1,200 pF | 122 | 122 | F | G | J | K | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 1,500 pF | 152 | 152 | F | G | J | K | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 1,800 pF | 182 | 182 | F | G | J | K | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 2,000 pF | 202 | 202 | F | G | J | K | | | | | | | | | | | | | | | | |
| 2,200 pF | 222 | 222 | F | G | J | K | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 2,700 pF | 272 | 272 | F | G | J | K | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 3,300 pF | 332 | 332 | F | G | J | K | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 3,900 pF | 392 | 392 | F | G | J | K | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 4,700 pF | 472 | 472 | F | G | J | K | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 5,600 pF | 562 | 562 | F | G | J | K | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 6,800 pF | 682 | 682 | F | G | J | K | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |
| 8,200 pF | 822 | 822 | F | G | J | K | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | • |
| 10,000 pF | 103 | 103 | F | G | J | K | • | • | • | • | • | • | • | | • | • | • | • | • | ٠ | • | • |
| 12,000 pF | 123 | 123 | F | G | J | K | • | • | • | • | • | • | • | | • | • | • | • | • | ٠ | • | • |
| 15,000 pF | 153 | 153 | F | G | J | K | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | • |
| 18,000 pF | 183 | 183 | F | G | J | K | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | • |
| 22,000 pF | 223 | 223 | F | G | J | K | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | • |
| 27,000 pF | 273 | 273 | F | G | J | K | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | • |
| 33,000 pF | 333 | 333 | F | G | J | к | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | |
| 39,000 pF | 393 | 393 | F | G | J | K | ٠ | • | • | • | • | • | • | | • | • | • | • | • | ٠ | • | |
| 47,000 pF | 473 | 473 | F | G | J | к | • | • | • | • | • | • | • | ĺ | • | • | • | • | • | • | • | |
| 56,000 pF | 563 | 563 | F | G | J | к | • | • | • | • | • | • | • | ĺ | • | • | • | • | • | • | • | |
| 68,000 pF | 683 | 683 | F | G | J | к | • | • | • | • | • | • | | | • | • | • | • | • | • | • | |
| 82,000 pF | 823 | 823 | F | G | J | к | • | • | • | • | • | | | | • | • | • | • | • | • | • | |
| 100,000 pF | 104 | 104 | F | G | J | K | • | • | • | • | • | | | | • | • | • | • | • | • | • | |
| 120,000 pF | 124 | 124 | F | G | J | K | | | | | | | | | • | • | • | • | • | • | | |
| 150,000 pF | 154 | 154 | F | G | J | K | | | | | | | | | • | • | • | • | • | • | | |
| 180,000 pF | 184 | 184 | F | G | J | K | | | | | | | | | • | • | • | • | • | | | |
| | Cap Code | Can Code | Ra | ted Vo | ltage (| VDC) | 4 | 6.3 | 9 | 16 | 25 | 20 | 100 | 200 | 4 | 6.3 | 9 | 16 | 25 | 50 | 100 | 200 |
| Capacitance | (MIL-PRF-32535 Part Number) | (KEMET Part Number) | voltage Code | | | | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | 7 | 9 8 4 3 5 1 2 | | | | | | 2 |
| | | | Ca | ase Si | ze/Se | ries | | | | 18 | 12 | | | | | | | 22 | 20 | | | |



Table 2 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size | Metric Size | | Dens Maxi Land Pi | sity Lev mum (I rotrusio | vel A: Most) on (mm |) | | Dens Media Land Pi | sity Lev an (Nor rotrusio | vel B: minal) on (mm |) | | Dens Minii Land Pi | sity Lev mum (L rotrusio | vel C: .east) on (mm |) |
|-------------|----------------|------|-------------------------|--------------------------------|---------------------------|------|------|--------------------------|---------------------------------|----------------------------|------|------|--------------------------|--------------------------------|----------------------------|------|
| ooue | ooue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 |
| 2220 | 5650 | 2.75 | 1.70 | 5.50 | 8.20 | 6.50 | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | 2.55 | 1.30 | 5.30 | 6.60 | 5.60 |

Density Level A: For low-density product applications. It is recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. It provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations, the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of Surface Mount Multilayer Ceramic Capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR, or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/ J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Termination Finish |
|---|--------------------|
| Tomereature | SnPb |
| Preheat/Soak | |
| Temperature minimum (T _{smin}) | 100°C |
| Temperature maximum (T _{smax}) | 150°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds |
| Ramp-up rate $(T_{L} to T_{p})$ | 3°C/second maximum |
| Liquidous temperature (T_L) | 183°C |
| Time above liquidous (t _L) | 60 – 150 seconds |
| Peak temperature (T_p) | 235°C |
| Time within 5°C of maximum peak temperature (t _p) | 20 seconds maximum |
| Ramp-down rate $(T_p to T_l)$ | 6°C/second maximum |
| Time 25°C to peak temperature | 6 minutes maximum |

Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 3 – Performance & Reliability: Test Methods and Conditions

| Inspection | Test Method | MIL-PRF-32535 M-Level | MIL-PRF-32535 T-Level |
|---|--------------------------------|--------------------------|-----------------------------|
| | In-Process In | spection | |
| Nondestructive internal examination (pre-termination) | MIL-PRF-32535 Method 4.6.1 | Not required | Yes (100%) |
| Visual examination (post-termination) | MIL-PRF-32535 Method 4.6.2 | Not required | Yes (100%) |
| | Group A Ins | pection | |
| Thermal shock | MIL-PRF-32535 Method 4.6.3 | Not required | Yes (100%) |
| Nondestructive internal examination (case sizes ≥ 0805 only) | MIL-PRF-32535 Method 4.6.1 | Not required | Yes (100%) |
| Voltage conditioning | MIL-PRF-32535 Method 4.6.3 | Yes (100%) | Yes (100%) |
| Visual and mechanical inspection | MIL-PRF-32535 Method 4.6.2 | Yes (per inspection lot) | Yes (production lot sample) |
| Destructive physical analysis (DPA) | MIL-PRF-32535 Method 4.6.8 | Not required | Yes (production lot sample) |
| Solderability (solder dipped and solder plated terminations only) | MIL-PRF-32535 Method 4.6.11 | Yes (per inspection lot) | Yes (production lot sample) |
| Wire bond strength (gold-plated terminations only) | MIL-PRF-32535 Method 4.6.12 | Yes (per inspection lot) | Yes (production lot sample) |
| | Group B Insp | pection | |
| Thermal shock | MIL-PRF-32535 Method 4.6.3 | Yes (periodic) | Yes (production lot sample) |
| Life | MIL-PRF-32535 Method 4.6.16 | Yes (periodic) | Yes (production lot sample) |
| Temperature humidity bias (load humidity) | MIL-PRF-32535 Method 4.6.15 | Yes (periodic) | Yes (production lot sample) |
| Voltage - temperature limits/temperature characteristic | MIL-PRF-32535 Method 4.6.14 | Yes (periodic) | Yes (production lot sample) |
| Dielectric breakdown voltage (UVBD) | MIL-PRF-32535 Method 4.6.17 | Yes (periodic) | Yes (production lot sample) |
| | Group C Ins | pection | |
| Board flex | MIL-PRF-32535 Method 4.6.9 | Yes (periodic) | Yes (periodic) |
| Shear stress | MIL-PRF-32535 Method 4.6.10 | Yes (periodic) | Yes (periodic) |
| Resistance to soldering heat | MIL-PRF-32535 Method 4.6.13 | Yes (periodic) | Yes (periodic) |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. In addition, temperature fluctuations should be minimized to avoid condensation on the parts. The atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years upon receipt.



Construction



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Capacitor Marking:

KEMET MIL-PRF-32535 ceramic capacitors will be marked in accordance with the military specification on case sizes \geq 0805. Case sizes below 0805 will not be marked. Two sides of the ceramic body will be laser marked with a " \bar{K} " to identify KEMET, followed by two characters to identify the capacitance value.

The marking appears in legible contrast. Illustrated below is an example of an MLCC with laser the marking of " $\bar{K}A5$ ", which designates a KEMET device with the rated capacitance of 100 nF.



| Capacitance (pF) For Various Alpha/Numeral Identifiers | | | | | | | | | | |
|--|------------------|-----|----|-----|-------|--------|---------|-----------|------------|-------------|
| Alaba | Numeral | | | | | | | | | |
| Alpna | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Character | Capacitance (pF) | | | | | | | | | |
| A | 0.1 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 |
| Н | 0.2 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 |
| М | 0.3 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 |
| d | 0.4 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 |
| f | 0.5 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 |
| m | 0.6 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 |
| n | 0.7 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 |
| t | 0.8 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 |
| у | 0.9 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 |


Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8 and 12 mm tape on 7" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems.



Table 4 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tono oizo | Embossed Plastic | Punched Paper | |
|---------------|-----------|---------------------|------------------|--|
| EIA Case Size | (W)* | 7" Reel | 7" Reel | |
| | | Pitch (P1)* | Pitch (P1)* | |
| 0402 | 8 | | 2 | |
| 0603 | 8 | | 4 | |
| 0805 | 8 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | |
| ≥ 1812 | 12 | 8 | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 5 - Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | |
|--------------|--|----------------------------------|----------------------------|---------------------------|---------------------------|---------------------------|----------------------------------|----------------------------------|--------------------|
| Tape Size | D _o | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T₁ Maximum |
| 8 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.0 (0.039) | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.05 (0.079±0.002) | 25.0 (0.984) | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 12 mm | | 1.5 (0.059) | | | | 30 (1.181) | | | |
| | | Va | ariable Dimer | nsions – Milli | meters (Inch | es) | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B ₀ a | and K _o |
| | | | | | | | | | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5±0.05 (0.138±0.002) | 4.0±0.10 (0.157±0.004) | 2.5 (0.098) | 8.3 (0.327) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independent of each other.

2. The tape with or without components, shall pass around R without damage (see Figure 6).

3. If S1 < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Document 481 paragraph 4.3 (b)).

4. B1 dimension is a reference dimension for a tape feeder clearance only.

5. The cavity defined by A, B, and K, shall surround the component with sufficient clearance that:

(a) The component does not protrude above the top surface of the carrier tape.

(b) The component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed. (c) Rotation of the component is limited to 20° maximum for 8 and 12 mm tapes; 10° maximum for 16 mm tapes (see Figure 3).

(d) Lateral movement of the component is restricted to 0.5 mm maximum for 8 mm and 12 mm wide tape; to 1.0 mm maximum for 16 mm tape (see Figure 4).

(e) See addendum in EIA Document 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 6 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | |
|--|---|--|-----------------------------|---------------------------|------------------------|-----------------|-----------------------|
| Tape Size | D _o | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 |
| 8 mm | 1.5 + 0.10/-0.0 (0.059 + 0.004/-0.0) | 1.75±0.104.0±0.102.0±0.05(0.069±0.004)(0.157±0.004)(0.079±0.002) | | 0.100 (0.004) | 0.75 (0.030) | 25.0 (0.984) | |
| Variable Dimensions — Millimeters (Inches) | | | | | | | |
| Tape Size | Pitch | E ₂ Minimum | F | P1 | T Maximum | W Maximum | A_0 and B_0 |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 (0.138 ±0.002) | 2.0±0.05 (0.079±0.002) | 1.1 | 8.3 (0.327) | Note 1 |
| 8 mm | Single (4 mm) | (0.246) | | 4.0±0.10 (0.157±0.004) | (0.098) | 8.3 (0.327) | |

1. The cavity defined by A_{ρ} , B_{ρ} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3).

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4).

e) see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6).



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 Newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 Newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 7 – Reel Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | |
|-----------|--|---|------------------------|-----------------------------|--|--|--|--|
| Tape Size | A | B Minimum | С | D Minimum | | | | |
| 8 mm | 178±0.20 (7.008±0.008) | 1.5 | 13.0 + 0.5/-0.2 | 20.2 (0.795) | | | | |
| 12 mm | 330±0.20 (13.000±0.008) | (0.059) | (0.521 + 0.02/-0.008) | | | | | |
| | Variable | Dimensions – Millimeter | rs (Inches) | | | | | |
| Tape Size | N Minimum See Note 2, Tables 2–3 | W ₁ | W ₂ Maximum | W ₃ | | | | |
| 8 mm | 50 | 8.4 + 1.5/-0.0 (0.331 + 0.059/-0.0) | 14.4 (0.567) | Shall accomadate tape width | | | | |
| 12 mm | (1.969) | 12.4 + 2.0/-0.0 (0.488 + 0.078/-0.0) | 18.4 (0.724) | without interference | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Waffle Tray Packaging Information – 2" x 2" w/ Static Protection

Figure 9 – Waffle Tray Dimensions – Inches (Millimeters)





Table 8A – Waffle Tray Dimensions – Inches

| Caa | o Sizo | | 2" x 2" Waffle Tray Dimensions – Inches | | | | | | | | Packaging Quantity | |
|---------------------|-------------|--------|---|--------|--------|--------|--------|--------|-------|---------|---------------------------|--|
| Uds | e 512e | М | M1 | M2 | M3 | Х | Y | Z | A° | MATRIX | (pcs/unit | |
| EIA (in) | Metric (mm) | ±0.003 | ±0.003 | ±0.002 | ±0.002 | ±0.002 | ±0.002 | ±0.003 | ±1/2° | (X x Y) | packaging) | |
| 0402 | 1005 | 0.175 | 0.153 | 0.077 | 0.110 | 0.073 | 0.042 | 0.041 | 7 | 16 X 23 | 368 | |
| 0603 | 1608 | 0.175 | 0.153 | 0.077 | 0.110 | 0.073 | 0.042 | 0.041 | 7 | 16 X 23 | 368 | |
| 0805 | 2012 | 0.232 | 0.186 | 0.181 | 0.171 | 0.062 | 0.092 | 0.036 | 10 | 10 X 10 | 100 | |
| 1206 ^{1,2} | 3216 | 0.194 | 0.228 | 0.193 | 0.124 | 0.067 | 0.130 | 0.065 | 5 | 14 X 9 | 126 | |
| 1206 ^{1,3} | 3216 | 0.250 | 0.250 | 0.375 | 0.167 | 0.100 | 0.200 | 0.070 | 5 | 10 X 5 | 50 | |
| 1210 | 3225 | 0.217 | 0.244 | 0.215 | 0.174 | 0.110 | 0.145 | 0.080 | 5 | 10 X 8 | 80 | |
| 1812 | 4532 | 0.271 | 0.285 | 0.286 | 0.243 | 0.150 | 0.200 | 0.075 | 5 | 7 X 6 | 42 | |
| 2220 | 5650 | 0.318 | 0.362 | 0.424 | 0.34 | 0.24 | 0.32 | 0.032 | 5 | 5 X 4 | 20 | |

¹ Packaging of 1206 (3216 metric) case size capacitors is dependent upon the nominal chip thickness of the device. Contact KEMET Sales for Waffle Tray quantities for specified part number.

² Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of \leq 1.25 mm (0.049 inches).

³ Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of > 1.25 mm (0.049 inches).

Table 8B – Waffle Tray Dimensions – Millimeters

| Cas | o Ciro | | 2" x 2" Waffle Tray Dimensions - Millimeters | | | | | | | | Packaging Quantity |
|---------------------|-------------|-------|--|-------|-------|-------|-------|-------|-------|---------|---------------------------|
| Cas | e Size | М | M1 | M2 | M3 | Х | Y | Z | A° | MATRIX | (pcs/unit |
| EIA (in) | Metric (mm) | ±0.08 | ±0.08 | ±0.05 | ±0.05 | ±0.05 | ±0.05 | ±0.08 | ±1/2° | (X x Y) | packaging) |
| 0402 | 1005 | 4.45 | 3.89 | 1.96 | 2.79 | 1.85 | 1.07 | 1.04 | 7 | 16 X 23 | 368 |
| 0603 | 1608 | 4.45 | 3.89 | 1.96 | 2.79 | 1.85 | 1.07 | 1.04 | 7 | 16 X 23 | 368 |
| 0805 | 2012 | 5.89 | 4.72 | 4.60 | 4.34 | 1.57 | 2.34 | 0.91 | 10 | 10 X 10 | 100 |
| 1206 ^{1,2} | 3216 | 4.93 | 5.79 | 4.90 | 3.15 | 1.70 | 3.30 | 1.65 | 5 | 14 X 9 | 126 |
| 1206 ^{1,3} | 3216 | 6.35 | 6.35 | 9.53 | 4.24 | 2.54 | 5.08 | 1.78 | 5 | 10 X 5 | 50 |
| 1210 | 3225 | 5.51 | 6.20 | 5.46 | 4.42 | 2.79 | 3.68 | 2.03 | 5 | 10 X 8 | 80 |
| 1812 | 4532 | 6.88 | 7.24 | 7.26 | 6.17 | 3.81 | 5.08 | 1.91 | 5 | 7 X 6 | 42 |
| 2220 | 5650 | 8.08 | 9.19 | 10.77 | 8.64 | 6.10 | 8.13 | 0.81 | 5 | 5 X 4 | 20 |

¹ Packaging of 1206 (3216 metric) case size capacitors is dependent upon the nominal chip thickness of the device. Contact KEMET Sales for Waffle Tray quantities for specified part number.

² Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of \leq 1.25 mm (0.049 inches).

³ Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of > 1.25 mm (0.049 inches).



Overview

The KEMET MIL-PRF-32535 X7R surface mount capacitors are designed, tested and screened to meet demanding high reliability defense and aerospace applications. MIL-PRF-32535 is Defense Logistics Agency's (DLA) first capacitor specification for defense and aerospace that capitalizes on industry leading base metal electrode (BME) technology. Qualified under performance specification, MIL-PRF-32535 and QPL listed, this series meets or exceeds the requirements outlined by DLA and is currently available in M (standard reliability) and T (high reliability) product levels. Driven by the demand for higher capacitance and smaller case size MLCCs in high reliability applications, KEMET's MIL-PRF-32535 X7R provides over an 55-fold increase in capacitance over MIL-PRF-55681 and MIL-PRF-123, allowing for reduced board space and continuing the trend for miniaturization.

In addition to being the first BME X7R dielectric qualified for use in defense and aerospace applications, MIL-PRF-32535 is the first DLA specification to recognize a flexible termination option. KEMET's flexible termination utilizes a pliable and conductive silver epoxy between the base metal and nickel barrier layers of the termination system. The addition of this epoxy layer inhibits the transfer of board stress to the rigid ceramic body, therefore mitigating flex cracks, which can result in a low IR or short circuit failures.

Benefits

- Patented BME technology
- Qualified per MIL-PRF-32535 (QPL)
- Standard reliability (M Level)
- High reliability (T Level)
- Flexible termination option available
- EIA 0402, 0603, 0805, 1206, 1210, 1812, 2220 case sizes
- DC voltage ratings of 4 V, 6.3 V, 10 V, 16 V, 25 V, 50 V, and 100 V
- Capacitance offerings ranging from 39 pF up to 10 uF
- Available capacitance tolerances of ±5%, ±10% and 20%
- · Non-polar device, minimizing installation concerns

Applications

- Decoupling
- Bypass
- Filtering
- · Transient voltage suppression





MIL-PRF-32535 Ordering Information

| M32535 | 04 | E2 | Z | 103 | K | Z | Μ | В |
|------------|---|-------------------------------|---|---|---------------------------------|--|----------------------------|-----------|
| MIL Prefix | Slash Sheet | Characteristic/ Dielectric | Rated Voltage (VDC) | Capacitance Code (pF) | Capacitance Tolerance | Termination ^{1, 2, 3, 4, 5} | Product Level | Electrode |
| | 02 = 0402 03 = 0603 04 = 0805 05 = 1206 06 = 1210 07 = 1812 08 = 2220 | E2 = X7R | V = 4 W = 6.3 X = 10 Y = 16 Z = 25 A = 50 B = 100 | Two significant digits and number of zeros. | J = ±5% K = ±10% M = ±20% | D = Sn/Pb solder dipped G = Nickel gold-plating R = Flexible termination with solder plating V = Flexible termination with nickel gold-plating Z = Sn/Pb solder plated | M = M Level T = T Level | B = BME |

¹ Termination options D, R, and V are not available in EIA 0402 case size.

² Termination option D is not available in EIA 0603 case size.

³ Termination options D, G, and Z are not available in EIA 1812 case size.

⁴ Termination options D, G and Z are not available for 100 V.

 $^{\rm 5}$ Termination options D, G and Z are not available in EIA 2220 case size for 50 V.

KEMET Part Number Equivalent (For Reference Only)

(Do not use this ordering code if a QPL MIL-SPEC part type is required. Please order using MIL-SPEC ordering code. Details regarding MIL-PRF-32535 QPL ordering information is outlined above.)

| С | 0805 | K | 104 | J | 3 | R | М | L | - |
|---------|--|--------------------------|--|---------------------------------------|---|------------|--|--|--|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance ² | Rated Voltage (VDC) | Dielectric | Product Level | Termination Finish | Packaging/ Grade (C-Spec) |
| | 0402 0603 0805 1206 1210 1812 2220 | K = MIL-PRF-32535 | Two significant digits and number of zeros. | J = ±5% K = ±10% M = ±20% | 7 = 4 9 = 6.3 8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 | R = X7R | M = M Level standard termination N = M Level flexible termination T = T Level standard termination V = T Level flexible termination | L = Sn/Pb solder plated H = Sn/Pb solder dipped G = Nickel gold-plating | See "Packaging C-Spec Ordering Options Table" |



Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) |
|----------------------------------|---|
| Standard Packaging (Waffle Tray) | Not required (blank) |
| 7" Tape & Reel | Contact Sales |

¹ Default packaging with no C-Spec is "Waffle Tray," and is recommended for order quantities of less than 250 pieces. See Waffle Tray packaging information section for additional details.

¹ See Tape & Reel Packaging information section of the datasheet for additional details.

Dimensions per MIL-PRF-32535 – Inches (Millimeters)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness (Max) | B Bandwidth | Maximum Part Weight (mg) ³ | Mounting Technique |
|---------------------|------------------------|--------------------|--------------------|-------------------------|----------------|---|-----------------------|
| 0402 | 1005 | 0.040+0.006/-0.004 | 0.020+0.005/-0.004 | 0.025 | 0.004 (0.100) | 1.6 | Solder reflow |
| | | (1.02+0.15/-0.10) | (0.51+0.13/-0.10) | (0.64) | Minimum | | only |
| 0603 | 1608 | 0.063+0.008/-0.006 | 0.032+0.008/-0.006 | 0.040 | 0.016 ±0.008 | 63 | |
| 0003 1000 | (1.60+0.2/-0.15) | (0.81+0.2/-0.15) | (1.02) | (0.41±0.20) | 0.0 | | |
| 09051 | 00051 0010 | 0.079+0.012/-0.01 | 0.050+0.012/-0.01 | 0.062 | 0.020±0.010 | 20 | Solder wave or |
| 0805 | 2012 | (2.01+0.3/-0.25) | (1.27+0.3/-0.25) | (1.57) | (0.51±0.25) | 20 | solder reflow |
| 12062 | 2216 | 0.126+0.012/-0.01 | 0.063+0.012/-0.01 | 0.071 | 0.020±0.014 | F 7 | |
| 1200- | 5210 | (3.20+0.3/-0.25) | (1.60+0.3/-0.25) | (1.8) | (0.51±0.36) | 57 | |
| 10102 | 2225 | 0.126+0.012/-0.01 | 0.098+0.012/-0.010 | 0.110 | 0.020±0.014 | 100 | |
| 1210- | 3225 | (3.20+0.3/-0.25) | (2.49+0.3/-0.25) | (2.79) | (0.51±0.36) | 108 | |
| 10102 | 4500 | 0.178±0.012 | 0.126±0.012 | 0.110 | 0.024±0.018 | 016 | Solder reflow |
| 1012- | 1812 ² 4532 | (4.52±0.30) | (3.20±0.30) | (2.79) | (0.61±0.46) | 210 | only |
| 00002 | 2220 ² 5650 | 0.224±0.016 | 0.197±0.016 | 0.110 | 0.025±0.018 | 400 | |
| 22202 | | (5.69+0.41) | (5 00+0 41) | (2 79) | (0.64+0.46) | 430 | |

¹ For EIA 0805 solder dipped termination finish, add 0.020 (0.51) to the positive length tolerance and 0.015 (0.38) to the positive width and thickness tolerance.

² For EIA 1206, 1210, 1812 and 2220 solder dipped termination finishes, add 0.025 (0.64) to the positive length tolerance and 0.015 (0.38) to the positive width and thickness tolerance.

³ Maximum Part Weight represents the maximum weight in the given case size for all voltages.



Environmental Compliance

These devices are RoHS compliant only if ordered with gold (Au) termination finish.

Electrical Parameters/Characteristics

| Item | Parameters/Characteristics | | | | |
|---|---|--|--|--|--|
| Operating temperature range | -55°C to +125°C | | | | |
| Capacitance change with reference to +25°C and 0 VDC applied (TCC) | ±15% | | | | |
| Aging rate (maximum % capacitance loss/decade hour) | 3% | | | | |
| ¹ Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA) | | | | |
| ² Dissipation Factor (DF) maximum limit at 25°C | Maximum Allowable DF (%)Rated Voltage (VDC)4 6.3 10 16 25 ≥ 50 7.5 7.5 5.0 3.5 3.5 2.5 | | | | |
| ³ Insulation Resistance (IR) minimum limit at 25°C | Rated voltage < 25 V 500 M Ω µF or 100 G Ω , whichever is less Rated voltage ≥ 25 V 1,000 M Ω µF or 100 G Ω , whichever is less (Rated voltage applied for 120 seconds maximum at 25°C) | | | | |

¹ DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

² Capacitance and dissipation factor (DF) measured under the following conditions:

1 MHz ±100 kHz and 1.0 V_{rms} ±0.2 V if capacitance ≤ 1,000 pF

1 kHz \pm 50 Hz and 1.0 V_{ms} ± 0.2 V if capacitance > 1,000 pF

³ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Capacitance and dissipation factor (DF) measured under the following conditions:

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as automatic level control (ALC). The ALC feature should be switched to "ON."



Table 1A – Capacitance Range/Selection Waterfall (0402 – 0805 Case Sizes)

| | | Ca | Case Size | | | | 04 | 02 | | | | | 06 | 03 | | | | | | 0805 | 5 | | |
|------------------------|------------|---------|-----------|---------|------------|-----|----|----|----|----|-----|-----|-------|-----------------------|----------|----|------------|-----|----|------|----|----|-----|
| | | Volta | ge Code | (MIL) | v | w | x | Y | z | A | v | w | x | Y | z | Α | v | w | X | Y | z | Α | В |
| Capacitance | Сар | Voltage | e Code (l | KEMET) | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 | 1 |
| | Code | Rated | Voltage | (VDC) | 4 | | 6 | 16 | 25 | 20 | 4 | 6.3 | 6 | 16 | 25 | 20 | 4 | 6.3 | 5 | 16 | 25 | 20 | 8 |
| | | Capaci | tance To | lerance | | | | - | | | | • | Produ | ct Avai | lability | | | • | | | | | - |
| 39 pF | 390 | J | K | М | • | • | • | • | • | • | | | | | | | | | | | | | |
| 47 pF | 470 | J | К | М | • | • | • | • | • | • | | | | | | | | | | | | | |
| 56 pF | 560 | J | K | M | • | • | • | • | • | • | | | | | | | | | | | | | |
| 68 pF 82 nF | 820 | J | K | M | | | | | | | | | | | | | | | | | | | |
| 100 pF | 101 | J | K | M | • | • | • | • | • | • | | | | | | | | | | | | | |
| 120 pF | 121 | J | К | М | • | • | • | • | • | • | | | | | | | | | | | | | |
| 150 pF | 151 | J | K | M | • | • | • | • | • | • | | | | | | | | | | | | | |
| 180 pF | 181 | J | K | M | • | • | • | • | • | • | | | | | | | | | | | | | |
| 220 pF 270 nF | 221 | J | K | M | | • | • | • | • | • | | | | | | | | | | | | | |
| 330 pF | 331 | J | K | M | • | • | • | • | • | • | | | | | | | | | | | | | |
| 390 pF | 391 | J | К | М | • | • | • | • | • | • | | | | | | | | | | | | | |
| 470 pF | 471 | J | К | M | • | • | • | • | • | • | | | | | | | | | | | | | |
| 560 pF | 561 | J | K | M | • | • | • | • | • | • | | | | | | | | | | | | | |
| 680 pF 820 nF | 821 | J | ĸ | M | | | | | | | | | | | | | | | | | | | |
| 1.000 pF | 102 | J | ĸ | M | | • | • | • | | | • | • | • | • | • | • | | | | | | | |
| 1,200 pF | 122 | J | К | м | • | • | • | • | • | • | • | • | • | • | • | • | | | | | | | |
| 1,500 pF | 152 | J | K | М | • | • | • | • | • | • | • | • | • | • | • | • | | | | | | | |
| 1,800 pF | 182 | J | K | M | • | • | • | • | • | • | • | • | • | • | • | • | | | | | | | |
| 2,200 pF 2,700 pF | 222 | J | K | M | | | | | | | | | | | | | | | | | | | |
| 3.300 pF | 332 | J | K | M | | | | • | | • | | • | | | | • | | | | | | | |
| 3,900 pF | 392 | J | K | M | • | • | • | • | • | • | • | • | • | • | • | • | | | | | | | |
| 4,700 pF | 472 | J | K | М | • | • | • | • | • | • | • | • | • | • | • | • | | | | | | | |
| 5,600 pF | 562 | J | K | M | • | • | • | • | • | • | • | • | • | • | • | • | | | | | | | |
| 6,800 pF 8 200 pF | 822 | J | ĸ | M | | | | | | • | | | | | | | | | | | | | |
| 10.000 pF | 103 | J | K | M | | | | • | | | | • | | | | | • | • | • | • | • | • | •1 |
| 12,000 pF | 123 | J | K | М | • | • | • | • | • | | • | • | • | • | • | • | • | • | • | • | • | • | •1 |
| 15,000 pF | 153 | J | K | M | • | • | • | • | • | | • | • | • | • | • | • | • | • | • | • | • | • | •1 |
| 18,000 pF | 183 | J | K | M | • | • | • | • | • | | • | • | • | • | • | • | • | • | • | • | • | • | •1 |
| 22,000 pF 27,000 pF | 223 | J | ĸ | M | | | | • | • | | | | | | | | | | | | | | •1 |
| 33000 pF | 333 | J | K | M | • | • | • | | | | • | • | • | • | • | • | • | • | • | • | • | • | •1 |
| 39,000 pF | 393 | J | к | м | • | • | • | | | | • | • | • | • | • | • | • | • | • | • | • | • | •1 |
| 47,000 pF | 473 | J | K | М | • | • | • | | | | • | • | • | • | • | • | • | • | • | • | • | • | •1 |
| 51,000 pF | 513 | J | K | M | | | | | | | • | • | • | • | • | | | | | | | | .1 |
| 56,000 pF | 683 | J | ĸ | M | | | | | | | • | • | • | • | • | | • | • | • | • | • | • | •1 |
| 82,000 pF | 823 | J | K | M | | | | | | | • | • | • | • | | | • | • | • | • | • | • | |
| 100,000 pF | 104 | J | К | М | | | | | | | • | • | • | • | • | | • | • | • | • | • | • | |
| 120,000 pF | 124 | J | K | М | | | | | | | • | • | • | • | • | | • | • | • | • | • | • | |
| 150,000 pF | 154 | J | K | M | | | | | | | • | • | • | • | • | | • | • | • | • | • | • | |
| 220 000 pF | 224 | J | ĸ | M | | | | | | | | | | | | | | | | | | | |
| 270,000 pF | 274 | J | ĸ | M | | | | | | | | | | | | | • | • | • | • | • | | |
| 330,000 pF | 334 | J | К | М | | | | | | | | | | | | | • | • | • | • | • | | |
| 390,000 pF | 394 | J | K | М | | | | | | | | | | | | | • | • | • | • | • | | |
| 470,000 pF | 474 | J | K | M | | | | | | | | | | | | | • | • | • | • | • | | |
| 560,000 pF | 504 684 | J | K | M | | | | | | | | | | | | | | | | | | | |
| 820,000 pF | 824 | J | K | M | | | | | | | | | | | | | • | • | • | | _ | | |
| 1,000,000 pF | 105 | J | К | М | | | | | | | | | | | | | • | • | • | | | | |
| | | Ra | ted Volta | age | 4 | 5.3 | 10 | 16 | 25 | 50 | 4 | 5.3 | 10 | 16 | 25 | 50 | 4 | 5.3 | 10 | 16 | 25 | 50 | 100 |
| Capacitance | Cap Code | V | ltano Co | de | 7 | 0 | Я | 4 | 2 | 5 | 7 | 9 | 8 | 4 | 2 | 5 | 7 | 0 | 8 | 4 | 2 | 5 | 1 |
| | | | Case Siz | e | ⊢ ′ | , 7 | 04 | 02 | 3 | J | · ' | , , | 06 | j 4 503 | 3 | J | <u>⊢ '</u> | , , | 0 | 0805 | 3 | J | |

¹ Only available with flexible termination.



Table 1B - Capacitance Range/Selection Waterfall (1206 - 1210 Case Sizes)

| | | Ca | ase Si | ze | | | | 1206 | • | | | 1210 | | | | | | |
|--------------|----------|--------|-----------|---------|---|-----|----|------|----|-----|---------|---------|------|----|------|----|----|-----|
| | | Volta | ge Code | (MIL) | v | w | X | Y | z | A | В | v | w | X | Y | z | Α | В |
| Canacitanao | Сар | Voltag | e Code (k | (EMET) | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 7 | 9 | 8 | 4 | 3 | 5 | 1 |
| Capacitance | Code | | | , | | | - | | | | - | | | - | | | | |
| | | Rated | Voltage | (VDC) | 4 | 6.3 | 1 | 16 | 25 | 50 | 100 | 4 | 6.3 | 10 | 16 | 25 | 50 | 100 |
| | | Capaci | tance To | lerance | | | | | | Pre | oduct A | vailabi | lity | | | | | |
| 82,000 pF | 823 | J | K | М | | | | | | | | • | • | • | • | • | • | •1 |
| 100,000 pF | 104 | J | K | M | • | • | • | • | • | • | •1 | • | • | • | • | • | • | •1 |
| 120,000 pF | 124 | J | K | M | | | | | | | | • | • | • | • | • | • | |
| 150,000 pF | 154 | J | K | M | • | • | • | • | • | • | •1 | • | • | • | • | • | • | •1 |
| 180,000 pF | 184 | J | K | M | • | • | • | • | • | • | | • | • | • | • | • | • | •1 |
| 220,000 pF | 224 | J | K | M | • | • | • | • | • | • | | • | • | • | • | • | • | •1 |
| 270,000 pF | 274 | J | К | M | • | • | • | • | • | • | | • | • | • | • | • | • | •1 |
| 330,000 pF | 334 | J | К | M | • | • | • | • | • | • | | • | • | • | • | • | • | •1 |
| 390,000 pF | 394 | J | К | M | • | • | • | • | • | | | • | • | • | • | • | • | |
| 470,000 pF | 474 | J | К | M | • | • | • | • | • | | | • | • | • | • | • | • | |
| 560,000 pF | 564 | J | K | M | • | • | • | • | • | | | • | • | • | • | • | • | |
| 680,000 pF | 684 | J | K | M | • | • | • | • | • | | | • | • | • | • | • | • | |
| 820,000 pF | 824 | J | K | M | • | • | • | • | • | | | • | • | • | • | • | | |
| 1,000,000 pF | 105 | J | К | M | • | • | • | • | • | | | • | • | • | • | • | | |
| 1,200,000 pF | 125 | J | К | M | • | • | • | • | • | | | • | • | • | • | • | | |
| 1,500,000 pF | 155 | J | K | М | • | • | • | • | • | | | • | • | • | • | • | | |
| 1,800,000 pF | 185 | J | к | м | • | • | • | | | | | • | • | • | • | • | | |
| 2,200,000 pF | 225 | J | к | м | • | • | • | | | | | • | • | • | • | • | | |
| 2,700,000 pF | 275 | J | К | М | | | | | | | | | | | | | | |
| 3,300,000 pF | 335 | J | К | М | | | | | | | | • | • | • | | | | |
| | | Ra | ted Volta | ige | 4 | 6.3 | 10 | 16 | 25 | 50 | 100 | 4 | 6.3 | 10 | 16 | 25 | 50 | 100 |
| Capacitance | Cap Code | Vo | oltage Co | de | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 7 | 9 | 8 | 4 | 3 | 5 | 1 |
| | | C | Case Siz | e | | | | 1206 | | | | | | | 1210 | | | |

¹Only available with flexible termination.



Table 1C - Capacitance Range/Selection Waterfall (1812 - 2220 Case Sizes)

| | | Ca | ase Si | ze | 1812 | | | | | | | 2220 | | | | | |
|---------------|----------|---------|-----------|---------|------|-----|----|------|----|-------|----------|---------|-----|----|----|----|----|
| | | Volta | ge Code | (MIL) | v | w | X | Y | Z | A | В | v | w | X | Y | z | A |
| Capacitance | Сар | Voltage | e Code (H | (EMET) | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 7 | 9 | 8 | 4 | 3 | 5 |
| | Code | Rated | Voltage | (VDC) | 4 | 6.3 | 10 | 16 | 25 | 50 | 100 | 4 | 6.3 | 10 | 16 | 25 | 50 |
| | | Capaci | tance To | lerance | | 1 | 1 | 1 | 1 | Produ | ct Avail | ability | I | 1 | 1 | 1 | 1 |
| 100,000 pF | 104 | J | K | M | •1 | •1 | •1 | •1 | •1 | •1 | •1 | • | • | • | • | • | •1 |
| 120,000 pF | 124 | J | K | M | | | | | | | | | | | | | |
| 150,000 pF | 154 | J | K | M | •1 | •1 | •1 | •1 | •1 | •1 | •1 | • | • | • | • | • | •1 |
| 180000 pF | 184 | J | K | M | •1 | •1 | •1 | •1 | •1 | •1 | •1 | • | • | • | • | • | •1 |
| 220,000 pF | 224 | J | K | M | •1 | •1 | •1 | •1 | •1 | •1 | •1 | • | • | • | • | • | •1 |
| 270,000 pF | 274 | J | K | M | •1 | •1 | •1 | •1 | •1 | •1 | •1 | • | • | • | • | • | •1 |
| 330,000 pF | 334 | J | K | M | •1 | •1 | •1 | •1 | •1 | •1 | •1 | • | • | • | • | • | •1 |
| 390,000 pF | 394 | J | K | M | •1 | •1 | •1 | •1 | •1 | •1 | •1 | • | • | • | • | • | •1 |
| 470,000 pF | 474 | J | K | M | •1 | •1 | •1 | •1 | •1 | •1 | •1 | • | • | • | • | • | •1 |
| 560,000 pF | 564 | J | K | M | •1 | •1 | •1 | •1 | •1 | •1 | •1 | • | • | • | • | • | •1 |
| 680,000 pF | 684 | J | K | М | •1 | •1 | •1 | •1 | •1 | •1 | •1 | • | • | • | • | • | •1 |
| 820,000 pF | 824 | J | K | M | •1 | •1 | •1 | •1 | •1 | •1 | •1 | • | • | • | • | • | •1 |
| 1,000,000 pF | 105 | J | K | M | •1 | •1 | •1 | •1 | •1 | •1 | •1 | • | • | • | • | • | •1 |
| 1,200,000 pF | 125 | J | К | М | •1 | •1 | •1 | •1 | •1 | •1 | | • | • | • | • | • | •1 |
| 1,500,000 pF | 155 | J | К | М | •1 | •1 | •1 | •1 | •1 | •1 | | • | • | • | • | • | •1 |
| 1,800,000 pF | 185 | J | K | М | •1 | •1 | •1 | •1 | •1 | •1 | | • | • | • | • | • | |
| 2,200,000 pF | 225 | J | к | м | •1 | •1 | •1 | •1 | •1 | | | • | • | • | • | • | |
| 2,700,000 pF | 275 | J | к | м | •1 | •1 | •1 | •1 | •1 | | | • | • | • | • | • | |
| 3,300,000 pF | 335 | J | к | м | •1 | •1 | •1 | •1 | •1 | | | • | • | • | • | • | |
| 3,900,000 pF | 395 | J | к | м | •1 | •1 | •1 | •1 | •1 | | | • | • | • | • | | |
| 4,700,000 pF | 475 | J | K | М | •1 | •1 | •1 | | | | | • | • | • | • | | |
| 5,600,000 pF | 565 | J | K | м | | | | | | | | • | • | | | | |
| 6,800,000 pF | 685 | J | K | М | | | | | | | | • | • | | | | |
| 8,200,000 pF | 825 | J | K | М | | | | | | | | • | • | | | | |
| 10,000,000 pF | 106 | J | K | М | | | | | | | | • | • | | | | |
| | | Ra | ted Volta | ige | 4 | 6.3 | 10 | 16 | 25 | 50 | 100 | 4 | 6.3 | 5 | 16 | 25 | 50 |
| Capacitance | Cap Code | Va | ltage Co | de | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 7 | 9 | 8 | 4 | 3 | 5 |
| | | C | ase Siz | e | | | | 1812 | | | | | | 22 | 20 | | |

¹Only available with flexible termination.



Table 2 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size Code | Metric Size | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | | Dens Media Land Pi | sity Lev an (Nor rotrusio | vel B: minal) on (mm |) | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | |
|---------------------|----------------|--|------|------|------|------|--------------------------|---------------------------------|----------------------------|------|---|------|------|------|------|------|
| oouc | oouc | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 |
| 2220 | 5650 | 2.75 | 1.70 | 5.50 | 8.20 | 6.50 | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | 2.55 | 1.30 | 5.30 | 6.60 | 5.60 |

Density Level A: For low-density product applications. It is recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. It provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations, the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of Surface Mount Multilayer Ceramic Capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR, or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/ J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Termination Finish |
|---|--------------------|
| Tomereature | SnPb |
| Preheat/Soak | |
| Temperature minimum (T _{smin}) | 100°C |
| Temperature maximum (T _{smax}) | 150°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds |
| Ramp-up rate $(T_L to T_P)$ | 3°C/second maximum |
| Liquidous temperature (T_L) | 183°C |
| Time above liquidous (t _L) | 60 – 150 seconds |
| Peak temperature (T_p) | 235°C |
| Time within 5°C of maximum peak temperature (t _p) | 20 seconds maximum |
| Ramp-down rate $(T_p to T_l)$ | 6°C/second maximum |
| Time 25°C to peak temperature | 6 minutes maximum |

Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 3 – Performance & Reliability: Test Methods and Conditions

| Inspection | Test Method | MIL-PRF-32535 M-Level | MIL-PRF-32535 T-Level |
|---|--------------------------------|--------------------------|-----------------------------|
| | In-Process In | spection | |
| Nondestructive internal examination (pre-termination) | MIL-PRF-32535 Method 4.6.1 | Not required | Yes (100%) |
| Visual examination (post-termination) | MIL-PRF-32535 Method 4.6.2 | Not required | Yes (100%) |
| | Group A Ins | pection | |
| Thermal shock | MIL-PRF-32535 Method 4.6.3 | Not required | Yes (100%) |
| Nondestructive internal examination (case sizes ≥ 0805 only) | MIL-PRF-32535 Method 4.6.1 | Not required | Yes (100%) |
| Voltage conditioning | MIL-PRF-32535 Method 4.6.3 | Yes (100%) | Yes (100%) |
| Visual and mechanical inspection | MIL-PRF-32535 Method 4.6.2 | Yes (per inspection lot) | Yes (production lot sample) |
| Destructive physical analysis (DPA) | MIL-PRF-32535 Method 4.6.8 | Not required | Yes (production lot sample) |
| Solderability (solder dipped and solder plated terminations only) | MIL-PRF-32535 Method 4.6.11 | Yes (per inspection lot) | Yes (production lot sample) |
| Wire bond strength (gold-plated terminations only) | MIL-PRF-32535 Method 4.6.12 | Yes (per inspection lot) | Yes (production lot sample) |
| | Group B Insp | pection | |
| Thermal shock | MIL-PRF-32535 Method 4.6.3 | Yes (periodic) | Yes (production lot sample) |
| Life | MIL-PRF-32535 Method 4.6.16 | Yes (periodic) | Yes (production lot sample) |
| Temperature humidity bias (load humidity) | MIL-PRF-32535 Method 4.6.15 | Yes (periodic) | Yes (production lot sample) |
| Voltage - temperature limits/temperature characteristic | MIL-PRF-32535 Method 4.6.14 | Yes (periodic) | Yes (production lot sample) |
| Dielectric breakdown voltage (UVBD) | MIL-PRF-32535 Method 4.6.17 | Yes (periodic) | Yes (production lot sample) |
| | Group C Ins | pection | • |
| Board flex | MIL-PRF-32535 Method 4.6.9 | Yes (periodic) | Yes (periodic) |
| Shear stress | MIL-PRF-32535 Method 4.6.10 | Yes (periodic) | Yes (periodic) |
| Resistance to soldering heat | MIL-PRF-32535 Method 4.6.13 | Yes (periodic) | Yes (periodic) |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. In addition, temperature fluctuations should be minimized to avoid condensation on the parts. The atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years upon receipt.



Construction



*Termination Finishes: Solder Plated

SnPb - 3% Pb Minimum

Inner Electrodes (Ni)

Gold (Au)

Barrier Layer

(Ni)

Termination

Finish*



Capacitor Marking:

KEMET MIL-PRF-32535 ceramic capacitors will be marked in accordance with the military specification on case sizes \geq 0805. Case sizes below 0805 will not be marked. Two sides of the ceramic body will be laser marked with a " \bar{K} " to identify KEMET, followed by two characters to identify the capacitance value.

The marking appears in legible contrast. Illustrated below is an example of an MLCC with laser the marking of " $\bar{K}A5$ ", which designates a KEMET device with the rated capacitance of 100 nF.



| | Capacitance (pF) For Various Alpha/Numeral Identifiers | | | | | | | | | | | | |
|-----------|--|-----|----|-----|-------|----------|---------|-----------|------------|-------------|--|--|--|
| Alasha | | | | | | Numera | al | | | | | | |
| Alpna | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | |
| Character | | | | | Сара | acitance | e (pF) | | | | | | |
| А | 0.1 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 | | | |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 | | | |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 | | | |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 | | | |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 | | | |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 | | | |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 | | | |
| Н | 0.2 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 | | | |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 | | | |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 | | | |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 | | | |
| М | 0.3 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 | | | |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 | | | |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 | | | |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 | | | |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 | | | |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 | | | |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 | | | |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 | | | |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 | | | |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 | | | |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 | | | |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 | | | |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 | | | |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 | | | |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 | | | |
| d | 0.4 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 | | | |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 | | | |
| f | 0.5 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 | | | |
| m | 0.6 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 | | | |
| n | 0.7 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 | | | |
| t | 0.8 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 | | | |
| v | 0.9 | 9.0 | 90 | 900 | 9.000 | 90.000 | 900.000 | 9.000.000 | 90.000.000 | 900.000.000 | | | |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8 and 12 mm tape on 7" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems.



Table 4 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tono cizo | Embossed Plastic | Punched Paper |
|---------------|-----------|---------------------|------------------|
| EIA Case Size | (W)* | 7" Reel | 7" Reel |
| | | Pitch (P1)* | Pitch (P1)* |
| 0402 | 8 | | 2 |
| 0603 | 8 | | 4 |
| 0805 | 8 | 4 | 4 |
| 1206 - 1210 | 8 | 4 | 4 |
| ≥ 1812 | 12 | 8 | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 5 - Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | | | | | |
|--|---------------------------------------|----------------------------------|----------------------------|---------------------------|---------------------------|---------------------------|----------------------------------|----------------------------------|--------------------|--|--|
| Tape Size | D _o | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T₁ Maximum | | |
| 8 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.0 (0.039) | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.05 (0.079±0.002) | 25.0 (0.984) | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | |
| 12 mm | | 1.5 (0.059) | | | | 30 (1.181) | | | | | |
| | | Va | ariable Dimer | nsions – Milli | meters (Inch | es) | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B ₀ a | and K _o | | |
| | | | | | | | | | | | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5±0.05 (0.138±0.002) | 4.0±0.10 (0.157±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independent of each other.

2. The tape with or without components, shall pass around R without damage (see Figure 6).

3. If S1 < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Document 481 paragraph 4.3 (b)).

4. B1 dimension is a reference dimension for a tape feeder clearance only.

5. The cavity defined by A, B, and K, shall surround the component with sufficient clearance that:

(a) The component does not protrude above the top surface of the carrier tape.

(b) The component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed. (c) Rotation of the component is limited to 20° maximum for 8 and 12 mm tapes; 10° maximum for 16 mm tapes (see Figure 3).

(d) Lateral movement of the component is restricted to 0.5 mm maximum for 8 mm and 12 mm wide tape; to 1.0 mm maximum for 16 mm tape (see Figure 4).

(e) See addendum in EIA Document 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 6 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | | | | |
|--|---|----------------------------|---------------------------|---------------------------|------------------------|-----------------|-----------------------|--|--|--|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | | | |
| 8 mm | 1.5 + 0.10/-0.0 (0.059 + 0.004/-0.0) | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.05 (0.079±0.002) | 0.100 (0.004) | 0.75 (0.030) | 25.0 (0.984) | | | | |
| Variable Dimensions – Millimeters (Inches) | | | | | | | | | | | |
| Tape Size | Pitch | E ₂ Minimum | F | P1 | T Maximum | W Maximum | A_0 and B_0 | | | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5±0.05 | 2.0±0.05 (0.079±0.002) | 1.1 | 8.3 (0.327) | Note 1 | | | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138±0.002) | 4.0±0.10 (0.157±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | | | |

1. The cavity defined by A_{ρ} , B_{ρ} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3).

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4).

e) see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6).



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 Newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 Newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 7 – Reel Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | | | | | |
|--|-------------------------------------|---|------------------------|-----------------------------|--|--|--|--|--|--|--|
| Tape Size | A | B Minimum | С | D Minimum | | | | | | | |
| 8 mm | 178±0.20 (7.008±0.008) | 1.5 | 13.0 + 0.5/-0.2 | 20.2 | | | | | | | |
| 12 mm | 330±0.20 (13.000±0.008) | (0.059) | (0.521 + 0.02/-0.008) | (0.795) | | | | | | | |
| | Variable | Dimensions – Millimeter | rs (Inches) | | | | | | | | |
| Tape Size | N Minimum See Note 2, Tables 2–3 | W ₁ | W ₂ Maximum | W ₃ | | | | | | | |
| 8 mm | 50 | 8.4 + 1.5/-0.0 (0.331 + 0.059/-0.0) | 14.4 (0.567) | Shall accomadate tape width | | | | | | | |
| 12 mm | (1.969) | 12.4 + 2.0/-0.0 (0.488 + 0.078/-0.0) | 18.4 (0.724) | without interference | | | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Waffle Tray Packaging Information – 2" x 2" w/ Static Protection

Figure 9 – Waffle Tray Dimensions – Inches (Millimeters)





Table 8A – Waffle Tray Dimensions – Inches

| Caa | o Sizo | | | 2" x 2' | ' Waffle T | ray Dime | nsions – | Inches | | | Packaging Quantity |
|---------------------|-------------|--------|--------|---------|------------|----------|----------|--------|-------|---------|---------------------------|
| Case Size | | М | M1 | M2 | M3 | Х | Y | Z | A° | MATRIX | (pcs/unit |
| EIA (in) | Metric (mm) | ±0.003 | ±0.003 | ±0.002 | ±0.002 | ±0.002 | ±0.002 | ±0.003 | ±1/2° | (X x Y) | packaging) |
| 0402 | 1005 | 0.175 | 0.153 | 0.077 | 0.110 | 0.073 | 0.042 | 0.041 | 7 | 16 X 23 | 368 |
| 0603 | 1608 | 0.175 | 0.153 | 0.077 | 0.110 | 0.073 | 0.042 | 0.041 | 7 | 16 X 23 | 368 |
| 0805 | 2012 | 0.232 | 0.186 | 0.181 | 0.171 | 0.062 | 0.092 | 0.036 | 10 | 10 X 10 | 100 |
| 1206 ^{1,2} | 3216 | 0.194 | 0.228 | 0.193 | 0.124 | 0.067 | 0.130 | 0.065 | 5 | 14 X 9 | 126 |
| 1206 ^{1,3} | 3216 | 0.250 | 0.250 | 0.375 | 0.167 | 0.100 | 0.200 | 0.070 | 5 | 10 X 5 | 50 |
| 1210 | 3225 | 0.217 | 0.244 | 0.215 | 0.174 | 0.110 | 0.145 | 0.080 | 5 | 10 X 8 | 80 |
| 1812 | 4532 | 0.271 | 0.285 | 0.286 | 0.243 | 0.150 | 0.200 | 0.075 | 5 | 7 X 6 | 42 |
| 2220 | 5650 | 0.318 | 0.362 | 0.424 | 0.34 | 0.24 | 0.32 | 0.032 | 5 | 5 X 4 | 20 |

¹ Packaging of 1206 (3216 metric) case size capacitors is dependent upon the nominal chip thickness of the device. Contact KEMET Sales for Waffle Tray quantities for specified part number.

² Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of \leq 1.25 mm (0.049 inches).

³ Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of > 1.25 mm (0.049 inches).

Table 8B – Waffle Tray Dimensions – Millimeters

| Case Size | | | 2" x 2" Waffle Tray Dimensions - Millimeters | | | | | | | | | |
|---------------------|-------------|-------|--|-------|-------|-------|-------|-------|-------|---------|------------|--|
| | | М | M1 | M2 | M3 | Х | Y | Z | A° | MATRIX | (pcs/unit | |
| EIA (in) | Metric (mm) | ±0.08 | ±0.08 | ±0.05 | ±0.05 | ±0.05 | ±0.05 | ±0.08 | ±1/2° | (X x Y) | packaging) | |
| 0402 | 1005 | 4.45 | 3.89 | 1.96 | 2.79 | 1.85 | 1.07 | 1.04 | 7 | 16 X 23 | 368 | |
| 0603 | 1608 | 4.45 | 3.89 | 1.96 | 2.79 | 1.85 | 1.07 | 1.04 | 7 | 16 X 23 | 368 | |
| 0805 | 2012 | 5.89 | 4.72 | 4.60 | 4.34 | 1.57 | 2.34 | 0.91 | 10 | 10 X 10 | 100 | |
| 1206 ^{1,2} | 3216 | 4.93 | 5.79 | 4.90 | 3.15 | 1.70 | 3.30 | 1.65 | 5 | 14 X 9 | 126 | |
| 1206 ^{1,3} | 3216 | 6.35 | 6.35 | 9.53 | 4.24 | 2.54 | 5.08 | 1.78 | 5 | 10 X 5 | 50 | |
| 1210 | 3225 | 5.51 | 6.20 | 5.46 | 4.42 | 2.79 | 3.68 | 2.03 | 5 | 10 X 8 | 80 | |
| 1812 | 4532 | 6.88 | 7.24 | 7.26 | 6.17 | 3.81 | 5.08 | 1.91 | 5 | 7 X 6 | 42 | |
| 2220 | 5650 | 8.08 | 9.19 | 10.77 | 8.64 | 6.10 | 8.13 | 0.81 | 5 | 5 X 4 | 20 | |

¹ Packaging of 1206 (3216 metric) case size capacitors is dependent upon the nominal chip thickness of the device. Contact KEMET Sales for Waffle Tray quantities for specified part number.

² Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of \leq 1.25 mm (0.049 inches).

³ Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of > 1.25 mm (0.049 inches).

U2J with KONNEKT[™] Technology for High-Efficiency, High-Density Power Applications (Commercial Grade)





Overview

KEMET's U2J with KONNEKT[™] Technology surface mount capacitors are designed for high-efficiency and high-density power applications. KONNEKT utilizes an innovative Transient Liquid Phase Sintering (TLPS) material to create a leadless multi-chip solution. When combined with KEMET's ultra-stable U2J dielectric, KONNEKT enables a low-loss, low-inductance package capable of handling extremely high ripple currents in the hundreds of kilohertz.

U2J is an extremely stable Class I dielectric material that exhibits a negligible shift in capacitance with respect to



voltage and a predictable and linear change in capacitance with reference to ambient temperature, with minimal aging effect. Capacitance change is limited to -750 ± 120 ppm/°C from -55°C to +125°C.

U2J with KONNEKT[™] Technology can also be mounted in a low-loss orientation to further increasing its power handling capability. The low-loss orientation lowers ESR (Effective Series Resistance) and ESL (Effective Series Inductance) which increases ripple current handling capability.

Benefits

- Extremely high-power density and ripple current capability
- Extremely low equivalent series resistance (ESR)
- Extremely low equivalent series inductance (ESL)
- Operating temperature range of -55°C to +125°C
- Retains over 99% of nominal capacitance at full rated voltage
- Low noise
- · Surface mountable using standard MLCC reflow profiles
- Low-loss orientation option for higher current handling capability
- RoHS compliant and Pb-free

Standard



Applications

- Wide bandgap (WBG), silicon carbide (SiC) and gallium nitride (GaN) systems
- Data centers
- LLC resonant converters
- · Switched tank converters
- · Wireless charging systems
- · Photovoltaic systems
- · Power converters
- Inverters
- DC link
- Snubber

Low Loss





Typical Performance

| | | | | Typical Ripple Current (A _{rms}) ¹ | | | | |
|-----------|---------------------------|------------------------------|------------------------|---|---------|---------|--|--|
| Part Type | Mounting Configuration | Typical ESR at 25°C, 100 kHz | Typical ESL at 25°C | 100 kHz | 200 kHz | 300 kHz | | |
| 1812 | Standard | 1.15 mΩ | 1.1 nH | 12.0 | 12.0 | 11.5 | | |
| 940 nF | Low Loss | 0.77 mΩ | 0.45 nH | 18.0 | 18.0 | 16.0 | | |
| 1812 | Standard | 1.3 mΩ | 1.6 nH | 11.0 | 10.0 | 10.0 | | |
| 1.4 uF | Low Loss | 0.35 mΩ | 0.4 nH | 20.0 | 34.0 | 31.0 | | |

¹ Ripple current measurements performed at 85°C with a peak capacitor temperature of 95°C. Samples mounted to heat sink with no forced air cooling. Maximum ambient and self heating cannot exceed 125°C.





Typical Performance cont.



Ordering Information

| С | 1812 | С | 145 | J | 5 | J | L | С | 7XXX |
|----------------|-----------------------|--------------------------|---|--------------------------|----------------------|------------|-------------------------|------------------------------------|--|
| Series | Case Size (L"x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (V) | Dielectric | Subclass Designation | Termination Finish ¹ | Packaging (Suffix/C-Spec) |
| C = Ceramic | 1812 | C = Standard | Two single digits and number of zeros. | J = ±5% K = ±10% | 5 = 50 V | J = U2J | L = KONNEKT | C = 100% matte Sn | See "Packaging C-Spec Ordering Options Table" |

¹ Additional termination finish options may be available. Contact KEMET for details. See Table 1A for available capacitance and voltage ratings.

Table 1A - Product Ordering Codes, Ratings, and Package Quantities

| | | | Voltage | Number of Chips | | | Typical | Tape & Re | Tape & Reel Quantity | |
|-----------------------------------|-------------|-------------|---------|--------------------|-------------|-------------------------------|-----------------------------------|----------------|----------------------|--|
| KEMET Part Number ¹ | Capacitance | Cap Code | | | Orientation | Thickness mm (inch) | Average Piece Weight (g) | 7" Tape & Reel | 13" Tape & Reel | |
| 010100044(-)5 4 0(h) | 940 nF | 944 | 50 V | 2 | Standard | 3.5 (0.137) ±0.40 (0.016) | 0.22 | 500 | 2,000 | |
| C1012C944(8)55EC(D) | | | | | Low Loss | 3.20 (0.126) ±0.30 (0.012) | 0.22 | 500 | 2,200 | |
| 010100145(-)5 11 0(1-) | 1 4 F | 445 | 50 V | 3 | Standard | 5.3 (0.208) ±0.60 (0.024) | 0.22 | 200 | 900 | |
| C1812C143(a)55EC(b) | 1.4 μr | 145 | | | Low Loss | 3.20 (0.126) ±0.30 (0.012) | 0.55 | 500 | 2,200 | |

¹ Complete part number requires additional characters in the numbered positions provided in order to indicate capacitance tolerance and grade. For each numbered position, available options are as follows:

(a) Capacitance tolerance character "J" or "K"

(b) See Table 1B for C-Spec options



Table 1B - Packaging C-Spec Ordering Options Table

| Mountii | ng Orientation | Packaging Type | Packaging/Grade Ordering Code (C-Spec) | | |
|----------|----------------|-------------------|---|--|--|
| | | 7" Reel/Unmarked | TU | | |
| Standard | | 13" Reel/Unmarked | 7210 | | |
| Low Loss | | 7" Reel/Unmarked | 7805 | | |
| | | 13" Reel/Unmarked | 7810 | | |

Dimensions – Millimeters (Inches)

| Standard Mounting | Low Loss Mounting | Standard Mounting | Low Loss Mounting |
|---------------------------------------|-------------------|---------------------------------------|-------------------|
| 2 Chips | 2 Chips | 3 Chips | 3 Chips |
| T T T T T T T T T T T T T T T T T T T | T T | T T T T T T T T T T T T T T T T T T T | |

| Number of Chips | Mounting | EIA SIZE CODE | METRIC SIZE CODE | L LENGTH | W WIDTH | T THICKNESS | B Bandwidth | Mounting Technique |
|--------------------|----------|---------------------|------------------------|-------------------------------|-----------------------------|-----------------------------|----------------|--------------------------|
| 2 | Standard | - 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.2 (0.126) ±0.3 (0.012) | 3.5 (0.137) ±0.4 (0.016) | | Solder Reflow Only |
| | Low Loss | | | | 3.5 (0.137) ±0.4 (0.016) | 3.2 (0.126) ±0.3 (0.012) | 0.6 (0.024) | |
| 3 | Standard | | | | 3.2 (0.126) ±0.3 (0.012) | 5.3 (0.208) ±0.6 (0.024) | ±0.35 (0.014) | |
| | Low Loss | | | | 5.3 (0.208) ±0.6 (0.024) | 3.2 (0.126) ±0.3 (0.012) | | |



Table 2 - Performance and Reliability: Test Methods and Conditions

| Test | Reference | Test Condition | Limits |
|---|-------------------|--|--|
| Visual and Mechanical | KEMET Internal | No defects that may affect performance (10X) | Dimensions according KEMET Spec Sheet |
| Capacitance (Cap) | KEMET Internal | 1 kHz ±50 Hz and 1.0 ±0.2 V _{rms} Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours | Within Tolerance |
| Dissipation Factor (DF) | KEMET Internal | 1 kHz ±50 Hz and 1.0 ±0.2 V _{rms} | Dissipation factor (DF) maximum limit at 25°C = 0.1% |
| Insulation Resistance (IR) | KEMET Internal | Apply rated voltage for 120 seconds at 25°C | Within Specification To obtain IR limit, divide MΩ-μF value by the capacitance and compare to GΩ limit. Select the lower of the two limits. |
| | | | 1,000 MΩ-μF or 100 GΩ |
| | | Frequency: 1 kHz ±50 Hz Capacitance Change with Reference to +25°C and 0 VDC Applied | |
| Temperature Coefficient of Capacitance (TCC) | KEMET Internal | * See part number specification sheet for voltage Step Temperature (°C) 1 +25°C 2 -55°C 3 +25°C (Reference Temperature) 4 +125°C | -750 ±120 ppm/°C |
| Dielectric Withstanding Voltage (DWV) | KEMET Internal | 250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit Withstand test voltage without insulation breakdown or damage. |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | KEMET Internal | Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours. Please refer to a part number specific datasheet for referee time details. | 0.1% Loss/Decade Hour |
| Terminal Strength | KEMET Internal | Shear stress test per specific case size, Time: 60±1 seconds Case Size Force 1812 18N | No evidence of mechanical damage |



Table 2 - Performance and Reliability: Test Methods and Conditions cont.

| Test | Reference | Test Condition | Limits |
|------------------------|---------------------------|--|---|
| Board Flex | AEC-Q200-005 | Standard Termination system 2.0 mm Test time: 60 ± 5 seconds Ramp time: 1 mm/second $50 \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad$ | No evidence of mechanical damage |
| Solderability | KEMET Custom Test | 1. Board shear – SAC305 solder. Shear force of 1.8 kg (minimum) 2. Wetting balance – IEC 60068–2–69 | Visual Inspection. 95% coverage on termination. No leaching. |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to +125°C) 2-3 cycles per hour Soak Time 1 or 5 minute | Measurement at 24 hours ±4 hours after test conclusion. Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C / 85% RH and rated voltage, or 200 VDC maximum. Low Volt Humidity: 1,000 hours 85C°/85% RH and 1.5 V. | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits: Cap: ±0.3% or ±0.25pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5% |
| Moisture Resistance | MIL-STD-202 Method 106 | Number of cycles required 10, 24 hours per cycle. Steps 7a and 7b not required | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±0.3% or ±0.25pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5% |
| Thermal Shock | MIL-STD-202 Method 107 | Number of cycles required 5, (-55°C to 125°C) Dwell time 15 minutes. | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |



Table 2 - Performance and Reliability: Test Methods and Conditions cont.

| Test | Reference | Test Condition | Limits | |
|-----------------------------|---------------------------|---|--|--|
| High Temperature Life | MIL-STD-202 | 1,000 hours at 125°C with 1.0 X rated voltage applied. | Within Post Environmental Limits | |
| Storage Life | Method 108 | 1,000 hours at 125°C, Unpowered | Cap: ±0.3% or ±0.25pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5% Cap: Initial Limit DF: Initial Limit IR: Initial Limit | |
| Vibration | MIL-STD-202 Method 204 | 5 G's for 20 minutes, 12 cycles each of 3 orientations. Test from 10 – 2,000 Hz | Cap: Initial Limit DF: Initial Limit IR: Initial Limit | |
| Mechanical Shock | MIL-STD-202 Method 213 | 1,500 G's 0.5ms Half-sine, Velocity Change: 15.4 feet/second (Condition F) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit | |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents. | Visual Inspection 10X Readable marking, no decoloration or stains. No physical damage. | |

Environmental Compliance



Lead (Pb)-free, RoHS, and REACH compliant without exemptions.



Table 3 – KONNEKT Land Pattern Design Recommendations per IPC-7351 (mm)

| Chip Number | Orientation | EIA SIZE Code | METRIC SIZE CODE | Median (Nominal) Land Protrusion | | | | | |
|----------------|--------------------------|------------------|---------------------|-------------------------------------|------|------|------|------|--|
| | | | | C | Y | X | V1 | V2 | |
| 2 | Standard and Low Loss | | 4532 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | |
| 3 | Standard | 1812 | | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | |
| | Low loss | | | 2.05 | 1.40 | 5.90 | 6.00 | 6.40 | |


Recommended Reflow Soldering Profile

KEMET's KONNEKT family of high density surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with convection and IR reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Termination Finish | | |
|---|--------------------|--|--|
| Tomereature | 100% matte Sn | | |
| Preheat/Soak | | | |
| Temperature Minimum (T _{smin}) | 150°C | | |
| Temperature Maximum (T _{Smax}) | 200°C | | |
| Time (t_s) from T_{Smin} to T_{Smax} | 60 – 120 seconds | | |
| Ramp-Up Rate ($T_L to T_p$) | 3°C/second maximum | | |
| Liquidous Temperature (T_L) | 217°C | | |
| Time Above Liquidous (t _L) | 60 – 150 seconds | | |
| Peak Temperature (T _P) | 260°C | | |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 30 seconds maximum | | |
| Ramp-Down Rate (T_p to T_L) | 6°C/second maximum | | |
| Time 25°C to Peak Temperature | 8 minutes maximum | | |
| Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow. | | | |







Storage & Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. In addition, temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years upon receipt.

Construction





Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12, 16 and 24 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 1B for details on reeling quantities for commercial chips.



Table 4 – Carrier Tape Configuration, Embossed Plastic (mm)

| EIA Case Size | | | Embossed Plastic | | |
|---------------|----------------|-------------------|------------------|----------|--|
| | Chip Number | Tape Size (W)* | 7" Reel | 13" Reel | |
| | Humber | (11) | Pitch $(P_1)^2$ | | |
| KONNEKT 1812 | 2 | 16 | 8 | 8 | |
| | 3 | 16 | 12 | 12 | |

1. Refer to Figures 1 and 2 for W and P1 carrier tape reference locations.

2. Refer to Tables 4 and 5 for tolerance specifications.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 5 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | | | |
|--|--|----------------------------------|----------------------------|---------------------------|----------------------------|-----------------------|----------------------------------|-----------------------------|---------------------------|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum |
| 16 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 (0.059) | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.05 (0.079±0.002) | 30 (1.181) | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | |
| Tape Size | Tape SizePitchB1 Maximum Note 4E2 MinimumFP1T2 MaximumW MaximumA0,B0 & K0 | | | | | | | & K ₀ | |
| 16 mm | Triple (12mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5±0.05 (0.138±0.002) | 12.0±0.10 (0.157±0.004) | 4.6 (0.181) | 16.3 (0.642) | No | te 5 |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6).

3. If S1 < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Document 481 paragraph 4.3 (b)).

4. B1 dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{ρ} , B_{ρ} and K_{ρ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3).

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 mm and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4)

(e) For KPS Series product, A0 and B0 are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see Addendum in EIA Document 481 for standards relating to more precise taping requirements.



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|------------|----------------------------------|
| 16 mm | 0.1 to 1.3 Newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300±10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 2 – Maximum Component Rotation



Figure 3 – Maximum Lateral Movement



Figure 4 – Bending Radius





Figure 5 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 6 – Reel Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | |
|--|---|---------------------------------------|--|--|--|--|
| Tape Size | А | A B Minimum | | D Minimum | | |
| 16 mm | 178±0.20 (7.008±0.008) or 330±0.20 (13.000±0.008) | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | |
| Tape Size | N Minimum See Note 2, Tables 2-3 | W ₁ | W ₂ Maximum | W ₃ | | |
| 16 mm | 50 (1.969) | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | Shall accommodate tape width without interference | | |



Figure 6 – Tape Leader & Trailer Dimensions



Figure 7 – Maximum Camber





Overview

KEMET's M3 Medical Grade series provides a broad offering of surface mount multilayer ceramic capacitors (MLCCs) for high reliability medical applications, including implantable devices, that require long term life and performance. By utilizing robust designs, along with strict process and material control, this series provides a high reliability solution necessary for a wide variety of critical medical applications. Each lot is traceable down to raw materials and undergoes enhanced in-process and end-of-line testing including lot acceptance. KEMET's M3 Medical Grade series provides a baseline specification, which can be adapted to customer specific requirements for critical medical applications. KEMET's M3 Medical Grade series is available in C0G, X7R, and X5R dielectrics from EIA 0402 to 1210 case sizes with capacitance values ranging from 0.5 pF to 5.6 μ F. This series is available in voltage ratings up to 200 V, and is available in Sn, SnPb, and Au termination options.

The M3 series is available to customers willing to partner with KEMET to align application and performance requirements. For more information, please contact your local Sales Representative.

Benefits

- · Custom testing and screening available upon request
- Enhanced designs
- · Lot traceability down to raw materials
- 100% voltage conditioning
- End of Line Screening
- · Lot acceptance testing data provided
- C0G, X7R, and X5R dielectrics
- · Capacitance offerings ranging from 0.5 pF up to 5.6 μF
- EIA 0402 1210 case sizes
- DC voltage ratings of 6.3 V, 10 V, 16 V, 25 V, 50 V, 100 V, and 200 V
- Sn, SnPb, Au termination options
- Available capacitance tolerances of ±0.10 pF, ±0.25 pF, ±0.5 pF, ±1%, ±2%, ±5%, ±10%, and ±20%
- Low ESR and Low ESL

Applications

Typical Applications May Include:

- Cardiac pacemakers
- · Neuromodulation devices
- Implantable cardioverter-defibrillator (ICD)
- Heart pumps





Ordering Information

| С | 0603 | Т | 473 | K | 5 | R | Α | С | M003 | - |
|--------|--------------------------------------|--------------------------|---|--|---|-------------------------------|-------------------------|--|----------------------------|---|
| Series | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (V) | Dielectric | Subclass Designation | Termination Finish | Medical C-Spec | Packaging (Suffix/ C-Spec) |
| С | 0402 0603 0805 1206 1210 | Т | Two single digits and number of zeros. Use 9 for 1.0 - 9.9 pF Example: 2.2 pF = 229 | $B = \pm 0.1 \text{ pF}$ $C = \pm 0.25 \text{ pF}$ $D = \pm 0.5 \text{ pF}$ $F = \pm 1\%$ $G = \pm 2\%$ $J = \pm 5\%$ $K = \pm 10\%$ $M = \pm 20\%$ | 9 = 6.3 8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 2 = 200 | G = COG R = X7R P = X5R | A = N/A | C = 100% matte Sn L = SnPb (5% Pb minimum) G = Gold (Au) 100 µin minimum | M003 - Medical Grade | See "Packaging C-Spec Ordering Options Table" below |

Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) |
|-------------------------------------|---|
| Standard Packaging (7" Tape & Reel) | Not required (blank) |
| Waffle Tray | 7292 |

¹ Default packaging with no Packaging C-Spec is "7" Tape & Reel"

¹ See Tape & Reel Packaging information section of the datasheet for additional details.

Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant if ordered with tin (Sn) or gold (Au) termination finish.



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|----------------------------|------------------------------------|
| 0402 | 1005 | 1.00 (0.040) ±0.05 (0.002) | 0.50 (0.020) ±0.05 (0.002) | | 0.30 (0.012) ±0.10 (0.004) | 0.30 (0.012) | Solder Reflow Only |
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | Colder Ways |
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | See Table 2 for Thickness | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave Or Solder Deflow |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | N/A | Soluel Reliow |
| 1210 | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | - | 0.50 (0.02) ±0.25 (0.010) | | Solder Reflow Only |

Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|--|
| Operating temperature range | C0G/X7R: -55°C to +125°C X5R: -55°C to +85°C |
| Capacitance change with reference to +25°C and 0 VDC applied (TCC) | C0G: ±30 PPM/°C X5R/X7R: ±15% |
| Aging rate (maximum % capacitance loss/decade hour) | C0G: 0% X7R: 3% X5R: 5% |
| ¹ Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA) |
| ² Dissipation Factor (DF) Maximum Limit at 25°C | COG: 0.1% X5R/X7R: See Tables 1A and 1B |
| ³ Insulation Resistance (IR) Minimum Limit at 25°C | C0G: 1,000 • MΩ - μF or 100 GΩ X5R/X7R: See Tables 1C and 1D (Y) |

¹ DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

² Capacitance and dissipation factor (DF) measured under the following conditions:

1 MHz ±100 kHz and 1.0 ±0.2 V $_{rms}$ V if capacitance \leq 1,000 pF 1 kHz ±50 Hz and 1.0 ±0.2 V $_{rms}$ if capacitance > 1,000 pF

³ To obtain IR limit, divide $M\Omega - \mu F$ value by the capacitance and compare to $G\Omega$ limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."



Table 1A - Dissipation Factor Limit Table X7R

| Rate DC Voltage | Dissipation Factor |
|-----------------|---------------------------|
| < 16 | 5.0% |
| 16/25 | 3.5% |
| > 25 | 2.5% |

Table 1B - Dissipation Factor Limit Table X5R

| Rate DC Voltage | Capacitance | Dissipation Factor |
|-----------------|-------------|--------------------|
| < 25 | < 0.56 µF | 5.0% |
| | ≥ 0.56 µF | 10.0% |
| 25 | All | 3.5% |
| > 25 | All | 2.5% |

Table 1C - Insulation Resistance Limit Table X7R

| EIA Case Size | 1,000 megohm microfarads or 100 GΩ | 500 megohm microfarads or 10 GΩ |
|---------------|---------------------------------------|------------------------------------|
| 0402 | < 0.012 µF | ≥ 0.012 µF |
| 0603 | < 0.047 µF | ≥ 0.047 µF |
| 0805 | < 0.15 µF | ≥ 0.15 µF |
| 1206 | < 0.47 µF | ≥ 0.47 µF |
| 1210 | < 0.39 µF | ≥ 0.39 µF |

Table 1D - Insulation Resistance Limit Table X5R

| EIA Case Size | 1,000 megohm microfarads or 100 GΩ | 500 megohm microfarads or 10 GΩ | 100 megohm microfarads |
|---------------|---------------------------------------|------------------------------------|---------------------------|
| 0402 | < 0.012 µF | ≥ 0.012 µF < 1.0 µF | N/A |
| 0603 | < 0.047 µF | ≥ 0.047 µf < 1.0 µF | N/A |
| 0805 | < 0.15 µF | ≥ 0.15 µF < 1.0 µF | ≥ 1.0 µF |
| 1206 | < 0.47 µF | ≥ 0.47 µF < 1.0 µF | ≥ 1.0 µF |
| 1210 | < 0.39 µF | ≥ 0.39 µF < 1.0 µF | ≥ 1.0 µF |



Table 2A – COG Product Ordering Codes and Ratings

| | | | C | as | e | Si | ize | 9 | | (|)40 | 2 | | | | 06 | 03 | | | | | 08 | 05 | | | | | 12 | 06 | | | | | 12 | 10 | | |
|-------------------|-------------|------|----------|-------|------|------|------|---|----|--------|---------|------|-----|----|--------|---------|---------|----------|------------|--------------|--------|---------|------|------------------------|----------|------|----------|------------|--------|-----|----------|------|--------|----|-----|-----|-----|
| Can | Сар | - | | /olt: | 206 | | oho | | 8 | 4 | 2 | 5 | 1 | 8 | 4 | 2 | 5 | 1 | 2 | 8 | 4 | 2 | 5 | 1 | 2 | 8 | 4 | 2 | 5 | 1 | 2 | 8 | 4 | 2 | 5 | 1 | 2 |
| Cap | Code | - De | • •te | | | 200 | . (V | DC) | 0 | ۲ د | - LO | 0 | 2 | 0 | ۲ و | 5 10 | • | 8 | 2 | 0 | ۲ و | 5 10 | • | 2 | 2 | 0 | ۲ و | 5 10 | , 0 | 2 | 2 | 0 | ۲ و | 5 | 0 | 2 | 2 |
| | | | C | | aci | tai | nce | <u>, , , , , , , , , , , , , , , , , , , </u> | | - | 2 | - CO | = | - | - | 7 | مت P | rodu | _⊼ Ict/ | l – Avail | abil | itv a | nd (| _ ≍ Chip | ⊼ Thi | ckne | ess (| _∾ Code | es | = | 5 | - | - | 2 | -u | = | 5 |
| | | | - | Tol | era | an | ce | | | | | | | | 0.0 | 0.0 | 0.0 | See | Tab | le 2 | for | Chip | o Th | ickn | ess | Dim | ensi | ions | | 50 | 50 | 1 50 | 50 | 50 | 50 | 50 | 50 |
| 0.5 pF 0.75 nF | 508 758 | B | C C | D | | | | | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB CB | CB CB | | | | | | | EB | EB FB | EB | EB | EB | EB FB | FB | FB | FB | FB | FB | FB |
| 1 pF | 109 | B | c | D | | | | | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB | CB | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 1.1 pF | 119 | В | С | D | | | | | BB | BB | BB | BB | BB | СВ | СВ | СВ | СВ | СВ | СВ | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 1.2 pF | 129 | B | C | D | - | | | | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB | CB | | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 1.5 pF | 159 | B | c | D | | | | | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB | CB | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 1.6 pF | 169 | в | С | D | | | | | BB | BB | BB | BB | BB | СВ | СВ | СВ | СВ | СВ | СВ | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 1.8 pF | 189 | В | C | D | | | | | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB | CB | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 2 pF | 209 | B | C | D | ÷ | | | | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB | CB | | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 2.4 pF | 249 | в | c | D | | | | | BB | BB | BB | BB | BB | СВ | CB | CB | CB | CB | CB | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 2.7 pF | 279 | в | С | D | | | | | BB | BB | BB | BB | BB | СВ | СВ | СВ | СВ | СВ | СВ | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 3 pF | 309 | В | C | D | | | | | BB | BB | BB | BB | BB | СВ | CB | СВ | СВ | СВ | СВ | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 3.3 pF | 339 | B | C | D | - | | | | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB | CB | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 3.0 µF 3.9 nF | 309 | B | c | ם | | | | | BB | BB | BB | BB | BB | СВ | CB | CB | CB | CB | CB | | DC | DC | | | | FB | FB | FB | FB | FB | FB | FB | FB | FB | FB | FB | FB |
| 4.3 pF | 439 | В | c | D | | | | | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB | CB | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 4.7 pF | 479 | в | С | D | | | | | BB | BB | BB | BB | BB | СВ | СВ | СВ | СВ | СВ | | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 5.1 pF | 519 | В | C | D | | _ | _ | | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB | | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 5.6 pF | 569 | В | C | D | | | | | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB | | | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 6.8 pF | 689 | В | c | D | | | | | BB | BB | BB | BB | BB | СВ | CB | CB | CB | CB | | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 7.5 pF | 759 | В | c | D | | | | | BB | BB | BB | BB | BB | СВ | CB | CB | CB | CB | | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 8.2 pF | 829 | В | С | D | | | | | BB | BB | BB | BB | BB | СВ | CB | CB | CB | CB | | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 9.1 pF | 919 | В | C | D | - | _ | | | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 10 pF 11 nF | 110 | | | | F | G | J | KM | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB | | | | | | | | FR | FR | FR | FR | FR | FR | FR | FB | FB | FB | FB | FB |
| 12 pF | 120 | | | | F | G | J | KM | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 13 pF | 130 | | | | F | G | J | KM | BB | BB | BB | BB | BB | СВ | СВ | СВ | СВ | СВ | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 15 pF | 150 | | | | F | G | J | KM | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 16 pF | 180 | | | | F | G | J | K M | BB | BB | BB | BB | | СВ | CB | CB | CB | CB | | | | | | DC | | FB | FB | FB | FB | FB | FB | FB | FB | FB | FB | FB | FB |
| 20 pF | 200 | | | | F | G | J | K M | BB | BB | BB | BB | | CB | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 22 pF | 220 | | | | F | G | J | KM | BB | BB | BB | BB | | СВ | СВ | СВ | СВ | СВ | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 24 pF | 240 | | | | F | G | J | KM | BB | BB | BB | BB | | CB | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 27 µF 30 nF | 300 | | | | F | G | J | KM | BB | BB | BB | BB | | CB | CB | CB | CB | CB | | | | | | | | FR | FR | FR | FR | FR | FR | FR | FB | FB | FB | FB | FB |
| 33 pF | 330 | | | | F | G | J | KM | BB | BB | BB | BB | | CB | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 36 pF | 360 | | | | F | G | J | KM | BB | BB | BB | BB | | СВ | СВ | СВ | СВ | СВ | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 39 pF | 390 | | | | F | G | J | KM | BB | BB | BB | BB | | CB | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 43 pF 47 pF | 430 | | | | F | G | J | KM | BB | BB | BB | BB | | CB | CB | CB | CB | CB | | | | | | | | EB | EB FB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 51 pF | 510 | | | | F | G | J | KM | BB | BB | BB | BB | | СВ | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 56 pF | 560 | | | | F | G | J | КМ | BB | BB | BB | BB | | СВ | СВ | СВ | СВ | СВ | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 62 pF | 620 | | | | F | G | J | KM | BB | BB | BB | BB | | CB | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 68 pF 75 pF | 680 750 | | | | F | G | J | K M | BB | BB | BB | BB | | CB | CB | CB | CB | CB | | | | | DC | | | EB | EB EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 82 pF | 820 | | | | F | G | J | KM | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 91 pF | 910 | | | | F | G | J | КМ | BB | BB | BB | BB | BB | СВ | СВ | СВ | СВ | СВ | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 100 pF | 101 | | | | F | G | J | KM | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB |
| 110 pF | 111 | | | | F | G | J | KM | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | FB |
| 120 pF | 131 | | | | F | G | J | KM | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | FB |
| 150 pF | 151 | | | | F | G | J | KM | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | FB |
| 160 pF | 161 | | | | F | G | J | KM | BB | BB | BB | BB | BB | СВ | СВ | СВ | СВ | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | FB |
| | | R | ate | d V | olta | age | e (V | DC) | 9 | 16 | 25 | 50 | 100 | 9 | 16 | 25 | 50 | 100 | 200 | 2 | 16 | 25 | 50 | 100 | 200 | 9 | 16 | 25 | 50 | 100 | 200 | 9 | 16 | 25 | 50 | 100 | 200 |
| Capacitance | Cap Code | | ۷ | olta | age | e Co | ode | | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 2 | 8 | 4 | 3 | 5 | 1 | 2 | 8 | 4 | 3 | 5 | 1 | 2 | 8 | 4 | 3 | 5 | 1 | 2 |
| | | | | Ca | se | Siz | ze | | | | 040 | 2 | | | | 06 | 03 | | | | | 08 | 05 | | | | | 12 | 06 | | | | | 12 | :10 | | |



Table 2A - COG Product Ordering Codes and Ratings cont.

| | | | | Ca | as | е | Si | ze | 9 | | | (|)40 | 2 | | | | 00 | 503 | | | | | 80 | 805 | | | | | 12 | 06 | | | | | 12 | 10 | | |
|------------------------|-------------|---|----|---------|------------|------------|-----|-----------|--------|---|----------|----|-----|----|-----|-------|----|----|-----|-------------|-----------|---------------|---------------|---------------|-------------|--------------|--------------|-------------|-------------|-------------|---------|-----|-----|-------|----|----|-----|----------|-----|
| Cap | Сар | Γ | | Vo | olta | ige | Co | ode | | | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 2 | 8 | 4 | 3 | 5 | 1 | 2 | 8 | 4 | 3 | 5 | 1 | 2 | 8 | 4 | 3 | 5 | 1 | 2 |
| | Code | F | Ra | ted | l Vo | olta | ge | (۷ | DC |) | 10 | 16 | 25 | 50 | 0 | 5 | 16 | 25 | 20 | 0 | 200 | 9 | 16 | 25 | 50 | 0 | 200 | 9 | 16 | 25 | 50 | 0 | 200 | 5 | 16 | 25 | 50 | <u>0</u> | 500 |
| | | | | Ca 1 | apa Fol | nci era | tan | nce ce | ; | | | | | | | | | | P | rodu See | ict Ta | Avai ble 2 | labi ? for | lity a Chi | and p Th | Chij icki | o Th ness | ickn Din | ess iens | Cod ions | es ; | | | 1 | | | | | |
| 180 pF | 181 | | | | | F | G | J | K | М | BB | BB | BB | BB | BB | СВ | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | FB |
| 200 pF | 201 | | | | | | G | J | ĸ | M | DD RR | RR | RR | RR | RR | CB | CB | | CB | CB | | | | | | | | EB | EB | EB | EB | EB | | L P P | FB | FB | FB | L P | L P |
| 220 pF 240 nF | 241 | | | | | F | G | | ĸ | м | RR | BB | BB | BB | BB | CB | CB | CB | CB | CB | | | | | | | | FR | FR | FR | FB | FB | | FB | FB | FB | FR | FB | FD |
| 270 pF | 271 | Ŀ | | | | F | G | J | K | м | BB | BB | BB | BB | BB | СВ | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | |
| 300 pF | 301 | L | | | | F | G | J | К | м | BB | BB | BB | BB | BB | СВ | CB | CB | CB | СВ | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | |
| 330 pF | 331 | | | | | F | G | J | K | м | BB | BB | BB | BB | BB | СВ | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | |
| 360 pF | 361 | | | | | F | G | J | K | М | BB | BB | BB | BB | | СВ | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | |
| 390 pF | 391 | L | | | | F | G | J | K | М | BB | BB | BB | BB | | СВ | CB | CB | CB | СВ | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | |
| 430 pF | 431 | | | | | F | G | J | K | М | BB | BB | BB | BB | | СВ | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | |
| 470 pF | 471 | | | | | F | G | J | K | М | BB | BB | BB | BB | | CB | CB | CB | CB | CB | | DD | DD | DD | DD | DD | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | |
| 510 pF | 511 | | | | | | G | J | K | М | BB | BB | BB | BB | | CB | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | |
| 560 pF | 561 621 | | | | | | G | J | K | M | BB BB | BB | BB | BB | | CB | CB | CB | CB | CB | | | DC | | DC | | | EB | EB | EB | EB | EB | | L P P | FB | FR | FB | FB | |
| 620 pF | 681 | Ŀ | | | | F | G | J | ĸ | M | BB | BB | BB | BB | | CB | | | | CB | | | | | | | | ED | ED | ED | ED | ED | | FB | FB | FB | FB | FB | |
| 750 pF | 751 | | | | | F | G | | ĸ | м | RR | BB | BB | | | CB | CB | CB | CB | CB | | | | | | | | FR | FB | FR | FB | FR | | FR | FB | FB | FB | FB | |
| 820 pF | 821 | L | | | | F | G | J | ĸ | м | BB | BB | BB | | | СВ | CB | СВ | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | |
| 910 pF | 911 | L | | | | F | G | J | ĸ | м | BB | BB | BB | | | СВ | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | |
| 1,000 pF | 102 | | | | | F | G | J | K | М | BB | BB | BB | | | СВ | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | |
| 1,100 pF | 112 | | | | | F | G | J | Κ | М | | | | | | СВ | CB | CB | CB | СВ | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | |
| 1,200 pF | 122 | | | | | F | G | J | K | М | | | | | | СВ | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | |
| 1,300 pF | 132 | | | | | F | G | J | K | М | | | | | | СВ | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EC | EC | EC | EC | EC | | FC | FC | FC | FC | FC | |
| 1,500 pF | 152 | | | | | F | G | J | K | М | | | | | | CB | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | EC | EC | EC | EC | EC | | FE | FE | FE | FE | FE | |
| 1,600 pF | 162 | L | 6 | | | | G | J | K | M | | | | | | CB | CB | CB | CB | CB | | DC | DC | DC | DC | DC | | ED | ED | ED | ED | ED | | I FE | FE | FE | FE | FE | |
| 1,800 pF | 182 | | | | | | | J | K V | | | | | | | LCB | CB | | CB | CB | | | | | | | | | ED | ED | ED | ED | | | FE | FE | FE | FE | |
| 2,000 pF | 202 | | | | | | | J | ĸ | м | | | | | | | CB | | CB | CB | | | | | | | | | FR | FR | FR | FR | | | FG | FG | FG | FG | |
| 2,200 pF | 242 | | | | | F | G | J | ĸ | м | | | | | | СВ | CB | CE | CB | | | | DC | DC | DC | DC | | EB | EB | EB | EB | EB | | FC | FC | FC | FC | FC | |
| 2,700 pF | 272 | L | | | | F | G | J | K | М | | | | | | СВ | CB | CB | CB | | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | | FC | FC | FC | FC | FC | |
| 3,000 pF | 302 | Г | Т | Т | | F | G | J | K | М | | | | | | СВ | CB | CB | CB | | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | | FF | FF | FF | FF | FF | |
| 3,300 pF | 332 | | | | | F | G | J | K | м | | | | | | СВ | CB | CB | CB | | | DC | DC | DC | DC | DC | | EB | EB | EB | EB | EB | | FF | FF | FF | FF | FF | |
| 3,600 pF | 362 | | | | | F | G | J | K | М | | | | | | СВ | CB | CB | CB | | | DD | DD | DD | DD | DD | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | |
| 3,900 pF | 392 | | | | | F | G | J | K | М | | | | | | СВ | CB | CB | CB | | | DD | DD | DD | DD | DD | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | |
| 4,300 pF | 432 | L | | | | F | G | J | K | M | | | | | | CB | CB | CB | CB | | | DD | DD | DD | DD | DD | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | |
| 4,700 pF | 472 | | | | | F | G | J | K | М | | | | | | CB | CB | CB | CB | | | | DD | DD | DD | DD | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | |
| 5,100 pF | 512 | | | | | | | J | K V | M | | | | | | I C B | CB | CB | | | | סט | 00 | 00 | 00 | 00 | | EB | EB | EB | EB | EB | | L P P | FR | FR | FB | FB | |
| 6 200 pF | 622 | | | | | F | G | 1 | ĸ | м | | | | | | CB | CB | CB | | | | | DG | DG | DG | | | FR | FR | FR | FR | FR | | FR | FR | FR | FR | FR | |
| 6.800 pF | 682 | | | | | F | G | J | ĸ | м | | | | | | СВ | CB | CB | | | | DG | DG | DG | DG | DG | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | |
| 7,500 pF | 752 | Г | Г | Т | | F I | G | J | K | м | | | | | | 100 | | | | | | DG | DG | DG | DG | DG | | EB | EB | EB | EB | EB | | FB | FB | FB | FB | FB | |
| 8,200 pF | 822 | | | | | F I | G | J | К | м | | | | | 1 | 1 | | | | 1 | | DG | DG | DG | DG | DG | | EC | EC | EC | EC | EC | | FB | FB | FB | FB | FB | |
| 9,100 pF | 912 | | | | | F I | G | J | ĸ | м | | | | | | | | | | | | DD | DD | DD | DD | | | EC | EC | EC | EC | EC | | FB | FB | FB | FB | FB | |
| 10,000 pF | 103 | | | | | F I | G | J | ĸ | м | | | | | | | | | | | | DD | DD | DD | DD | | | EC | EC | EC | EC | EC | | FB | FB | FB | FB | FB | |
| 12,000 pF | 123 | L | | | | F | G | J | Κ | М | | | | | | | | | | | | DC | DC | DC | | | | ED | ED | ED | ED | ED | | FB | FB | FB | FB | FB | |
| 15,000 pF | 153 | | | | | F | G | J | K | М | | | | | | | | | | | | DD | DD | DD | | | | EF | EF | EF | EF | EF | | FC | FC | FC | FC | FC | |
| 18,000 pF | 183 | | | | | F | G | J | K | М | | | | | | | | | | | | | | | | | | EH | EH | EH | EH | EH | | FC | FC | FC | FC | FC | |
| 22,000 pF | 223 | | | | | | G | J | ĸ | M | | | | | | | | | | | | | | | | | | EC | EC | EC | EC | | | L FF | FF | FF | FF | FF | |
| 27,000 pF 33,000 pF | 333 | | | | | F | G | J | K | M | | | | | | | | | | | | | | | | | | FR | FR | FR | EE | | | FH | FH | FH | FH | FH | |
| 39.000 pF | 393 | I | T | | | F | G | J | K | м | | | | | | | | | | | | | | | | | | | 20 | | | | | FF | FF | FF | FF | | |
| 47,000 pF | 473 | | | | | F | G | J | ĸ | м | | | | | 1 | 1 | | | | | | | | | | | | | | | | | | FE | FE | FE | FE | | |
| 56,000 pF | 563 | | | | | F | G | J | К | м | | | | | | | | | | | | | | | | | | | | | | | | FB | FB | FB | | | |
| | 0 | | Ra | ted | l Vo | olta | ge | (V | DC |) | 10 | 16 | 25 | 50 | 100 | 2 | 16 | 25 | 50 | 100 | 200 | 2 | 16 | 25 | 50 | 100 | 200 | 9 | 16 | 25 | 50 | 100 | 200 | 9 | 16 | 25 | 50 | 100 | 200 |
| Capacitance | Cap Code | | | Vo | olta | ige | Co | ode | | | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 2 | 8 | 4 | 3 | 5 | 1 | 2 | 8 | 4 | 3 | 5 | 1 | 2 | 8 | 4 | 3 | 5 | 1 | 2 |
| | | | | (| Cas | se | Siz | e | | | | | 040 | 2 | | 1 | | 0 | 603 | | | | | 08 | 805 | | | | | 12 | 206 | | | 1 | | 12 | 210 | | |



Table 2B – X7R Product Ordering Codes and Ratings

| | | | | C | as | se | s S | Siz | ze | | | (|)4(| 02 | | | | 0 | 60 | 3 | | | | | 80 | 305 | | | | | 1 | 20 | 6 | | | | | | 12 1 | 0 | | | |
|-------------------|------------|---|-------|-----|-----|-----|------|-----|----------|-----|------|----|-----|--------------|--------------|-----|----|------|------------|---|-----|------|------|------|------|--------|------|------|-----------|-------|------|------|-----|-----|-----|-----|--------------|--------------|--------------|--------------|--------------|------------|-----|
| Can | Сар | F | _ | V | olt | ad | ie C | cod | le | _ | 9 | 8 | 4 | 3 | 5 | 9 | 8 | 4 | 3 | 3 | 5 | 1 | 9 | 8 | 4 | 3 | 5 | 1 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | 9 | 8 | 4 | 3 | 5 | 1 | 1 | 2 |
| oup | Code | F | Rat | tec | d V | olt | taq | e (| VD |)C) | | 2 | 4 | 2 5 | 00 | | 2 | 1 | 2 12 | 3 | 6 | 00 | | 2 | 16 | 55 | 00 | 8 | | 2 | 16 | 22 | 6 | 8 | 8 | 1 | 2 | 4 | 22 | 6 | 8 | ; ; | 8 |
| | | F | | C | ap | ac | ita | inc | ce | -, | | | | | | 10 | | 1. | | | Pro | | ct A | vail | abil | lity a | and | Chip |) Th | ickr | iess | Co | des | | 0 | 1.6 | | 1. | | | | <u> </u> | N |
| 0.5 | 500 | | | | To | leı | ran | ice | <u>)</u> | _ | | DD | DI | ום נ | | _ | _ | _ | _ | | S | ee ' | Tab | le 2 | for | Chi | p Th | icki | iess I | : Dir | nen | sior | IS | | | - | _ | | _ | _ | | _ | _ |
| 0.5 pF 0.75 pF | 508 758 | | | 2 | D | | | | | | BB | BB | BI | 3 BE | 3 BB | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 pF | 109 | E | | 2 | D | | | | | | BB | BB | BI | 3 BE | BB | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.1 pF | 119 | E | | 2 | D | | | | | | BB | BB | BI | B BE | B BB | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.2 pF | 129 | E | | | D | | | | | | BB | BB | BI | B BE | B BB | | | | | | | | | | | | | | | | | | | | | | - | | | | - | | |
| 1.5 pF | 159 | | | 2 | D | | | | | | BB | BB | BI | 3 BE | 8 BB | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.6 pF | 169 | E | 8 | 2 | D | | | | | | BB | BB | BI | 3 BE | B BB | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.8 pF | 189 | E | 8 | 2 | D | | | | | | BB | BB | BI | B BE | B BB | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 pF | 209 | | | | D | | | | | | BB | BB | BI | 3 BE | 3 BB | | | | | ÷ | | | | | | | | | | | | | | | | | - | | | | - | | |
| 2.2 pr 2.4 pF | 229 | | | 2 | D | | | | | | BB | BB | BI | 3 BE | B BB | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.7 pF | 279 | E | 3 | 2 | D | | | | | | BB | BB | BI | B BE | B BB | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 pF | 309 | E | 8 | 2 | D | | | | | | BB | BB | BI | B BE | B BB | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3.3 pF | 339 | E | | | D | | | | | | BB | BB | BI | B BE | BB | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3.0 µF 3.9 nF | 309 | | | 2 | ם | | | | | | BB | BB | BI | S DI S RE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4.3 pF | 439 | E | | 2 | D | | | | | | BB | BB | BI | 3 BE | BB | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4.7 pF | 479 | E | 8 0 | 2 | D | | | | | | BB | BB | BI | 3 BE | BB BB | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5.1 pF | 519 | E | 3 (| 0 | D | | | | | | BB | BB | BI | B BE | B BB | | | | - | 4 | _ | _ | | | | | | | | | | | | | | | _ | | _ | _ | _ | 4 | |
| 5.6 pF | 569 | | | | D | | | | | | BB | BB | BI | 3 BE | 3 BB | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6.8 pF | 689 | | | 2 | D | | | | | | BB | BB | BI | 3 BE | 8 BB | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7.5 pF | 759 | E | 3 | 2 | D | | | | | | BB | BB | BI | B BE | B BB | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8.2 pF | 829 | E | 3 (| 2 | D | | | | | | BB | BB | BI | B BE | B BB | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9.1 pF | 919 | E | 8 0 | 2 | D | F | | Ι. | | | BB | BB | BI | B BE | BB | | 0 | | | | 0.0 | CD. | D.C. | 0.0 | | | | | | | - | - | | - | ГР | | | | | , _r | | | - п |
| 10 pF 11 nF | 100 | | | | | F | G | J | K | | | BB | BI | 3 BI 3 BI | 8 88 8 88 | CB | | | 3 C 3 C | B | CB | CB | | | | | | | FR | FR | FR | FB | FB | FB | FB | |) FB 3 FF | | 3 FB 8 FF | ; FB } FF | 3 FB 3 FF | 3 F 3 F | B |
| 12 pF | 120 | | | | | F | G | J | K | | BB | BB | BI | 3 BI | BBB | CB | CE | | 3 C | B | CB | CB | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | EB | FE | 3 FE | FI | BFE | 3 FE | 3 FE | 3 F | :B |
| 13 pF | 130 | | | | | F | G | J | K | M | I BB | BB | В | B BI | B BE | СВ | CE | CI | 3 C | B | СВ | СВ | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | EB | FE | 3 FB | FE | 3 FB | ; FP | 3 FB | 3 F | B |
| 15 pF | 150 | | | | | F | G | J | K | | BB | BB | BI | B BE | BB | CB | CB | | 3 C | B | CB | CB | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | EB | FE | FB | FI | 3 FB | FB | FB | 3 F | В |
| 16 pF 18 nF | 160 | | | | | F | G | J | K | | | BB | BI | 3 BI 3 BI | 8 88 8 88 | CB | | | | B | CB | CB | | | | | | | FR | FR | FR | FB | FB | FB | FB | |) FB 3 FF | FI | 3 FB 8 FF | + FB + FF |) FB 3 FF | 3 F 3 F | B |
| 20 pF | 200 | | | | | F | G | J | K | | I BB | BB | B | B BI | BBB | CB | CE | | 3 C | B | CB | CB | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | EB | FE | 3 FE | FI | BFE | FE | 3 FE | 3 F | B |
| 22 pF | 220 | | | | | F | G | J | K | M | I BB | BB | B | B BI | B BB | СВ | CE | CI | B C | B | СВ | СВ | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | EB | FE | 3 FB | FI | 3 FB | FP | 3 FB | 3 F | B |
| 24 pF | 240 | | | | | F | G | J | K | | I BB | BB | B | B BI | BB | CB | CE | | BC | B | CB | CB | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | EB | FE | 3 FE | FI | 3 FE | S FE | 3 FB | 3 F | B |
| 27 pF 30 pF | 270 | | | | | F | G | J | K K | | | BB | B | B BI | | CB | | | | B | CB | CB | | | | | | | FR | FR | FR | FR | FR | FB | | | 3 FE 3 FE | 5 FI 1 FI | 3 FE R FF | 1 FE 3 FE | 3 FB 3 FF | 3 F 8 F | B |
| 33 pF | 330 | | | | | F | G | J | K | | I BB | BB | B | BB | B BE | CB | CE | | BC | B | CB | CB | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | EB | FE | 3 FE | , 3 FI | BFE | 3 FE | 3 FE | 3 F | :B |
| 36 pF | 360 | | | | | F | G | J | K | (N | I BB | BB | В | B BI | B BE | СВ | CE | B CI | вС | В | СВ | СВ | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | EB | FE | 3 FE | B FI | B FE | 3 FE | 3 FE | 3 F | B |
| 39 pF | 390 | | | | | F | G | J | K | | I BB | BB | BI | B BE | B BB | CB | CB | CI | 3 C | B | CB | CB | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | EB | FE | 3 FB | FE | 3 FB | FB | 3 FB | 3 F | В |
| 43 pF | 430 | | | | | F | G | J | K | | | BB | B | B B B | B BB | CB | CB | | 3 C | B | | CB | | DC | | | DC | DC | EB | EB | EB | EB | EB | EB | EB | | S FB | F | 3 FB | FB | FB | 3 F | В |
| 47 pF 51 pF | 510 | | | | | F | G | J | K | | | BB | BI | 3 BI | B BB | CB | CE | | 3 C | B | СВ | CB | | DC | DC | | DC | DC | EB | EB | EB | EB | EB | EB | EB | | 3 FE | | B FE | FE | 3 FB | эг 3 F | B |
| 56 pF | 560 | | | | | F | G | J | K | M | BB | BB | B | B BI | B BE | СВ | CE | CI | B C | B | CB | CB | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | EB | FE | 3 FE | FI | B FE | FE | 3 FE | 3 F | B |
| 62 pF | 620 | | | | | F | G | J | K | M | I BB | BB | B | B BI | B BE | СВ | CE | CI | BC | B | СВ | СВ | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | EB | FE | 3 FE | FI | 3 FE | } FE | 3 FB | 3 F | B |
| 68 pF | 680 750 | | | | | F | G | J | K | | | BB | B | BB | B BE | CB | CE | | BC | B | | CB | | DC | | | | | EB | EB | EB | EB | EB | EB | EB | | 3 FE | | 3 FE | i FE | 3 FB | 3 F | B |
| 75 pF 82 pF | 820 | | | | | F | G | J | K | | | BB | B | B BI | 3 BE | CB | CE | | BC | B | СВ | CB | | DC | | | | | EB | EB | EB | EB | EB | EB | EB | | 3 FE |) FI 3 FI | B FE |) FE 3 FE | 3 FE | эг 3 F | B |
| 91 pF | 910 | | | | | F | G | J | ĸ | | I BB | BB | B | B BI | B BE | CB | CE | | BC | B | CB | CB | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | EB | FE | 3 FE | B FI | B FE | 3 FF | 3 FE | 3 F | :В |
| 100 pF | 101 | | | | | F | G | J | K | (M | I BB | BB | В | B BI | B BE | СВ | CE | B C | BC | В | СВ | СВ | DC | DC | DC | C DC | DC | DC | EB | EB | EB | EB | EB | EB | EB | FE | FP | F | 3 FB | FP | FB | 3 F | В |
| 120 pF | 121 | | | | | F | G | J | K | M | BB | BB | BI | B BE | BB | CB | CB | CI | | B | CB | CB | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | | FE | FB | FI | 3 FB | FB | FB | 3 F | B |
| 150 pF 180 pF | 151 | | | | | F | G | J | K | | | BB | B | 3 BI | 8 BB | CB | CE | | | B | CB | CB | | DC | | | | | FB | FB | FB | FR | FR | FR | | |) FB 3 FF | F | 3 FB 8 FF | + FB |) FB 3 FF |) F 3 F | B |
| 220 pF | 221 | | | | | F | G | J | K | | BB | BB | B | B BI | B BE | СВ | CE | CI | 3 C | B | CB | CB | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | EB | | FE | FE | FI | BFE | FE | FE | 3 F | B |
| 270 pF | 271 | | | | | F | G | J | K | M | BB | BB | В | B BI | B BE | СВ | CE | CI | 3 C | В | СВ | СВ | DC | DC | DC | ; DC | DC | DC | EB | EB | EB | EB | EB | EB | | FE | 3 FE | FI | 3 FE | FE | 3 FB | 3 | |
| | | | Ra | tec | d V | olt | tag | e (| VD | C) | 6.3 | 9 | 16 | 5. 55 | 22 | 6.3 | 9 | 16 | 2 | 3 | 20 | 100 | 6.3 | 9 | 16 | 25 | 50 | 100 | 6.3 | 9 | 16 | 25 | 50 | 100 | 200 | 6.3 | 9 | 16 | 25 | 20 | 9 | | 200 |
| Capacitance | Cap | | | V | olt | ag | e C | Cod | le | | 9 | 8 | 4 | 3 | 5 | 9 | 8 | 4 | 3 | 3 | 5 | 1 | 9 | 8 | 4 | 3 | 5 | 1 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | 2 |
| | Coue | | | (| Ca | se | e Si | ize | • | | | - | 04 |)2 | | 1 | | 0 | 603 | 3 | | | | | 08 | B05 | | | | | | 120 | 6 | | | | | | 121 | 0 | | | |



Table 2B – X7R Product Ordering Codes and Ratings cont.

| | 0 | Case Size | | 0 | 40 | 2 | | | | 06 | 03 | | | | | 08 | 805 | | | | | 1 | 20 | 6 | | | | | | 1 | 21 | 0 | | |
|------------------|------------|--------------------------|---------------------------------------|----|------|----|----|-----|----|----|----|-----|------------|-------------|---------------|-------------|---------------|------------|--------------|-----|------------|-------------|------------|-----------|----------------|----------|-----|-----|----|----|----------|----|----------|-----|
| Сар | Cap | Voltage Code | 9 | 8 | 4 | 3 | 5 | 9 | 8 | 4 | 3 | 5 | 1 | 9 | 8 | 4 | 3 | 5 | 1 | 9 | 8 | 4 | 3 | 5 | | 1 | 2 | 9 | 8 | 4 | 3 | 5 | 1 | 2 |
| | Code | Rated Voltage (VDC) | 6.3 | 10 | 16 | 25 | 50 | 6.3 | 10 | 16 | 25 | 50 | 100 | 6.3 | 5 | 16 | 25 | 50 | 10 | 6.3 | 10 | 16 | 25 | 50 | | | 200 | 6.3 | 9 | 16 | 25 | 50 | 10 | 200 |
| | | Capacitance Tolerance | | | | | | | | | | Pro | odu See | ct A Tab | vaila le 2 | abil for | ity a Chip | nd o Th | Chip ickr | Thi | ckn Din | ess nen: | Co sior | des 1s | | | | | | | | | | |
| 330 pF | 331 | FGJKM | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB | CB | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | 3 E | B | | FB | FB | FB | FB | FB | FB | |
| 390 pF 470 pF | 391 | FGJKM | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB | CB | | | | | | | EB | EB | EB | EB | | 8 E 8 E | B | | FB | FB | FB | FB | FB | FB | |
| 560 pF | 561 | FGJKM | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB | CB | | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | 3 E | B | | FB | FB | FB | FB | FB | FB | |
| 680 pF | 681 | F G J K M | BB | BB | BB | BB | BB | CB | CB | CB | CB | CB | CB | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | BE | B | | FB | FB | FB | FB | FB | FB | |
| 820 pF | 821 | F G J K M | BB | BB | BB | BB | | СВ | СВ | СВ | СВ | СВ | СВ | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | BE | B | | FB | FB | FB | FB | FB | FB | |
| 1,000 pF | 102 | F G J K M | BB | BB | BB | BB | | СВ | СВ | СВ | СВ | СВ | CB | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EE | 3 E | B | | FB | FB | FB | FB | FB | FB | |
| 1,200 pF | 122 | FGJKM | BB | BB | BB | BB | | CB | CB | CB | CB | CB | CB | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EE | 3 E | B | | FB | FB | FB | FB | FB | FB | |
| 1,500 pF | 152 | FGJKM | BB | BB | BB | BB | | CB | CB | CB | CB | CB | CB | | DC | DC | DC | DC | DC | EC | EC | EC | EC | EU | ; E | | | FE | FE | FE | FE FE | FE | FE FE | |
| 1,800 pF | 182 | FGJKM | BB | BB | BB | BB | | CB | CB | CB | CB | CB | | | | | | | | ED | ED | ED | ED | | | ED ER | | FE | FE | FC | FC | FC | FE | |
| 2,200 pr | 272 | FGJKM | BB | BB | BB | BB | | CB | CB | CB | CB | CB | CB | | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | | B | | FC | FC | FC | FC | FC | FC | |
| 3,300 pF | 332 | F G J K M | BB | BB | BB | BB | | CB | CB | CB | CB | CB | CB | DC | DC | DC | DC | DC | DC | EB | EB | EB | EB | EB | 3 E | B | | FF | FF | FF | FF | FF | FF | |
| 3,900 pF | 392 | FGJKM | BB | BB | BB | BB | | СВ | СВ | СВ | СВ | СВ | СВ | DD | DD | DD | DD | DD | DD | EB | EB | EB | EB | EB | 3 E | B | | FB | FB | FB | FB | FB | FB | |
| 4,700 pF | 472 | F G J K M | BB | BB | BB | BB | | СВ | СВ | СВ | СВ | СВ | CB | DD | DD | DD | DD | DD | DD | EB | EB | EB | EB | EB | B E | B | | FB | FB | FB | FB | FB | FB | |
| 5,600 pF | 562 | FGJKM | BB | BB | BB | BB | | CB | CB | СВ | СВ | СВ | CB | DD | DD | DD | DD | DD | DD | EB | EB | EB | EB | EB | 3 E | B | | FB | FB | FB | FB | FB | FB | |
| 6,800 pF | 682 | FGJKM | BB | BB | BB | BB | | CB | CB | CB | CB | CB | CB | DG | DG | DG | DG | DG | DG | EB | EB | EB | EB | EE | 3 E | B | | FB | FB | FB | FB | FB | FB | |
| 8,200 pF | 822 | FGJKM | B B B B B B B B B B B B B B B B B B B | RR | RR | RR | | CB | CB | CB | CB | CB | CB | עט | | ע ט | | עט | | EC | EC | EC | EC | EL | | | | FB | FB | FB | FR | FB | FR | |
| 12,000 pF | 103 | | | BB | BB | BB | | CB | CB | CB | CB | CB | CB | DG | DG | | DG | DG | DG | FD | EU | EU | FD | EU F | , E) F | :0 :n | | FB | FB | FB | FB | FB | FB | |
| 15 000 pF | 153 | | BB | BB | BB | BB | | CB | CB | CB | CB | CB | CB | DG | DG | DG | DG | DG | DG | FF | FF | FF | FF | FF | | F | | FC | FC | FC | FC | FC | FC | |
| 18,000 pF | 183 | | BB | BB | BB | BB | | CB | CB | CB | CB | CB | CB | DG | DG | DG | DG | DG | DG | EH | EH | EH | EH | EF | 1 6 | EH | | FC | FC | FC | FC | FC | FC | : |
| 22,000 pF | 223 | | BB | BB | BB | BB | | СВ | СВ | СВ | СВ | СВ | | DG | DG | DG | DG | DG | DG | EH | EH | EH | EH | EF | 1 E | H | | FF | FF | FF | FF | FF | FF | |
| 27,000 pF | 273 | | BB | BB | | | | СВ | СВ | СВ | СВ | СВ | | DG | DG | DG | DG | DG | DG | EB | EB | EB | EB | EB | 8 E | B | | FG | FG | FG | FG | FG | FG | |
| 33,000 pF | 333 | | BB | BB | | | | СВ | СВ | СВ | СВ | СВ | | DG | DG | DG | DG | DG | DG | EB | EB | EB | EB | EB | BE | B | | FH | FH | FH | FH | FH | FH | |
| 39,000 pF | 393 | | BB | BB | | | | CB | CB | CB | CB | CB | | DG | DG | DG | DG | DG | DG | EB | EB | EB | EB | EB | 3 E | B | | FE | FE | FE | FE | FE | FE | |
| 47,000 pF | 4/3 | | RR | RR | | | | CB | CB | CB | CB | CB | | | DG | DG | DG | DG | DG | EB | EB | EB | EB | EB | 5 E | B B | | FE | FE | FE | FE | FE | FE | |
| 68 000 pF | 683 | | | | | | | CB | CB | CB | CB | | | חח | חח | םם חח | חח | חח | DG | FC | EC | EC | EC | EC | | | | FE | FE | FE | FF | FE | FF | |
| 82.000 pF | 823 | | | | | | | CB | CB | CB | CB | | | | DD | DD | DD | DD | | ED | ED | ED | ED | ED |) E | D | | FE | FE | FE | FE | FE | FE | |
| 0.1 uF | 104 | | | | | | | СВ | СВ | СВ | СВ | | | DG | DG | DG | DG | DG | | ED | ED | ED | ED | ED | | D | | FE | FE | FE | FE | FE | FE | |
| 0.12 uF | 124 | | | | | | | СВ | СВ | СВ | СВ | | | DG | DG | DG | DG | DG | | EM | EM | EM | EM | EN | 1 E | M | | FE | FE | FE | FE | FE | FE | |
| 0.15 uF | 154 | | | | | | | СВ | СВ | СВ | СВ | | | DG | DG | DG | DG | DG | | EM | EM | EM | EM | I EN | 1 E | M | | FF | FF | FF | FF | FF | FF | |
| 0.18 uF | 184 | | | | | _ | | СВ | СВ | | | | | DD | DD | DD | DD | | | EC | EC | EC | EC | EC | ; | _ | _ | FF | FF | FF | FF | FF | FF | |
| 0.22 uF | 224 | | | | | | | СВ | СВ | | | | | DD | DD | DD | DD | | | ED | ED | ED | ED | ED | | | | FC | FC | FC | FC | FC | | |
| 0.27 UF | 2/4 | | | | | | | | | | | | | ע ע | 00 | עע חח | עע חח | | | EM | EM | EM | EN | | 4 | | | FC | FC | FC | FC | FC | | |
| 0.33 UF | 304 304 | | | | | | | | | | | | | | DE | | | | | FC | EIVI | EIVI | EIV | | 1 | | | FG | FG | FG | FG | FG | | |
| 0.47 uF | 474 | | | | | | | | | | | | | DE | DE | DE | DE | | | EC | EC | EC | EC | | | | | FG | FG | FG | FG | FG | | |
| 0.56 uF | 564 | | | | | | | | | | | | | DG | DG | DG | DG | | | EC | EC | EC | EC | : | Г | Т | | FH | FH | FH | FH | FH | 1 | |
| 0.68 uF | 684 | | | | | | | | | | | | | DG | DG | | | | | ED | ED | ED | ED | | | | | FH | FH | FH | FH | FH | 1 | |
| 0.82 uF | 824 | | | | | | | | | | | | | DG | DG | | | | | ED | ED | ED | ED | | | | | FE | FE | FE | FE | | | |
| 1 uF | 105 | | | | | | | | | | | | | DG | DG | | | | | ED | ED | ED | ED | | | | | FE | FE | FE | FE | | | |
| 1.2 uF | 125 | | | | | _ | | | | | | | | | | | | | | EH | EH | EH | EH | | ł. | | _ | FG | FG | FG | FG | - | - | |
| 1.5 UF | 155 | | | | | | | | | | | | | | | | | | | FF | FF | EH | EH | | | | | FG | FG | FG | FG | | | |
| 2.2 uF | 225 | | | | | | | | | | | | | | | | | | | EF | EF | | | | | | | FG | FG | FG | FG | | | |
| 2.7 uF | 275 | | | | | | | | | | | | | | | | | | | | | | | | | | | FG | FG | | | | | |
| 3.3 uF | 335 | | | | | | | | | | | | | | | | | | | | | | | | | | | FM | FM | | | | | |
| | 0 | Rated Voltage (VDC) | 6.3 | 10 | 16 | 25 | 50 | 6.3 | 9 | 16 | 25 | 50 | 100 | 6.3 | 10 | 16 | 25 | 50 | 100 | 6.3 | 9 | 16 | 25 | 50 | 4 | | 200 | 6.3 | 5 | 16 | 25 | 50 | 100 | 200 |
| Capacitance | Code | Voltage Code | 9 | 8 | 4 | 3 | 5 | 9 | 8 | 4 | 3 | 5 | 1 | 9 | 8 | 4 | 3 | 5 | 1 | 9 | 8 | 4 | 3 | 5 | | 1 | 2 | 9 | 8 | 4 | 3 | 5 | 1 | 2 |
| | | Case Size | | (|)402 | 2 | | | | 06 | 03 | | | | | 08 | 305 | | | | | | 120 | 6 | | | | | | | 121 | 0 | | |



Table 2C – X5R Product Ordering Codes and Ratings

| | | | Cas | se S | Size | | | 04 | 02 | | | | 06 | 03 | | | | | 08 | 05 | | | | | 12 | 06 | | | | | 12 | 10 | | |
|------------------|------|-----|-------|------------------------------------|------------|-----|-----|-------------------|---------|----|-------------------|----------------|----|----|-----------|---------|------|-------------------|-------|---------------|---------|---------|--------------|-----|-------|-----------|----|---------|-----|-------------------|----|----|------------|--------|
| Сар | Cap | | Volt | age (| Code | | 9 | 8 | 4 | 3 | 9 | 8 | 4 | 3 | 5 | 1 | 9 | 8 | 4 | 3 | 5 | 1 | 9 | 8 | 4 | 3 | 5 | 1 | 9 | 8 | 4 | 3 | 5 | 1 |
| | Code | Ra | ted V | oltag | je (VI | DC) | 6.3 | 5 | 16 | 25 | 6.3 | 10 | 16 | 25 | 50 | 10 | 6.3 | 9 | 16 | 25 | 50 | 10 | 6.3 | 5 | 16 | 25 | 50 | 100 | 6.3 | 9 | 16 | 25 | 50 | 100 |
| | | | Cap | acita | ance | | | | | | | | | | "Pr | oduc | t Av | aila 2 fo | bilit | y an Nin T | d Ch | nip T | hick nick | nes | s Co | des «" | | | | | | | | |
| 3,900 pF | 392 | F | G | J | K | М | | | | | CB | CB | CB | CB | CB | CB | | 2 10 | | | | | | | 31011 | 3 | | | | | | | | |
| 4,700 pF | 472 | F | G | J | К | М | | | | | СВ | СВ | СВ | CB | CB | CB | | | | | | | | | | | | | | | | | | |
| 5,600 pF | 562 | F | G | J | K | M | | | | | СВ | СВ | CB | CB | CB | CB | | | | | | | | | | | | | | | | | | |
| 6,800 pF | 682 | F | G | J | K | M | | | | | CB | СВ | CB | CB | CB | CB | | | | | | | | | | | | | | | | | | |
| 8,200 pF | 822 | F | G | J | K | M | | | | | CB | CB | CB | CB | CB | CB | DD | DD | DD | DD | DD | DD | | | | | | | | | | | | |
| 10,000 pF | 103 | F | G | J | K | M | BB | BB | BB | BB | CB | CB | CB | CB | CB | CB | DD | DD | DD | DD | DD | DD | | | | | | | | | | | | |
| 12,000 pF | 123 | F | G | J | K | M | BB | BB | BB | BB | CB | СВ | CB | CB | CB | CB | DG | DG | DG | DG | DG | DG | | | | | | | | | | | | |
| 15,000 pF | 153 | F | G | J | K | M | BB | BB | BB | BB | CB | CB | CB | CB | CB | CB | DG | DG | DG | DG | DG | DG | | | | | | | | | | | | |
| 18,000 pF | 183 | F | G | J | K | M | BB | BB | BB | BB | CB | CB | CB | CB | CB | CB | DG | DG | DG | DG | DG | DG | | | | | | | | | | | | |
| 22,000 pF | 223 | F | G | J | K | M | BB | BB | BB | RR | CB | CB | CB | CB | CB | | DG | DG | DG | DG | DG | DG | 50 | | 50 | | | 50 | | | | | | |
| 27,000 pF | 2/3 | | G | J | K | M | RR | BB | | | CB | CB | CB | CB | CB | | DG | DG | DG | DG | DG | DG | EB | EB | EB | EB | EB | EB | | | | | | |
| 33,000 pF | 333 | | G | J | ĸ | | BB | BB | | | CB | CB | CB | CB | CB | | | DG | DG | DG | DG | DG | EB | EB | EB | EB | EB | EB | | | | | | |
| 39,000 pF | 393 | | G | J | r v | | | DD | | | | | | | | | | | | | | | | ED | ED | ED | ED | | | | | | | |
| 47,000 pF | 473 | | G | J | r v | | DD | DD | | | | | | CB | CD | | | | | | | | | ED | | ED | ED | | | EE | CC | EE | EE | EE |
| 68 000 pF | 683 | F | G | 1 | K | M | | | | | CB | CB | CB | CB | | | | | חח | | | 00 | EC | EC | EC | EC | EC | EC | FE | FE | FE | FE | FE | FE |
| 82 000 pF | 823 | F | G | J | ĸ | M | | | | | CB | CB | CB | CB | | | | | | | | | | ED | ED | ED | ED | ED | FE | FE | FE | FE | FF | FE |
| 02,000 pi | 104 | F | G | 1 | ĸ | M | | | | | CB | CB | CB | CB | | | | DG | DG | | DG | | | FD | FD | FD | FD | FD | FF | FF | FF | FF | FF | FE |
| 0.12 µF | 124 | F | G | Ĩ | ĸ | M | | | | | CB | CB | CB | CB | | | DG | DG | DG | DG | DG | | FM | FM | FM | FM | FM | FM | FF | FF | FE | FF | FF | FE |
| 0.12 µF | 154 | F | G | J | ĸ | м | | | | | CB | CB | CB | CB | | | DG | DG | DG | DG | DG | | FM | FM | FM | FM | FM | FM | FF | FF | FF | FF | FF | FF |
| 0.18 µF | 184 | F | G | J | K | M | | | | | CB | CB | 00 | 00 | | | | DD | DD | | 00 | | FC | FC | FC | FC | FC | 2.141 | FF | FF | FF | FF | FF | FF |
| 0.22 µF | 224 | F | G | J | ĸ | M | | | | | СВ | CB | | | | | DD | DD | DD | DD | | | ED | ED | ED | ED | ED | | FC | FC | FC | FC | FC | |
| 0.27 µF | 274 | F | G | J | K | M | | | | | | | | | | | DD | DD | DD | DD | | | EM | EM | EM | EM | EM | | FC | FC | FC | FC | FC | |
| 0.33 µF | 334 | F | G | J | к | м | | | | | | | | | | | DD | DD | DD | DD | | | ЕМ | EM | EM | EM | EM | | FE | FE | FE | FE | FE | |
| 0.39 µF | 394 | F | G | J | К | М | | | | | | | | | | | DE | DE | DE | DE | | | EC | EC | EC | EC | | | FG | FG | FG | FG | FG | |
| 0.47 µF | 474 | F | G | J | K | М | | | | | | | | | | | DE | DE | DE | DE | | | EC | EC | EC | EC | | | FG | FG | FG | FG | FG | |
| 0.56 µF | 564 | F | G | J | K | М | | | | | | | | | | | DG | DG | DG | DG | | | EC | EC | EC | EC | | | FH | FH | FH | FH | FH | |
| 0.68 µF | 684 | F | G | J | K | М | | | | | | | | | | | DG | DG | | | | | ED | ED | ED | ED | | | FH | FH | FH | FH | FH | |
| 0.82 µF | 824 | F | G | J | K | M | | | | | | | | | | | DG | DG | | | | | ED | ED | ED | ED | | | FC | FC | FC | FC | | |
| 1 µF | 105 | F | G | J | K | М | | | | | | | | | | | DG | DG | | | | | ED | ED | ED | ED | | | FC | FC | FC | FC | | |
| 1.2 µF | 125 | F | G | J | K | M | | | | | | | | | | | | | | | | | EH | EH | EH | EH | | | FG | FG | FG | FG | | |
| 1.5 µF | 155 | F | G | J | K | M | | | | | | | | | | | | | | | | | EH | EH | EH | EH | | | FG | FG | FG | FG | | |
| 1.8 µF | 185 | F | G | J | K | М | | | | | | | | | | | | | | | | | EF | EF | | | | | FG | FG | FG | FG | | |
| 2.2 µF | 225 | F | G | J | K | M | | | | | | | | | | | | | | | | | EF | EF | | | | | FG | FG | FG | FG | | |
| 2.7 µF | 275 | F | G | J | K | M | | | | | | | | | | | | | | | | | EH | EH | | | | | FG | FG | | | | |
| 3.3 µF | 335 | F | G | J | K | M | | | | | | | | | | | | | | | | | EH | EH | | | | | FM | FM | | | | |
| 3.9 µ⊦ 4 7 ∪Γ | 395 | | G | J | K | M | | | | | | | | | | | | | | | | | | | | | | | FG | FG | | | | |
| 4./μr 5.6.μc | 4/5 | | G | J | K K | M | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5.0 μΓ | 303 | Ra | ted V | oltan | ie (VI |)C) | m | e | 16 | 25 | m. | 0 | 9 | 25 | 0 | 8 | m. | <u>0</u> | 16 | 25 | 02 | 8 | m. | 0 | 16 | 25 | 02 | 00 | m. | 2 | 16 | 55 | <u> 10</u> | 8 |
| Canacitanac | Cap | | Volt | ane (| ode | , | 0 | ب و | - | 3 | و ه | - - | - | 3 | 5 | -∓ 1 | 0 | ب ۶ | - | 3 | 5 | -∓ 1 | 0 | 8 | 4 | 3 | 5 | ₩ 1 | 0 | ب ۶ | - | 3 | 5 | ₩ 1 |
| capacitance | Code | | | age Code 9 8 4 3 9 se Size 0402 | | | É | v | י חח | 03 | v | • | É | | ר פח | 05 | v | • | É | | - 12 | 06 | | | É | | 12 | 0 10 | Ŭ | | | | | |
| | 1 | I . | Ja | 500 | .25 | | 1 | 04 | | | 1 | | | | | | I I | | | | | | I I | | 14 | | | | 1 | | 14 | | | |



| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic | Quantity |
|-----------|-------------------|-------------|---------|----------------------|---------|----------|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| BB | 0402 | 0.50 ± 0.05 | 10,000 | 50,000 | 0 | 0 |
| СВ | 0603 | 0.80 ± 0.07 | 4,000 | 10,000 | 0 | 0 |
| DC | 0805 | 0.78 ± 0.10 | 4,000 | 10,000 | 0 | 0 |
| DD | 0805 | 0.90 ± 0.10 | 4,000 | 10,000 | 0 | 0 |
| DE | 0805 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EB | 1206 | 0.78 ± 0.10 | 4,000 | 10,000 | 4,000 | 10,000 |
| EC | 1206 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| ED | 1206 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| EE | 1206 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EH | 1206 | 1.60 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| EM | 1206 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| FB | 1210 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| FC | 1210 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| FE | 1210 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FF | 1210 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FG | 1210 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| FH | 1210 | 1.55 ± 0.15 | 0 | 0 | 2,000 | 8,000 |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic | Quantity |

Table 3 – Chip Thickness/Tape & Reel Packaging Quantities



Table 4 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size | Metric Size | | Dens Maxi Land P | sity Lev mum (I rotrusio | vel A: Most) on (mm |) | | Dens Media Land Pi | sity Lev an (Nor rotrusio | vel B: minal) on (mm |) | | Dens Minir Land Pr | sity Lev num (L rotrusio | vel C: .east) on (mm |) |
|-------------|----------------|------|------------------------|--------------------------------|---------------------------|------|------|--------------------------|---------------------------------|----------------------------|------|------|--------------------------|--------------------------------|----------------------------|------|
| Coue | Coue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/ J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Terminat | ion Finish |
|--|-----------------------|-----------------------|
| Tomeredure | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate $(T_L to T_P)$ | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T_L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |

Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 5 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | | Test | or Inspection Me | ethod | |
|---------------------------------|------------------------------------|---------------------------------|--|---|--------------------------|----------------|
| | | | Case Size | Force | Duration | |
| Terminal Strength | AEC-Q200-006 | | < 0805 | 5 N (0.51 kg) | () as a standa | |
| | | | ≥ 0805 | 10 N (1.02 kg) | 60 seconds | |
| Board Flex | AEC-Q200-005 | COG - 3.0 mm X7R/X5R - 2.0 | (minimum) mm (minimum) | | | |
| Resistance to Soldering Heat | MIL-STD-202 Method 210 | Test Condition | J, 1 heat cycle | | | |
| O a l d a sa h ilitera | | Magnification | 50X. Conditions: | | | |
| Solderability | J-81D-002 | a) Method B, 4 | hours at 155°C, dry | heat at 235°C | | |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (- | 55°C to +125°C), me | easurement at 24 hou | ırs, ±4 hours after te | st conclusion |
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity Measurement | : 1,000 hours 85°C/ at 24 hours, ±4 hou | 85% RH and 200 VDC rs after test conclusion | C maximum. Add 100 on |) KΩ resistor. |
| High Temperature Life | MIL-STD-202 Method 108/EIA -198 | C0G/X7R: 1,00 X5R: 1,000 hou | 0 hours at 125°C w Irs at 85°C with 2.0 | ith 2.0 X rated voltag X rated voltage appli | e applied ed | |

Storage & Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts. Atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability, chip stock should be used promptly, preferably within 1.5 years upon receipt.



Construction





Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 6 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | | Embosse | ed Plastic |
|---------------|-------------------|---------|--------------------|
| EIA Case Size | Tape Size (W)* | 7" Reel | 7" Reel |
| | () | Pitch | (P ₁)* |
| 0402 | 8 | | 2 |
| 0603 | 8 | | 2/4 |
| 0805 | 8 | 4 | 4 |
| 1206 - 1210 | 8 | 4 | 4 |

*Refer to Figures 1 and 2 for W and P₁ carrier tape reference locations. *Refer to Tables 2A, 2B and 2C for tolerance specifications.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 7 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | | (| Constant Dim | ensions — Mil | limeters (Inc | hes) | | | |
|----------|---------------------|------------------------|----------------|----------------|----------------|----------------|------------|--------------------------------|----------------|
| Таре | п | D ₁ Minimum | F | D | D | R Reference | S1 Minimum | Т | T ₁ |
| Size | D ₀ | Note 1 | L 1 | F ₀ | F 2 | Note 2 | Note 3 | Maximum | Maximum |
| 8 mm | | 1.0 | | | | 25.0 | | | |
| 0 11111 | 1.5 +0.10/-0.0 | (0.039) | 1.75 ±0.10 | 4.0 ±0.10 | 2.0 ±0.05 | (0.984) | 0.600 | 0.600 | 0.100 |
| 12 mm | (0.059 +0.004/-0.0) | 1.5 | (0.069 ±0.004) | (0.157 ±0.004) | (0.079 ±0.002) | 30 | (0.024) | (0.024) | (0.004) |
| 12 11111 | | (0.059) | | | | (1.181) | | | |
| | | , | Variable Dime | ensions — Mil | limeters (Inch | nes) | | | |
| Таре | Ditab | B ₁ Maximum | E ₂ | E | п | T ₂ | W | A D | ۰ <i>۷</i> |
| Size | PIICII | Note 4 | Minimum | Г | r ₁ | Maximum | Maximum | A ₀ ,D ₀ | αΝ |
| 0 mm | Single | 4.35 | 6.25 | 3.5 ±0.05 | 4.0 ±0.10 | 2.5 | 8.3 | | |
| 0 11111 | (4 mm) | (0.171) | (0.246) | (0.138 ±0.002) | (0.157 ±0.004) | (0.098) | (0.327) | Not | to F |
| 12 mm | Single (4 mm) | 8.2 | 10.25 | 5.5 ±0.05 | 8.0 ±0.10 | 4.6 | 12.3 | NU | |
| 12 11111 | and Double (8 mm) | (0.323) | (0.404) | (0.217 ±0.002) | (0.315 ±0.004) | (0.181) | (0.484) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B_1 dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{ρ} , B_{ρ} and K_{ρ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) see addendum in EIA Document 481 for standards relating to more precise taping requirements.



Table 8 – Punched (Paper) Carrier Tape Dimesions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|--|--|------------------------------|-----------------------------|--|---------------------------|----------------------------------|---------------------------------|--|--|--|
| Tape Size | D _o | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | | |
| 8 mm | 1.5 + 0.10/-0.0 (0.059 + 0.004/-0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.100 (0.004) | 0.75 (0.030) | 25.0 (0.984) | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | | |
| Tape Size | Pitch | E ₂ Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ & B ₀ | | | |
| 8 mm | Half (2 mm) Single (4 mm) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 2.0 ±0.05 (0.079 ±0.002) 4.0 ±0.10 (0.157 ±0.004) | 1.1 (0.098) | 8.3 (0.327) 8.3 (0.327) | Note 1 | | | |

1. The cavity defined by A_{ρ} , B_{ρ} and T, shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

(e) see addendum in EIA Document 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6).

Packaging Information Performance Notes

1. Cover Tape Break Force: 1.0 kg minimum.

2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength | | |
|--------------|----------------------------------|--|--|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) | | |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) | | |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.



Figure 2 – Maximum Component Rotation



Figure 3 – Maximum Lateral Movement



Maximum Component Rotation Side View $\overset{\circ}{s}$ Tape Maximum Width (mm) Rotation (\bigcirc_{s}°) 8,12 20 16 - 56 10 72 - 200 5

Figure 4 – Bending Radius





Figure 5 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 9 – Reel Dimensions

Metric will govern

| | Constant Dimensions — Millimeters (Inches) | | | | | | | | |
|--------------|--|-----------------------|--|----------------------------|--|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | | | |
| 8 mm | 178 ±0.20 (7.008 ±0.008) or | 1.5 (0.059) | 13.0 + 0.5/-0.2 (0.521 + 0.02/-0.008) | 20.2 (0.795) | | | | | |
| 12 mm | 330 ±0.20 (13.000 ±0.008) | | | (0.750) | | | | | |
| | Variable Di | mensions — Millimeter | s (Inches) | | | | | | |
| Таре | N Minimum | W | W ₂ | 14/ | | | | | |
| Size | See Note 2, Tables 6 – 7 | vv ₁ | Maximum | vv ₃ | | | | | |
| 0 mm | | 8.4 + 1.5/-0.0 | 14.4 | | | | | | |
| 0 11111 | 50 | (0.331 + 0.059/-0.0) | (0.567) | Shall accomadate tape | | | | | |
| 10 mm | (1.969) | 12.4 + 2.0/-0.0 | 18.4 | width without interference | | | | | |
| 12 11111 | | (0.488 + 0.078/-0.0) | (0.724) | | | | | | |



Figure 6 – Tape Leader & Trailer Dimensions



Figure 7 – Maximum Camber





Waffle Tray Packaging Information – 2" x 2" w/ Static Protection

Figure 8 – Waffle Tray Dimensions – Inches (Millimeters)





Table 10A – Waffle Tray Dimensions – Inches

| Case Size | | | Packaging Quantity | | | | | | | | |
|---------------------|-------------|--------|---------------------------|--------|--------|--------|--------|--------|--------|---------|------------|
| | | М | M1 | M2 | M3 | Х | Y | Z | A° | MATRIX | (pcs/unit |
| EIA (in) | Metric (mm) | ±0.003 | ±0.003 | ±0.002 | ±0.002 | ±0.002 | ±0.002 | ±0.003 | ± 1/2° | (X x Y) | packaging) |
| 0402 | 1005 | 0.175 | 0.153 | 0.077 | 0.110 | 0.073 | 0.042 | 0.041 | 7 | 16 X 23 | 368 |
| 0603 | 1608 | 0.175 | 0.153 | 0.077 | 0.110 | 0.073 | 0.042 | 0.041 | 7 | 16 X 23 | 368 |
| 0805 | 2012 | 0.232 | 0.186 | 0.181 | 0.171 | 0.062 | 0.092 | 0.036 | 10 | 10 X 10 | 100 |
| 1206 ^{1,2} | 3216 | 0.194 | 0.228 | 0.193 | 0.124 | 0.067 | 0.130 | 0.065 | 5 | 14 X 9 | 126 |
| 1206 ^{1,3} | 3216 | 0.250 | 0.250 | 0.375 | 0.167 | 0.100 | 0.200 | 0.070 | 5 | 10 X 5 | 50 |
| 1210 | 3225 | 0.217 | 0.244 | 0.215 | 0.174 | 0.110 | 0.145 | 0.080 | 5 | 10 X 8 | 80 |

¹ Packaging of 1206 (3216 metric) case size capacitors is dependent upon the nominal chip thickness of the device. Contact KEMET Sales for Waffle Tray guantities for specified part number.

² Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of \leq 1.25mm (0.049 inches).

³ Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of > 1.25mm (0.049 inches).

2" x 2" Waffle Tray Dimensions - Millimeters Packaging Quantity **Case Size** М M1 M2 A° М3 Х Υ Ζ MATRIX (pcs/unit Metric (mm) ±0.05 EIA (in) ±0.08 ±0.08 ±0.05 ±0.05 ±0.05 ±0.08 ± 1/2° $(X \times Y)$ packaging) 0402 1005 4.45 3.89 1.96 2.79 1.85 1.07 1.04 7 16 X 23 368 0603 1608 4.45 3.89 1.96 2.79 1.85 1.07 1.04 7 16 X 23 368 0805 2012 5.89 4.72 4.60 4.34 1.57 2.34 0.91 10 10 X 10 100 1206^{1,2} 3216 4.93 5.79 4.90 3.15 1.70 3.30 1.65 5 14 X 9 126 12061,3 3216 6.35 6.35 9.53 4.24 2.54 5.08 1.78 5 10 X 5 50 1210 3225 6.20 4.42 2.79 10 X 8 80 5.51 5.46 3.68 2.03 5

Table 10B - Waffle Tray Dimensions - Millimeters

¹ Packaging of 1206 (3216 metric) case size capacitors is dependent upon the nominal chip thickness of the device. Contact KEMET Sales for Waffle Tray guantities for specified part number.

² Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of \leq 1.25mm (0.049 inches).

³ Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of > 1.25mm (0.049 inches).



Overview

KEMET Power Solutions - Low loss (KPS MCL) High Temperature SMPS Ceramic Stacked Capacitors combine a robust and proprietary COG/NPO base metal electrode (BME) dielectric system with a durable lead-frame technology for high temperature and high power SMPS applications. These devices are specifically designed to withstand the demands of harsh industrial environments such as down-hole oil exploration and automotive/avionics engine compartment circuitry.

The KPS-MCL is constructed with large chip multilayer ceramic capacitors (MLCCs), vertically stacked and secured to a lead-frame termination system, using a high melting point (HMP) solder alloy. Vertically stacking the capacitors in lead frames allows for much lower ESR (low loss) and thermal resistance, which translates to very high ripple current capability. The lead-frame isolates the MLCCs from the printed circuit board (PCB), while establishing a parallel circuit configuration. Mechanically isolating the capacitors from the PCB improves mechanical and thermal stress performance, while the parallel circuit configuration allows for bulk capacitance in the same or smaller design footprint.

KEMET's high temperature COG capacitors are temperaturecompensating and are well suited for resonant circuit applications, or for those where Q and stability of capacitance characteristics are required. They exhibit no change in capacitance with respect to time and voltage, and boast a negligible change in capacitance with reference to ambient temperature. Capacitance change is limited to ±30 ppm/°C from -55°C to +200°C. In addition, these capacitors exhibit high insulation resistance with low dissipation factor at elevated temperatures up to +200°C. They also exhibit low ESR at high frequencies and offer greater volumetric efficiency over competitive high temperature BME ceramic capacitor devices.

Benefits

- Low-Loss
- Low ESR and ESL
- High thermal stability
- · High ripple current capability
- Straight Pin lead wires for "through-hole" mounting
- · Formed "J" and "L" lead wires for surface mounting
- Operating temperature range of -55°C to +200°C
- Case Codes (Case Sizes) 69 (2220) and 70 (2225)
- DC voltage ratings of 200 2,000 V
- Capacitance offerings ranging from 11 nF 1.2 μF
- Industrial grade
- High frequency performance and bulk capacitance in a reduced footprint





Applications

- Industrial
- Down-hole
- Defense and aerospace
- Hybrid and Electric Vehicles (HEVs, BEVs)

- SMPS
- Input and output filtering on power supplies, often found on "capacitor banks"
- Snubber circuits and DC link
- Resonator circuits

Ordering Information

| L1 | G | N | 69 | С | 224 | K | Α | 03 |
|-------------------|---|---|------------------------------|--|--|--------------------------|---|---|
| Product Family | Dielectric Classification/ Characteristic | Lead Configuration ¹ | Case Size/ Case Code (CC) | Rated Voltage (DC) | Capacitance Code (pF) | Capacitance Tolerance | Lead/ Termination Finish ² | Number of Chips |
| L1 | G = 200°C COG (BME) | N = Straight pin L = Formed "L" J = Formed "J" | 69 70 | 2 = 200 V C = 500 V B = 630 V D = 1,000 V F = 1,500 V G = 2,000 V | Two Significant Digits and number of zeros | J = ±5% K = ±10% | A = Silver H = Solder Coated (60/40) | 03 – 3 Chips 05 – 5 Chips 10 – 10 Chips |

¹ Lead configuration and dimension details are outlined in the "Dimensions" section of this document. Additional lead configurations may be available. Contact KEMET for details.

² Solder coated (60/40) lead termination finish (H) only available for Straight pin (N) lead configuration.

Lead Configurations – Inches (Millimeters)

| Lead Style Symbol | Lead Style | L Lead Length |
|----------------------|--------------|---------------------------|
| Ν | (N) Straight | 0.250 minimum (6.35) |
| L | (L) Formed | 0.055±0.005 (1.4±0.13) |
| J | (J) Formed | 0.055±0.005 (1.4±0.13) |

Additional lead configurations may be available. Contact KEMET for details.



Dimensions – Inches (Millimeters)



LEAD ALIGNMENT — Note: Lead alignment within pin rows shall be 0.01" maximum.

| Case Code | C Lead Spacing ² ±0.025 (0.635) | E Length | Number Of Leads Per Side | D Width ±0.025 (0.635) | A Height Maximum | B Height Maximum | H Lead Pitch ±0.005 (0.127) | K Lead Width ±0.002 (0.051) | F Seating Plane ¹ ±0.010 (0.250) | Mounting Technique |
|--------------|--|--|--------------------------------|------------------------------|------------------------|------------------------|---|---|--|--------------------------|
| | | | 3 0.32 (8.13) | | | | | | | |
| 69 | For straight lead (N) and (J) | 5 | 0.53 (13.5) | 0.21 (5.33) | 0.29 (7.37) | | | For straight lead (N), | | |
| | 0.25 | E = 0.30 (7.62) maximum For (L) lead: E = 0.38 (9.65) maximum | 10 | 1.06 (26.9) | | | 0.1 (2.54) | 0.02 (0.5) | seating plane is 0.055 (1.397) For (L) and (J) lead, seating plane is 0.070 (1.778) | Solder reflow only |
| | (6.35) | | 3 | 0.32 (8.13) | | | | | | |
| 70 | | | 5 | 0.53 (13.5) | 0.26 (6.60) | 0.34 (8.64) | | | | |
| | | | 10 | 1.06 (26.9) | | | | | | |

¹ Seating plane is the distance between the circuit board and the bottom of the lowest capacitor in the stack.

² Lead spacing dimension from outside of lead frame.



Environmental Compliance

KPS-MCL part types \ge 500 V with silver (Ag) plating are RoHS compliant with exemption 7a.

Electrical Parameters/Performance Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +200°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±30 ppm/°C (up to 200°C) |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 0% |
| Dielectric Withstanding Voltage (DWV) ¹ | 250% of rated voltage for voltage rating of < 500 V 130% of rated voltage for voltage rating of \ge 500 to < 1,000 V 120% of rated voltage for voltage rating of \ge 1,000 V (5 ±1 seconds and charge/discharge not exceeding 50 mA) |
| Dissipation Factor (DF) Maximum Limit at 25°C ² | 0.1% |
| Insulation Resistance (IR) Minimum Limit at 25°C ³ | 1,000 M Ω μF or 100 G Ω (Rated voltage applied for 120 ± 5 seconds at 25°C) |

¹ DWV is the voltage a capacitor can withstand for a short period of time. It exceeds the nominal and continuous working voltage of a capacitor.

² Capacitance and dissipation factor (DF) measured under the following conditions:

1 MHz ±100 kHz and 1.0 ±0.2 V_{rms} if capacitance \leq 1,000 pF.

1 kHz \pm 50 Hz and 1.0 \pm 0.2 V_{rms} if capacitance > 1,000 pF.

³ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to $G\Omega$ limit. Select the lower of the two limits.

Note: When measuring capacitance, it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."



Table 1 - Product Ordering Codes & Ratings

| KEMET Part Number ¹ | Capacitance (µF) ^{2,3} | Case Code | Chip Size | Number of Chips | Height A Inch (mm) Maximum | D Inch (mm) Maximum | RoHS Compliance | | |
|--|------------------------------------|--------------|--------------|--------------------|----------------------------------|------------------------------|---------------------|--|--|
| 200 V | | | | | | | | | |
| L1G(a)692284(b)(c)03 L1G(a)702364(b)(c)03 | 0.28 0.36 | 69 70 | 2220 2225 | 3 3 | 0.21 (5.3) 0.26 (6.6) | 0.32 (8.13) 0.32 (8.13) | No No | | |
| L1G(a)692464(b)(c)05 L1G(a)702604(b)(c)05 | 0.46 0.6 | 69 70 | 2220 2225 | 5 5 | 0.21 (5.3) 0.26 (6.6) | 0.53 (13.5) 0.53 (13.5) | No No | | |
| L1G(a)692924(b)(c)10 L1G(a)702125(b)(c)10 | 0.92 1.2 | 69 70 | 2220 2225 | 10 10 | 0.21 (5.3) 0.26 (6.6) | 1.06 (26.92) 1.06 (26.92) | No No | | |
| | • | | | 500 V | | | | | |
| L1G(a)69C114(b)(c)03 | 0.11 | 69 70 | 2220 | 3 | 0.21 (5.3) | 0.32 (8.13) | | | |
| L1G(a)70C144(b)(c)05 | 0.14 | 69 70 | 2220 | 5 | 0.21 (5.3) | 0.53 (13.5) | Yes | | |
| L1G(a)70C234(b)(c)03 L1G(a)69C364(b)(c)10 | 0.23 | 69 70 | 2220 | 10 | 0.20 (0.0) 0.21 (5.3) | 1.06 (26.9) | (See Note 4) | | |
| L16(a)/0C4/4(b)(c)10 | 0.47 | 70 | 2225 | 630 V | 0.20 (0.0) | 1.00 (20.9) | | | |
| L1G(a)69B663(b)(c)03 | 0.066 | 69 70 | 2220 | 3 | 0.21 (5.3) | 0.32 (8.13) | | | |
| L1G(a)70B843(b)(c)05 | 0.084 | 69 70 | 2220 | 5 | 0.21 (5.3) | 0.53 (13.5) | Yes | | |
| L1G(a)70B144(b)(c)05 L1G(a)69B224(b)(c)10 | 0.14 | 70 69 | 2225 | 5 10 | 0.20 (6.6) | 1.06 (26.9) | (see Note 4) | | |
| LIG(a)/0B284(b)(c)10 | 0.28 | 70 | 2225 | 1.000 V | 0.26 (6.6) | 1.06 (26.9) | | | |
| L1G(a)69D393(b)(c)03 | 0.039 | 69 | 2220 | 3 | 0.21 (5.3) | 0.32 (8.13) | | | |
| L1G(a)70D543(b)(c)03 | 0.054 | 70 69 | 2225 | 3 | 0.26 (6.6) | 0.32 (8.13) | Voc | | |
| L1G(a)70D903(b)(c)05 | 0.090 | 70 | 2225 | 5 | 0.26 (6.6) | 0.53 (13.5) | (see Note 4) | | |
| L1G(a)69D134(b)(c)10 | 0.130 | 69 | 2220 | 10 | 0.21 (5.3) | 1.06 (26.9) | | | |
| L1G(a)70D184(b)(c)10 | 0.180 | 70 | 2225 | 10 | 0.26 (6.6) | 1.06 (26.9) | | | |
| | | | | 1,500 V | | | | | |
| L1G(a)69F163(b)(c)03 | 0.016 | 69 | 2220 | 3 | 0.21 (5.3) | 0.32 (8.13) | | | |
| L1G(a)/0F203(b)(c)03 | 0.020 | 70 | 2225 | 3 | 0.26 (6.6) | 0.32 (8.13) | N. | | |
| LIG(a)69F2/3(b)(c)05 | 0.027 | 69 70 | 2220 | 5 | 0.21 (5.3) | 0.53 (13.5) | Yes (see Note 4) | | |
| L1G(a)/0F343(b)(c)05 L1G(a)60E522(b)(c)10 | 0.034 | 70 | 2225 | 5 | 0.20 (0.0) | 0.53 (13.5) | (See Note 4) | | |
| 11G(a)70F683(b)(c)10 | 0.068 | 70 | 2220 | 10 | 0.21 (0.3) | 1.06 (26.9) | | | |
| | 2,000 V | | | | | | | | |
| L1G(a)69G113(b)(c)03 | 0.011 | 69 | 2220 | 3 | 0.21 (5.3) | 0.32 (8.13) | | | |
| L1G(a)70G143(b)(c)03 | 0.014 | 70 | 2225 | 3 | 0.26 (6.6) | 0.32 (8.13) | | | |
| L1G(a)69G183(b)(c)05 | 0.018 | 69 | 2220 | 5 | 0.21 (5.3) | 0.53 (13.5) | Yes | | |
| L1G(a)70G233(b)(c)05 | 0.023 | 70 | 2225 | 5 | 0.26 (6.6) | 0.53 (13.5) | (see Note 4) | | |
| L1G(a)69G363(b)(c)10 | 0.036 | 69 | 2220 | 10 | 0.21 (5.3) | 1.06 (26.9) | | | |
| L1G(a)70G473(b)(c)10 | 0.047 | 70 | 2225 | 10 | 0.26 (6.6) | 1.06 (26.9) | | | |
| KEMET Part Number ¹ | Capacitance (µF) ^{2,3} | Case Code | Chip Size | Number of Chips | Height A Inch (mm) Maximum | D Inch (mm) Maximum | RoHS Compliance | | |

¹ Complete part number requires additional characters in the numbered positions provided in order to indicate lead configuration, capacitance tolerance and lead finish. For each numbered position, available options are as follows:

(a) Lead style character "N," "L," or "J."

(b) Capacitance tolerance character "J" or "K."

(c) Lead finish character "A" for 100% Ag, "H" for solder coated.

² Capacitance values listed are for stacked components and do not follow E12, E24 format defined by BS 2488 standard. Please contact factory to inquire about capacitance values not listed.

³ Identical capacitance values may be listed for the same voltage rating. User can select which case size and chip count is desired for the given capacitance value.

⁴ KPS-MCL Stacked Capacitors \geq 500 V with Ag plating are RoHS compliant by exemption 7a.



Soldering Process

The capacitors and assemblies outlined in this specification sheet are susceptible to thermal shock damage due to their large ceramic mass. Temperature profiles used should provide adequate temperature rise and cool-down time to prevent damage from thermal shock. In general, KEMET recommends against hand-soldering for these types of large ceramic devices, but if hand-soldering cannot be avoided, refer to hand-soldering section below.

Recommended Soldering Technique:

Solder reflow

Recommended Reflow Soldering Profile:



| - | • | |
|---|-------|--|
| | IMO | |
| | iiiic | |

| Profile Feature | Sn-Pb | Pb-Free | |
|--|-----------------|------------------|--|
| Preheat/Soak | | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | |
| Time (t_s) from T_{smin} to T_{smax}) | 60 – 90 seconds | 60 - 120 seconds | |
| Ramp-up rate $(T_L to T_P)$ | 2°C/second | 3°C/second | |
| Liquidous temperature (T_L) | 183°C | 217°C | |
| Time above liquidous (t_L) | 95 seconds | 95 seconds | |
| Peak temperature (T _P) | 240°C | 260°C | |
| Time within 5°C of maximum peak temperature $(t_{\mbox{\tiny p}})$ | 5 seconds | 5 seconds | |
| Ramp-down rate $(T_P to T_L)$ | 2°C/second | 2°C/second | |
| Time 25°C to peak temperature | 3.5 minutes | 3.5 minutes | |

Note: All temperatures refer to the center of the package, measured on the package body surface that is facing up during assembly reflow.

Preheating and Reflow Profile Notes:

Due to the differences in the coefficient of the thermal expansion for the different materials of construction, it is critical to monitor and control the heating and cooling rates during the soldering process. To ensure optimal component reliability, KEMET's recommended heating and cooling rate is 2°C/second. After soldering, the capacitors should be air cooled to room temperature before further processing. Forced air cooling is not recommended.



Soldering Process cont.

Recommendations for Hand-Soldering:

Care should be taken when hand-soldering large ceramic stacks. Excessive thermal shock on the ceramic material can lead to cracking and reliability issues. To reduce risk of thermal shock, KEMET recommends solder reflow, but if hand soldering cannot be avoided, please see recommended guidelines below.

Pre-Heating

Stacks should be preheated to a temperature within 50°C of reflow temperature. KEMET recommends a ramp rate of 2°C/ second to avoid thermal shock during the pre-heating process.

Hand-Soldering

When using a solder iron, keep tip of the iron as far away from ceramic body to avoid excessive heating.

Cool Down

After reflow, stacks should be allowed to cool at a preferable rate of 2°C/second until room temperature is reached.

Storage & Handling

Ceramic capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature-reels and may soften or warp, and tape peel force may increase. KEMET recommends that maximum storage temperature does not exceed 40°C and maximum storage humidity does not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts. Atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.


Table 2 - Performance & Reliability: Test Methods & Conditions

| Inspection | Test Method | Test Conditions | | | | | | | |
|--|---------------------------------|--|--|--|--|--|--|--|--|
| | Reliability/Environmental Tests | | | | | | | | |
| High Temperature Life | MIL-STD-202, Method 108 | 200°C, rated voltage, 1,000 hours | | | | | | | |
| Temperature Cycling | JESD22, Method JA-104 | -55°C to +200°C, 300 cycles | | | | | | | |
| Thermal Shock | MIL-STD-202, Method 107 | -55°C to +200°C, 20 seconds transfer, 15 minutes dwell, 20 cycles | | | | | | | |
| Moisture Resistance | MIL-STD-202, Method 106 | 20 cycles, no voltage applied | | | | | | | |
| Physical, Mechanical and Process Tests | | | | | | | | | |
| Vibration | MIL-STD-202, Method 204 | Condition D per MIL–PRF–49470, simple harmonic, 20 g peak, 10 – 2,000 Hz, 20 minute sweep, 12 sweeps per axis | | | | | | | |
| Resistance to Soldering Heat | MIL-STD-202, Method 210 | Condition B, 260°C, 10 seconds | | | | | | | |
| Terminal Strength | MIL-STD-202, Method 202 | Condition A | | | | | | | |
| Immersion | MIL-STD-202, Method 104 | Condition B | | | | | | | |
| Solderability | J-STD-002C | Category 3 For Sn-Pb solder alloy: Method A, 245°C, 5 seconds Method S, 220°C peak For Pb-Free solder alloy: Method A1, 260°C, 5 seconds Method S1, 245°C peak | | | | | | | |

8



Construction



Packaging

| Waffle Packaging Quantities | | | | | | | | |
|-----------------------------|------------|-----------------------------|--------------------------------------|--|--|--|--|--|
| Case Code | Lead Style | Number of Chips in Stack | Waffle Pack Quantity ¹ | | | | | |
| (0 | 1.7.17N | 3 and 5 | 50 | | | | | |
| 09 | L/J/N | 10 | 25 | | | | | |
| 70 | 1 / 1/N | 3 and 5 | 50 | | | | | |
| 70 | L/J/N | 10 | 25 | | | | | |

¹ Minimum order value applies. Contact KEMET for details.

KC-LINK[™] with KONNEKT[™] Technology for High-Efficiency, **High-Density Power Applications (Commercial & Automotive Grade)**





Overview

KEMET's KC-LINK[™] with KONNEKT[™] technology surface mount capacitors are designed for high-efficiency and high-density power applications. KONNEKT high density packaging technology uses an innovative Transient Liguid Phase Sintering (TLPS) material to create a surface mount multi-chip solution for high density packaging. By utilizing KEMET's robust and proprietary COG base metal electrode (BME) dielectric system, these capacitors are well suited for power converters, inverters, snubbers, and resonators where high efficiency is a primary concern.

KONNEKT technology enables a low-loss, low-inductance package capable of handling extremely high ripple currents with no change in capacitance versus DC voltage

Benefits

- · Extremely high-power density and ripple current capability
- Extremely low equivalent series resistance (ESR)
- Extremely low equivalent series inductance (ESL)
- · Low-loss orientation option for higher current handling capability
- Capacitance offerings ranging from 14 880 nF
- DC voltage ratings from 500 2,000 V
- Operating temperature range of -55°C to +150°C
- No capacitance shift with voltage
- No piezoelectric noise
- High thermal stability
- · Surface mountable using standard MLCC reflow profiles

Standard





and negligible change in capacitance versus temperature. With an operating temperature range up to 150°C, these capacitors can be mounted close to fast switching semiconductors in high power density applications, which require minimal cooling. KC-LINK with KONNEKT technology also exhibits high mechanical robustness compared to other dielectric technologies, allowing the capacitor to be mounted without the use of metal frames.

These capacitors can also be mounted in a low-loss orientation to further increase power handling capability. The low-loss orientation lowers ESR (Effective Series Resistance) and ESL (Effective Series Inductance) which increases ripple current handling capability.

Applications

- Wide bandgap (WBG), silicon carbide (SiC) and gallium nitride (GaN) systems
- Data centers
- EV/HEV (drive systems, charging)
- LLC resonant converters
- Switched tank converters
- Wireless charging systems
- Photovoltaic systems
- Power converters
- Inverters
- DC link
- Snubber

Low Loss



Built Into Tomorrow



Ordering Information

| CKC | 33 | C | 884 | K | С | G | L | С | XXXX |
|------------------|-------------------------------------|--------------------------|---|--------------------------|--|------------|-------------------------|-----------------------|--|
| Series | Case Size (L"x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (V) | Dielectric | Subclass Designation | Termination Finish | Orientation and Packaging (Suffix/C-Spec) |
| CKC = KC-LINK | 18 = 1812 21 = 2220 33 = 3640 | C = Standard | Two single digits and number of zeros. | K = ±10% | C = 500 V W = 650 V D = 1,000 V E = 1,200 V J = 1,700 V G = 2,000 V | G = COG | L = KONNEKT | C = 100% matte Sn | See "Packaging C-Spec Ordering Options Table" |

Additional termination finish options may be available. Contact KEMET for details.

Orientation and Packaging (Suffix/C-Spec) Options Table

| Mountin | ng Orientation ¹ | Tape and Reel Illustration | Packaging Type | Packaging/Grade Ordering Code (C-Spec) | | |
|----------|-----------------------------|-------------------------------|-------------------|---|------------------|------|
| | | Comme | ercial Grade | | | |
| Standard | Standard | | 7" Reel/Unmarked | TU | | |
| | | | 13" Reel/Unmarked | 7210 | | |
| Low Loss | | | 7" Reel | | 7" Reel/Unmarked | 7805 |
| | | | 13" Reel/Unmarked | 7810 | | |
| | | Autom | otive Grade | | | |
| Standard | | | 7" Reel/Unmarked | AUTO | | |
| Stanuaru | | | 13" Reel/Unmarked | AUT07210 | | |
| Low Loss | | | 7" Reel/Unmarked | AUT07805 | | |
| LUW 2033 | | | 13" Reel/Unmarked | AUT07810 | | |

¹ Orientation refers to the positioning of the KONNEKT capacitors in the Tape and Reel pockets. This allows pick and place machines to place capacitors on the PCB in the correct orientation.



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | Days Prior To | |
|-----------------------------|----------------------------------|----------------|------------------|
| C-Spec | Process/Product change | Implementation | |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum |
| AUTO | Yes (without approval) | Yes | 90 days minimum |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | PPAP (Product Part Approval Process) Level | | | | | | | |
|-----------------------------|--|---|---|---|---|--|--|--|
| C-Spec | 1 | 2 | 3 | 4 | 5 | | | |
| KEMET assigned ¹ | • | • | • | • | • | | | |
| AUTO | 0 | | 0 | | | | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)

| Standard Mounting | Standard Mounting | Low Loss Mounting | Standard Mounting | Low Loss Mounting |
|-------------------|-------------------|-------------------|-------------------|-------------------|
| 2 Chips | 3 Chips | 3 Chips | 4 Chips | 4 Chips |
| B | B | | B | |

| EIA SIZE CODE | METRIC SIZE CODE | Number of Chips | Mounting | L LENGTH | W WIDTH | T THICKNESS | B Bandwidth | Mounting Technique | Typical Average Piece Weight (g) |
|---------------------|------------------------|-------------------------------|-------------------------------|---|--------------------------------|--------------------------------|-------------------------------|-----------------------|---|
| | | 2 | Standard | | 3.20 (0.126) ±0.30 (0.012) | 5.10 (0.201) ±0.40 (0.016) | | | 0.3 |
| 1812 | 4532 | 2 | Standard | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | 7.70 (0.303) ±0.60 (0.24) | 0.60 (0.024) ±0.35 (0.014) | | 0.45 |
| | | 3 | Low Loss | | 7.70 (0.303) ±0.60 (0.24) | 3.20 (0.126) ±0.30 (0.012) | | | 0.45 |
| | | 2 | Standard Low Loss | $\begin{array}{c ccccccccccccccccccccccccccccccccccc$ | | | 0.6 | | |
| 2220 5750 | Standard | 5.70 (0.224) ±0.40 (0.016) | 5.00 (0.197) ±0.40 (0.016) | 7.70 (0.303) ±0.60 (0.24) | 0.60 (0.024) ±0.35 (0.014) | Solder | 1.0 | | |
| | | 5 | Low Loss | | 7.70 (0.303) ±0.60 (0.24) | 5.00 (0.197) ±0.40 (0.016) | | Reflow Only | 1.0 |
| | | 4 | Low Loss | | 10.30 (0.405) ±0.80 (0.031) | 5.00 (0.197) ±0.40 (0.016) | | | 1.4 |
| | | 2 | Standard | | 10.20 (0.402) ±0.40 (0.016) | 5.10 (0.201) ±0.40 (0.016) | | | 2.2 |
| | | 2 | Standard | | 10.20 (0.402) ±0.40 (0.016) | 7.70 (0.303) ±0.60 (0.24) | | | 3.3 |
| 3640 | 9210 | 3 | Low Loss | 9.30 (0.366) ±0.60 (0.024) | 7.70 (0.303) ±0.60 (0.24) | 10.20 (0.402) ±0.40 (0.016) | 1.27 (0.050) | | 3.3 |
| | | 4 | Standard | | 10.20 (0.402) ±0.40 (0.016) | 10.30 (0.405) ±0.80 (0.031) | | | 4.3 |
| | | 4 | Low Loss | | 10.30 (0.405) ±0.80 (0.031) | 10.20 (0.402) ±0.40 (0.016) | | | 4.3 |



Environmental Compliance



Lead (Pb)-free, RoHS, and REACH compliant without exemptions.

Typical Performance

| Number of Chips | Mounting Configuration | Typical ESR at 25°C, 100 kHz | Typical ESL at 25°C | Typical Ripple Current |
|-----------------|---------------------------|---------------------------------|------------------------|---|
| 2 | Standard | < 2.5 mΩ | < 1.5 nH | |
| 3 | Standard | < 2.5 mΩ | < 2.2 nH | |
| 3 | Low Loss | < 1.6 mΩ | < 0.75 nH | See Typical Performance Curves Below |
| 4 | Standard | < 2.5 mΩ | < 2.7 nH | |
| 4 | Low Loss | < 1.1 mΩ | < 0.45 nH | |







Standard Orientation





Standard Orientation





Low Loss Orientation





Low Loss Orientation





Table 1A - Product Ordering Codes and Ratings

| | | | Case Size | | 1812 | | | | 2220 |) | | | | 36 | 40 | | |
|-------------|-------------|-----------|--------------------------|-----|----------------------|-------|-----|-----|-------|-------|-------|-----|-----|-------|-------|-------|-------|
| | Capacitance | Number of | Voltage Code | С | W | D | С | W | D | Ε | J | С | W | D | Ε | J | G |
| Capacitance | Code | Chips | Rated Voltage (VDC) | 500 | 650 | 1,000 | 500 | 650 | 1,000 | 1,200 | 1,700 | 500 | 650 | 1,000 | 1,200 | 1,700 | 2,000 |
| | | | Capacitance Tolerance | | Product Availability | | | | | | | | | | | | |
| 14 nF | 143 | 2 | К | | | | | | | | • | | | | | | |
| 20 nF | 203 | 3 | K | | | | | | | | • | | | | | | |
| 24 nF | 243 | 2 | К | | | | | | | • | | | | | | | |
| 27 nF | 273 | 4 | К | | | | | | | | • | | | | | | |
| 30 nF | 303 | 2 | К | | | • | | | | | | | | | | | • |
| 36 nF | 363 | 3 | K | | | | | | | • | | | | | | | |
| 44 nF | 443 | 2 | K | | | | | | | | | | | | | • | |
| 45 nF | 453 | 3 | K | | | • | | | | | | | | | | | • |
| 48 nF | 483 | 4 | K | | | | | | | • | | | | | | | |
| 60 nF | 603 | 4 | K | | | | | | | | | | | | | | • |
| 66 nF | 663 | 2 | К | | | | | | • | | | | | | | | |
| 00111 | 000 | 3 | К | | | | | | | | | | | | | • | |
| 88 nF | 883 | 4 | К | | | | | | | | | | | | | • | |
| 94 nF | 943 | 2 | К | • | • | | | | | | | | | | • | | |
| 100 nF | 104 | 3 | K | | | | | | • | | | | | | | | |
| 110 nF | 114 | 2 | К | | | | | | | | | | | • | | | |
| 130 nF | 134 | 4 | К | | | | | | • | | | | | | | | |
| 140 nF | 144 | 3 | K | • | • | | | | | | | | | | • | | |
| 170 nF | 174 | 3 | K | | | | | | | | | | | • | | | |
| 190 nF | 194 | 4 | K | | | | | | | | | | | | • | | |
| 200 nF | 204 | 2 | K | | | | • | • | | | | | | | | | |
| 200111 | 201 | 4 | K | | | | | | | | | | | • | | | |
| 300 nF | 304 | 2 | K | | | | | | | | | | • | | | | |
| | | 3 | K | | | | • | • | | | | | | | | | |
| 400 nF | 404 | 4 | K | | | | • | • | | | | | | | | | |
| 440 nF | 444 | 2 | K | | | | | | | | | • | | | | | |
| 450 nF | 454 | 3 | K | | | | | | | | | | • | | | | |
| 600 nF | 604 | 4 | K | | | | | | | | | | • | | | | |
| 660 nF | 664 | 3 | К | | | | | | | | | • | | | | | |
| 880 nF | 884 | 4 | K | | | | | | | | | • | | | | | |

These products are protected under one or more of the following Patents: US Pat. No. 9,472,342B2, EP Pat. No. 2923366B1, JP Pat. No. 06091639B2, TW Pat. No. 579873B, US Pat. No. 10,068,707B2.

Table 1B - Chip Thickness/Tape & Reel Packaging Quantities

| Case | Number of | nber of Orientation | | Quantity | |
|------|-----------|---------------------|---------|----------|--|
| Size | Chips | Unentation | 7" Reel | 13" Reel | |
| | 2 | Standard | 200 | 900 | |
| 1812 | | Standard | 100 | 600 | |
| | 3 | Low Loss | 350 | 1,350 | |
| | 2 | Standard | 300 | 1,250 | |
| | 2 | Low Loss | 225 | 900 | |
| 2220 | 2 | Standard | 125 | 575 | |
| | 3 | Low Loss | 160 | 675 | |
| | 4 | Low Loss | 125 | 525 | |
| | 2 | Standard | 125 | 575 | |
| | | Standard | 75 | 375 | |
| 3640 | 3 | Low Loss | 50 | 275 | |
| | 4 | Standard | 50 | 225 | |
| | 4 | Low Loss | 50 | | |



Detailed Part Number List

| KEMET Part Number ¹ | Case Size | Capacitance | Voltage | Number of Chips | Orientation | Thickness mm (inch) | | |
|-----------------------------------|--------------|-------------|---------|--------------------|----------------------|--|--|--|
| CKC18C303KDGLC(a) | | 30 nF | 1,000 V | | | | | |
| CKC18C943KWGLC(a) | 1 | 94 nF | 650 V | 2 | Standard | 5.10 (0.201) ±0.40 (0.016) | | |
| CKC18C943KCGLC(a) | 1010 | 94 nF | 500 V | ĺ | | | | |
| CKC18C453KDGLC(a) | 1812 | 45 nF | 1,000 V | | | Standard: | | |
| CKC18C144KWGLC(a) | 1 | 140 nF | 650 V | 3 | Standard | 7.70 (0.303) ±0.60 (0.24) | | |
| CKC18C144KCGLC(a) | Ì | 140 nF | 500 V | ĺ | 2000 2033 | 3.20 (0.126) ±0.30 (0.012) | | |
| CKC21C143KJGLC(a) | | 14 nF | 1,700 V | | | | | |
| CKC21C243KEGLC(a) | | 24 nF | 1,200 V | | | | | |
| CKC21C663KDGLC(a) | | 66 nF | 1,000 V | 2 | Standard | 5.00 (0.197) ±0.40 (0.016) | | |
| CKC21C204KWGLC(a) | | 200 nF | 650 V | | 2000 2033 | | | |
| CKC21C204KCGLC(a) | | 200 nF | 500 V | | | | | |
| CKC21C203KJGLC(a) | | 20 nF | 1,700 V | | | | | |
| CKC21C363KEGLC(a) | | 36 nF | 1,200 V | 1 | | Standard: | | |
| CKC21C104KDGLC(a) | 2220 | 100 nF | 1,000 V | 3 | Standard | 7.70 (0.303) ±0.60 (0.24) | | |
| CKC21C304KWGLC(a) | | 300 nF | 650 V | 1 | 2011 2000 | 5.00 (0.197) ±0.40 (0.016) | | |
| CKC21C304KCGLC(a) | | 300 nF | 500 V | | | | | |
| CKC21C273KJGLC(a) |] | 27 nF | 1,700 V | | | | | |
| CKC21C483KEGLC(a) |] | 48 nF | 1,200 V |] | Low Loss | | | |
| CKC21C134KDGLC(a) |] | 130 nF | 1,000 V | 4 | | 5.00 (0.197) ±0.40 (0.016 | | |
| CKC21C404KWGLC(a) |] | 400 nF | 650 V | | | | | |
| CKC21C404KCGLC(a) | | 400 nF | 500 V | | | | | |
| CKC33C303KGGLC(a) | | 30 nF | 2,000 V | | | | | |
| CKC33C443KJGLC(a) | | 44 nF | 1,700 V | | | | | |
| CKC33C943KEGLC(a) | | 94 nF | 1,200 V | 2 | Standard | 5 10 (0 201) +0 40 (0 016) | | |
| CKC33C114KDGLC(a) | | 110 nF | 1,000 V | 2 | Standard | 5.10 (0.201) ±0.40 (0.010) | | |
| CKC33C304KWGLC(a) | | 300 nF | 650 V | | | | | |
| CKC33C444KCGLC(a) | | 440 nF | 500 V | | | | | |
| CKC33C453KGGLC(a) | | 45 nF | 2,000 V | | | | | |
| CKC33C663KJGLC(a) | | 66 nF | 1,700 V | | | Standard [.] | | |
| CKC33C144KEGLC(a) | | 140 nF | 1,200 V | 3 | Standard | 7.70 (0.303) ±0.60 (0.24) | | |
| CKC33C174KDGLC(a) | 3640 | 170 nF | 1,000 V | 5 | Low Loss | Low Loss: | | |
| CKC33C454KWGLC(a) | | 450 nF | 650 V | | | 10.20 (0.402) ±0.40 (0.010) | | |
| CKC33C664KCGLC(a) | | 660 nF | 500 V | | | | | |
| CKC33C603KGGLC(a) | | 60 nF | 2,000 V | | | | | |
| CKC33C883KJGLC(a) | | 88 nF | 1,700 V | | Standard Low Loss | | | |
| CKC33C194KEGLC(a) | | 190 nF | 1,200 V | | | Standard: | | |
| CKC33C204KEGLC(a) | | 200 nF | 1,200 V | 4 | | 10.30 (0.403) ±0.80 (0.031) Low Loss: | | |
| CKC33C224KDGLC(a) | | 220 nF | 1,000 V | | | 10.20 (0.402) ±0.40 (0.016) | | |
| CKC33C604KWGLC(a) | | 600 nF | 650 V | | | | | |
| CKC33C884KCGLC(a) | | 880 nF | 500 V | | | | | |

1 Complete part number requires additional characters in the numbered positions provided in order to indicate capacitance tolerance and grade. For each numbered position, available options are as follows:

(a) Product Grade, Orientation, and Packaging. See Orientation and Packaging (Suffix/C-Spec) Options Table



Table 2 – Performance & Reliability: Test Methods and Conditions

| Test | Reference | Test Condition | Limits |
|---|-------------------|--|--|
| Visual and Mechanical | KEMET Internal | No defects that may affect performance (10X) | Dimensions according KEMET Spec Sheet |
| Capacitance (Cap) | KEMET Internal | 1 kHz ±50 Hz and 1.0 ±0.2 V _{rms} if capacitance Capacitance measurements (including tolerance) are indexed to a referee time of 1.000 hours | Within Tolerance |
| Dissipation Factor (DF) | KEMET Internal | 1 kHz \pm 50 Hz and 1.0 \pm 0.2 V _{rms} | Dissipation factor (DF) maximum limit at 25°C = 0.1% |
| Insulation Resistance (IR) | KEMET Internal | 500 VDC applied for 120±5 seconds at 25°C | Within Specification To obtain IR limit, divide MΩ-μF value by the capacitance and compare to GΩ limit. Select the lower of the two limits. |
| Temperature Coefficient of Capacitance (TCC) | KEMET Internal | Frequency: 1 kHz ±50 Hz Capacitance change with reference to +25°C and 0 VDC applied. * See part number specification sheet for voltage Step Temperature (°C) 1 +25°C 2 -55°C 3 +25°C (Reference) 4 +150°C | ±30 PPM / °C |
| Dielectric Withstanding Voltage (DWV) | KEMET Internal | Rated DC Voltage (% of Rated)500 V500 V650 V650 V130%≥ 1,000 V120%(5 ±1 seconds and charge/discharge not exceeding 50 mA) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit Withstand test voltage without insulation breakdown or damage. |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | KEMET Internal | Maximum % capacitance loss/decade hour | 0% Loss/Decade Hour |
| Terminal Strength | Kemet Internal | Shear stress test per specific case size, Time: 60±1 seconds | No evidence of mechanical damage |



Table 2 – Performance & Reliability: Test Methods and Conditions cont.

| Test | Reference | Test Condition | Limits |
|-----------------------------|---------------------------|--|---|
| Board Flex | AEC-Q200-005 | Standard Termination system 3.0 mm Test time: 60±5 seconds Ramp time: 1 mm/seconds 50 F R230 t t t t t t t t t t t t t t t t t t t | No evidence of mechanical damage |
| Solderability | J-STD-002 | Magnification 10X. Conditions: Category 2 (Dry Bake 155°C / 4 hours ±15 minutes) a) Method B, 245°C, SnPb b) Method B1 at 245°C, Pb-Free c) Method D, at 260°C, SnPb or Pb-Free | Visual Inspection. 95% coverage on termination. No leaching |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to +150°C) 2-3 cycles per hour Soak Time 1 or 5 minutes | Measurement at 24 hours ±4 hours after test conclusion. Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and 200 VDC. Add 100 K Ω resistor. Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K Ω resistor. | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5% |
| Moisture Resistance | MIL-STD-202 Method 106 | Number of cycles required 10, 24 hours per cycle. Steps 7a and 7b not required | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5% |
| Thermal Shock | MIL-STD-202 Method 107 | Number of cycles required 5, (-55°C to 125°C) Dwell time 15 minutes. | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| High Temperature Life | MIL-STD-202 | 1,000 hours at 150°C with 1.0 X rated voltage applied. | Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift |
| Storage Life | Method 108 | 1,000 hours at 150°C, Unpowered | IR: 10% of Initial Limit DF Limits Maximum: 0.5% |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Test from 10 – 2,000 Hz | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Mechanical Shock | MIL-STD-202 Method 213 | 1,500 g's 0.5ms Half-sine, Velocity Change 15.4 ft/second (Condition F) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents | Visual Inspection 10X Readable marking, no decoloration or stains. No physical damage. |



Table 3 – KONNEKT Land Pattern Design Recommendations per IPC-7351 (mm)

| | | | Median (Nominal) Land Protrusion | | | | | | | | | |
|------------------|---------------------|-------------------|---|----------|----------|---------|-------|------|--------|----------|---------|------|
| | | | | Standa | ard Orie | ntation | | | Low Lo | oss Orie | ntation | |
| EIA SIZE Code | METRIC SIZE CODE | Thickness Code | V1 V2 C C C C C C C C C C C C C C C C C C C | | | | | | | | | |
| | | | 2, 3 | 3, & 4-C | hip Stac | k Pad S | ize | | 2-Chip | Stack P | ad Size | |
| | | | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 1812 | 4532 | GO | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | | | | | |
| 2220 | 5750 | JN | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | 2.65 | 1.50 | 6.50 | 7.30 | 7.00 |
| 3640 | 9210 | JF | 4.35 | 1.50 | 10.60 | 10.70 | 11.10 | | | | | |

| | | Thickness Code | Median (Nominal) Land Protrusion | | | | | | | | | |
|------------------|---------------------|-------------------|----------------------------------|--------|---------|---------|------|------|--------|---------|---------|---------|
| | | | Low Loss Orientation | | | | | | | | | |
| EIA SIZE CODE | METRIC SIZE CODE | | | | | | ×22 | | × × | V1 | | 2 /2 |
| | | | | 3-Chip | Stack P | ad Size | | | 4-Chip | Stack P | ad Size | |
| | | | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 1812 | 4532 | GO | 2.05 | 1.40 | 8.40 | 6.00 | 8.90 | | | | | |
| 2220 | 5750 | JN | 2.65 | 1.50 | 8.40 | 7.30 | 8.90 | 2.65 | 1.50 | 11.20 | 7.30 | 11.70 |
| 3640 | 9210 | JF | 4.35 | 1.50 | 8.40 | 10.70 | 8.90 | 4.35 | 1.50 | 11.20 | 10.70 | 11.70 |



Soldering Process

Recommended Reflow Soldering Profile

KEMET's KONNEKT family of high density surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with convection and IR reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Drofile Feature | Termination Finish | T _P | |
|--|--------------------|----------------|---|
| Frome reature | 100% matte Sn | 1 . | Maximum Ramp-up Rate = 3°C/second 1° °p °l Maximum Ramp-down Rate = 6°C/second |
| Preheat/Soak | |] ب '' | |
| Temperature Minimum (T _{smin}) | 150°C | | |
| Temperature Maximum (T _{smax}) | 200°C | ber | |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | | ↓ |
| Ramp-Up Rate (T_L to T_P) | 3°C/second maximum | | |
| Liquidous Temperature (T _L) | 217°C | 25 | - 25°C to Peak - ► |
| Time Above Liquidous (t _L) | 60 – 150 seconds | | Time |
| Peak Temperature (T _P) | 260°C | | |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 30 seconds maximum | | |
| Ramp-Down Rate $(T_p to T_L)$ | 6°C/second maximum | | |
| Time 25°C to Peak Temperature | 8 minutes maximum | | |

Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.

Hand Soldering and Removal of KONNEKT Capacitors

The preferred method of attachment for KEMET's KONNEKT Capacitors is IR or convection reflow where temperature, time and air flow are well controlled.

However, it is understood that the manual attachment of KONNEKT capacitors is necessary for prototype and lab testing. In these instances, care must be taken not to introduce excessive temperature gradients in the KONNEKT part type that may lead to cracking in the ceramic or separation of the TLPS material.

Please see KEMET's KONNEKT Soldering Guidelines here.



Storage & Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. In addition, temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years upon receipt.

Construction





Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12, 16 and 24 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 1B for details on reeling quantities for commercial chips.



Table 4 – Carrier Tape Configuration, Embossed Plastic (mm)

| | | _ | _ | Embossed Plastic | | |
|---------------|-------------------------------------|----------|-------------------------------|------------------|--------------------------------|--|
| EIA Case Size | Number Part of Chips Orientation | | Tape Size (W) ¹ | 7" Reel | 13" Reel | |
| | or ompo | | () | Pitch | (P ₁) ² | |
| | 2 | Standard | | 12 | 12 | |
| 1812 | 3 | Standard | 16 | 16 | 16 | |
| | 3 | Low Loss | | 8 | 8 | |
| | 2 | Standard | | 8 | 8 | |
| | 2 | Low Loss | | 12 | 12 | |
| 2220 | 3 | Standard | 16 | 12 | 12 | |
| | 3 | Low Loss | | 16 | 16 | |
| | 4 | Low Loss | | 20 | 20 | |
| | 2 | Standard | | 20 | 20 | |
| | 3 | Standard | | 20 | 20 | |
| 3640 | 3 | Low Loss | 24 | 20 | 20 | |
| | 4 | Standard | | 24 | 24 | |
| | 4 | Low Loss | | 24 | 24 | |

1. Refer to Figures 1 and 2 for W and P1 carrier tape reference locations.

2. Refer to Tables 4 and 5 for tolerance specifications.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 5 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions — Millimeters (Inches) | | | | | | | | |
|------------------------|--|----------------------------------|----------------------------|---------------------------|---------------------------|-----------------------|----------------------------------|------------------|---------------------------|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum |
| 8 mm 16 mm 24 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 (0.059) | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.05 (0.079±0.002) | 30 (1.181) | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |

| Variable Dimensions – Millimeters (Inches) | | | | | | | | |
|--|-------|----------------------------------|---------------------------|------------------------------|----------------------------|--|-----------------|--|
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ , B ₀ & K ₀ |
| 16 mm — | 8 mm | | 14.25 (0.561) | 8.0+/-0.10 (0.315±0.004) | 8.0±0.10 (0.315±0.004) | Standard Orientation 1812 & 2220 2 Chip 6.1 (0.240) 3 Chip 8.8 (0.346) 4 Chip 11.4 (0.449) | | Note 5 |
| | 12 mm | 9.0 | | | 12.0±0.10 (0.472±0.004) | | 16.3 (0.642) | |
| | 16 mm | (0.354) | | | 16.0±0.10 (0.630±0.004) | | | |
| | 20 mm | | | | 20.0±0.10 (0.787±0.004) | | | |
| 24 mm | 20 mm | 14.5 | 22.25 | 11.5+/-0.10 (0.452±0.004) | 20.0±0.10 (0.787±0.004) | 3640 | "24.3 | Noto F |
| | 24 mm | (0.571) | (0.875) | | 24.0±0.10 (0.944±0.004) | 11.2 (0.441) | (0.957)" | Note 5 |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6).

3. If S1 < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Document 481 paragraph 4.3 (b)).

4. B1 dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3).

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 mm and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4)

(e) For KPS Series product, A0 and B0 are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see Addendum in EIA Document 481 for standards relating to more precise taping requirements. © KEMET Electronics Corporation • One East Broward Boulevard Fort Lauderdale, FL 33301



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|------------|----------------------------------|
| 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |
| 24 mm | 0.1 to 1.6 newton (10 to 160 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300±10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 2 – Maximum Component Rotation



Figure 3 – Maximum Lateral Movement



Figure 4 – Bending Radius





Figure 5 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 6 – Reel Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | |
|----------------|---|-----------------------------------|---------------------------------------|----------------------------|--|--|--|--|--|
| Tape Size | A | B Minimum | С | D Minimum | | | | | |
| 16 mm 24 mm | 16 mm 178±0.20 16 mm (7.008±0.008) 0r 1.5 24 mm 330±0.20 (13.000±0.008) (0.059) | | 13.0+0.5/-0.2 (0.521+0.02/-0.008) | 20.2 (0.795) | | | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | | | | |
| Tape Size | N Minimum See Note 2, Tables 2-3 | W ₁ | W ₂ Maximum | W ₃ | | | | | |
| 16 mm | 16 mm (1.969) | | 22.4 (0.882) | Shall accommodate tape | | | | | |
| 24 mm | 50 (1.969) | 25+1.0/-0.0 (0.984+0.039/-0.0) | 27.4+1.0/-1.0 (1.078+0.039/-0.039) | width without interference | | | | | |



Figure 6 – Tape Leader & Trailer Dimensions



Figure 7 – Maximum Camber







Overview

KEMET's X7R with KONNEKT[™] technology surface mount capacitors are designed for applications where higher capacitance and voltage are needed without requiring additional board space. KONNEKT high density packaging technology uses an innovative Transient Liquid Phase Sintering (TLPS) material to create a surface mount multichip solution for high density packaging.

KEMET's X7R dielectric features a 125°C maximum operating temperature and is considered temperature stable. The Electronics Components, Assemblies and Materials Association (EIA) characterizes X7R dielectric as a Class II material. Components of this classification are fixed, ceramic dielectric capacitors suited for bypass and decoupling applications or for frequencydiscriminating circuits where Q and stability of capacitance characteristics are not critical. X7R exhibits a predictable change in capacitance with respect to time and voltage, boasting a minimal change in capacitance with reference to ambient temperature.



Capacitance change is limited to $\pm 15\%$ from -55°C to ± 125 °C.

In addition to their use in power supplies, these capacitors can be used in industries related to automotive (hybrid), telecommunications, medical, military, aerospace, semiconductors and test/diagnostic equipment. Automotive Grade devices are also available which meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements

For added reliability, KEMET's flexible termination technology is an available option that provides superior flex performance over standard termination systems. This technology was developed to address flex cracks, which are the primary failure mode of MLCCs and typically the result of excessive tensile and shear stresses produced during board flexure and thermal cycling. Flexible termination technology inhibits the transfer of board stress to the rigid body of the MLCC, therefore mitigating flex cracks which can result in low IR or short circuit failures.

Benefits

- Commercial and Automotive Grade (AEC-Q200)
- Industry-leading CV values
- Capacitance offerings ranging from 2.4 nF 20 μ F
- DC voltage ratings from 25 3,000 V
- EIA 1812 and 2220 case sizes
- Operating temperature range of -55°C to +125°C
- Low ESR and ESL
- Non-polar device, minimizing installation concerns
- · Lead (Pb)-free, RoHS, and REACH compliant
- · Surface mountable using standard MLCC reflow profiles
- Flexible termination option available.

Applications

- SMPS (Switch Mode Power Supplies)
- Lighting ballasts, HID lighting
- DC/DC Converters
- Telecom equipment
- · Industrial and medical equipment
- Filters
- Snubbers
- DC Blocking
- Bypass



Built Into Tomorrow



Ordering Information

| С | 1812 | C | 944 | K | С | R | L | С | XXXX |
|---------|-----------------------|---|---|--------------------------|---|------------|-------------------------|-----------------------|--|
| Ceramic | Case Size (L"x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (V) | Dielectric | Subclass Designation | Termination Finish | Orientation and Packaging (Suffix/C-Spec) |
| С | 1812 2220 | C = Standard X = Flexible Termination | Two single digits + number of zeros. | K = ±10% M = ±20% | $\begin{array}{l} 3 = 25 \ V \\ 5 = 50 \ V \\ 1 = 100 \ V \\ 2 = 200 \ V \\ A = 250 \ V \\ C = 500 \ V \\ B = 630 \ V \\ D = 1,000 \ V \\ F = 1,500 \ V \\ G = 2,000 \ V \\ Z = 2,500 \ V \\ H = 3,000 \ V \end{array}$ | R = X7R | L = KONNEKT | C = 100% matte Sn | See "Packaging and Orientation C-Spec Ordering Options Table" |

Additional termination finish options may be available. Contact KEMET for details.

Packaging C-Spec Ordering Options Table

| Packaging Type | Mounting Orientation ¹ | Packaging/Grade Ordering Code (C-Spec) | | | | | | | |
|-------------------|-----------------------------------|---|--|--|--|--|--|--|--|
| Commercial Grade | | | | | | | | | |
| 7" Reel/Unmarked | | TU | | | | | | | |
| 13" Reel/Unmarked | | 7210 | | | | | | | |
| | Automotive Grade | | | | | | | | |
| 7" Reel/Unmarked | | AUTO | | | | | | | |
| 13" Reel/Unmarked | 6 | AUT07210 | | | | | | | |

1 All parts are shipped in standard orientation which refers to the positioning of the KONNEKT capacitors in the Tape and Reel pockets.



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | Days Prior To | |
|-----------------------------|----------------------------------|--------------------------------------|------------------|
| C-Spec | Process/Product change | Process/Product change Obsolescence* | |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum |
| AUTO | Yes (without approval) | Yes | 90 days minimum |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive C-Spec | PPAP (Product Part Approval Process) Level | | | | | | | |
|-----------------------------|--|---|---|---|---|--|--|--|
| | 1 | 2 | 3 | 4 | 5 | | | |
| KEMET assigned ¹ | • | • | • | • | • | | | |
| AUTO | | | 0 | | | | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)



| Number of Chips | EIA SIZE CODE | METRIC SIZE CODE | TERMINATION | L LENGTH | W WIDTH | T THICKNESS | B Bandwidth | Mounting Technique | |
|--------------------|---------------------|--|-------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|------------------------------|---------------|
| 2 | 1010 | Standard 4.50 (0.177) ±0.30 (0.012) 3.20 (0.126) ±0.30 (0.012) See Table | | See Table 1A | 0.60 (0.024) ±0.35 (0.014) | Solder Reflow | | | |
| 2 18 | 1012 | 4332 | Flexible | 4.50 (0.178) ±0.40 (0.016) | 3.20 (0.126) ±0.30 (0.012) | for Thickness | 0.70 (0.028) ±0.35 (0.014) | Only | |
| 2 | 2 2220 | 220 5750 | Standard | 5.70 (0.224) ±0.40 (0.016) | 5.00 (0.197) ±0.40 (0.016 | See Table 1B for Thickness | See Table 1B | 0.60 (0.024) ±0.35 (0.014 | Solder Reflow |
| 2 | | | Flexible | 5.90 (0.232) ±0.75 (0.030) | 5.00 (0.197) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | Only | |



Table 1A - 1812 Product Ordering Codes, Ratings, and Package Quantities

| | | | | Number | | Typical | Tape & Ree | el Quantity |
|-----------------------------------|-------------|-------------|---------|-------------|-------------------------------|------------------------|-------------------|--------------------|
| KEMET Part Number ¹ | Capacitance | Cap Code | Voltage | of Chips | Thickness mm (inch) | Piece Weight (g) | 7" Tape & Reel | 13" Tape & Reel |
| C1812(a)206(b)3RLC(c) | 20 µF | 206 | 25 V | | 3.30 (0.130) ±0.40 (0.16) | 0.25 | 500 | 2,000 |
| C1812(a)945(b)5RLC(c) | 9.4 µF | 945 | 50 V | | 3.30 (0.130) ±0.40 (0.16) | 0.25 | 500 | 2,000 |
| C1812(a)665(b)1RLC(c) | 6.6 µF | 665 | 100 V | | 3.90 (0.153) ±0.40 (0.16) | 0.28 | 275 | 1,050 |
| C1812(a)944(b)2RLC(c) | 0.94 µF | 944 | 200 V | | 3.50 (0.138) ±0.30 (0.12) | 0.25 | 500 | 2,000 |
| C1812(a)944(b)ARLC(c) | 0.94 µF | 944 | 250 V | | 3.50 (0.138) ±0.30 (0.12) | 0.25 | 500 | 2,000 |
| C1812(a)664(b)CRLC(c) | 0.66 µF | 664 | 500 V | | 4.30 (0.169) ±0.20 (0.008) | 0.30 | 250 | 1,000 |
| C1812(a)304(b)BRLC(c) | 0.3 µF | 304 | 630 V | 2 | 3.50 (0.138) ±0.40 (0.16) | 0.25 | 500 | 2,000 |
| C1812(a)204(b)DRLC(c) | 0.2 µF | 204 | 1,000 V | | 3.50 (0.138) ±0.30 (0.12) | 0.25 | 500 | 2,000 |
| C1812(a)663(b)FRLC(c) | 0.066 µF | 663 | 1,500 V | | 5.10 (0.201) ±0.40 (0.16) | 0.35 | 200 | 900 |
| C1812(a)203(b)GRLC(c) | 0.044 µF | 203 | 2,000 V | | 5.10 (0.201) ±0.40 (0.016) | 0.35 | 200 | 900 |
| C1812(a)942(b)ZRLC(c) | 0.0094 µF | 942 | 2,500 V | | 5.10 (0.201) ±0.40 (0.016) | 0.35 | 200 | 900 |
| C1812(a)242(b)HRLC(c) | 0.0024 µF | 242 | 3,000 V | | 3.50 (0.138) ±0.30 (0.12) | 0.35 | 500 | 2,000 |

1 Complete part number requires additional characters in the numbered positions provided in order to indicate capacitance tolerance and grade. For each numbered position, available options are as follows:

(a) End Termination "C" or "X".

(b) Capacitance tolerance character "K" or "M."

(c) Product Grade: "TU" for Commercial or "AUTO" for Automotive



Table 1B - 2220 Product Ordering Codes, Ratings, and Package Quantities

| | | | | Number | | Typical | Tape & Ree | el Quantity |
|-----------------------------------|-------------|-------------|---------|-------------|------------------------------|-----------------------------------|-------------------|--------------------|
| KEMET Part Number ¹ | Capacitance | Cap Code | Voltage | of Chips | Thickness mm (inch) | Average Piece Weight (g) | 7" Tape & Reel | 13" Tape & Reel |
| C2220(a)206(b)5RLC(c) | 20 µF | 206 | 50 V | | 4.90 (0.193) ±0.30 (0.11) | 0.78 | 225 | 900 |
| C2220(a)205(b)1RLC(c) | 2 µF | 205 | 100 V | | 3.1 (0.122) ±0.30 (0.11) | 0.47 | 500 | 1,925 |
| C2220(a)205(b)2RLC(c) | 2 µF | 205 | 200 V | | 3.1 (0.122) ±0.30 (0.11) | 0.47 | 500 | 1,925 |
| C2220(a)205(b)ARLC(c) | 2 µF | 205 | 250 V | | 3.1 (0.122) ±0.30 (0.11) | 0.47 | 500 | 1,925 |
| C2220(a)944(b)CRLC(c) | 0.94 µF | 944 | 500 V | | 5.1 (0.200) ±0.40 (0.016) | 0.81 | 300 | 1,250 |
| C2220(a)664(b)BRLC(c) | 0.66 µF | 664 | 630 V | 2 | 5.1 (0.200) ±0.40 (0.016) | 0.80 | 300 | 1,250 |
| C2220(a)244(b)DRLC(c) | 0.24 µF | 244 | 1,000 V | | 5.1 (0.200) ±0.40 (0.016) | 0.80 | 300 | 1,250 |
| C2220(a)164(b)FRLC(c) | 0.16 µF | 164 | 1,500 V | | 5.1 (0.200) ±0.40 (0.016) | 0.79 | 300 | 1,250 |
| C2220(a)443(b)GRLC(c) | 0.044 µF | 443 | 2,000 V | | 5.1 (0.200) ±0.40 (0.016) | 0.80 | 300 | 1,250 |
| C2220(a)303(b)ZRLC(c) | 0.030 µF | 303 | 2,500 V | | 5.1 (0.200) ±0.40 (0.016) | 0.80 | 300 | 1,250 |
| C2220(a)303(b)HRLC(c) | 0.030 µF | 303 | 3,000 V | | 5.1 (0.200) ±0.40 (0.016) | 0.80 | 300 | 1,250 |

1 Complete part number requires additional characters in the numbered positions provided in order to indicate capacitance tolerance and grade. For each numbered position, available options are as follows:

(a) End Termination "C" or "X".

(b) Capacitance tolerance character "K" or "M."

(c) Product Grade: "TU" for Commercial or "AUTO" for Automotive



Performance and Reliability: Test Methods and Conditions (Commercial Only)

| Test | Reference | Test Condition | | | Limits | | |
|---|-------------------|--|---|--|---|---|--|
| Visual and Mechanical | KEMET Internal | No defects that may affect performance (10X) | [| Dimensions according KEMET Spec Sheet | | | |
| Capacitance (Cap) | KEMET Internal | C ≤ 10 µF 1 kHz ±50 Hz and 1.0 ±0.2 V _{rms} C > 10 µF 120 Hz ±10 Hz and 0.5 ±0.1 V _{rms} Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours | | Wit | nin Tolerance | | |
| | | C < 10 µF | | Withi | n Specification | | |
| Dissination | KEMET | Frequency: 1 kHz ±50 Hz Voltage: 1.0 ±0.2 V _{rms} ,0.5 ±0.2 V _{rms} | EIA Cas Size | e Rated DC Voltage | Capacitance | Dissipation Factor (Maximum %) | |
| Factor (DF) | Internal | C > 10 μF Frequency: 120 Hz +10 Hz | 1812 | | < 20 µF | 2.5 | |
| | | Voltage: 0.5 ±0.1 V _{rms} | 2220 | ALL | 20 µF | 3.5 | |
| | | | 2220 | | | 2.5 | |
| Insulation Resistance (IR) | KEMET Internal | Apply rated voltage for 120 seconds at 25°C | To obtain compa EIA Case Size 1812 2220 | Withi IR limit, divide N re to GΩ limit. S Rated DC Voltage 25 - 100 V 200 - 250 V 500 - 1,000 V 1,500 - 3,000 V 200 - 250 V 500 - 100 V 1,500 - 3,000 V 1,000 - 3,000 V | n Specification IΩ-µF value by t elect the lower of IR 500 megaohm n 1,000 megaohm n 1,000 megaohm n 1,000 megaohm n 1,000 megaohm n 1,000 megaohm n | he capacitance and of the two limits. Limit nicrofarads or 10 GΩ nicrofarads or 10 GΩ | |
| Temperature Coefficient of Capacitance (TCC) | KEMET Internal | $C \leq 10\mu F$ Frequency: 1 kHz ±50 Hz Voltage*: 1.0 ±0.2 V _{rms} C > 10\mu F Frequency: 120 Hz ±10 Hz Voltage: 0.5 ±0.1 V _{rms} * See part number specification sheet for voltage $\frac{Step}{1} \frac{Temperature (°C)}{1} + 25°C$ $2 -55°C$ $3 + 25°C (Reference)$ $4 + 125°C$ | | Capaci -55 | tance ±15% ove °C to +125°C | r | |



Performance and Reliability: Test Methods and Conditions (Commercial Only) cont.

| Test | Reference | Test Condition | Limits |
|--|-------------------------|--|---|
| Dielectric Withstanding Voltage (DWV) | KEMET Internal | Rated DC Voltage (% of Rated)< 500 | Cap: Initial Limit DF: Initial Limit IR: Initial Limit Withstand test voltage without insulation breakdown or damage. |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | KEMET Internal | Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours. Please refer to a part number specific datasheet for referee time details. | 3% Loss/Decade Hour |
| Terminal Strength | KEMET Internal | Shear stress test per specific case size, Time: 60±1 secondsCase SizeForce1812 222018N | No evidence of mechanical damage |
| Board Flex | AEC-Q200-005 | Standard Termination System 2.0 mm Flexible Termination System 3.0 mm Test time: 60± 5 seconds Ramp time: 1 mm/second | No evidence of mechanical damage |
| Solderability | KEMET Custom Test | 1. Board shear – SAC305 solder. Shear force of 1.8 kg (minimum) 2. Wetting balance – IEC 60068–2–69 | Visual Inspection. 95% coverage on termination. No leaching |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to +125°C) 2 - 3 cycles per hour Soak Time 1 or 5 minutes | Measurement at 24 hours ±4 hours after test conclusion. Cap: Initial Limit DF: Initial Limit IR: Initial Limit |



Performance and Reliability: Test Methods and Conditions (Commercial Only) cont.

| Test | Reference | Test Condition | Limits |
|-----------------------------|---------------------------|--|--|
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and 200 VDC maximum. Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. | Measurement at 24 hours ±4 hours after test conclusion.Within Post Environmental Limits Cap: ±20% shift IR: 10% of Initial LimitDF Limits Maximum (%)InitialPost 2.52.53.03.55.0 |
| Moisture Resistance | MIL-STD-202 Method 106 | Number of cycles required 10, 24 hours per cycle. Steps 7a and 7b not required. | Measurement at 24 hours ±4 hours after test conclusion.Within Post Environmental Limits Cap: ±20% shift IR: 10% of Initial LimitDF Limits Maximum (%)InitialPost 2.52.53.0 3.53.55.0 |
| Thermal Shock | MIL-STD-202 Method 107 | Number of cycles required 5, (-55°C to 125°C) Dwell time 15 minutes. | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| High Temperature Life | MIL-STD-202 | 1,000 hours at 125°C with 1.0 X rated voltage applied | Within Post Environmental Limits Cap: ±20% shift IR: 10% of Initial Limit DF Limits |
| Storage Life | Method 108 | 1,000 hours at 125°C, Unpowered | Maximum (%) Initial Post 2.5 3.0 3.5 5.0 |



Performance and Reliability: Test Methods and Conditions (Commercial Only) cont.

| Test | Reference | Test Condition | Limits |
|---------------------------|---|--|---|
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Test from 10 – 2,000 Hz | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Mechanical Shock | MIL-STD-202 Method 213 | 1,500 g's 0.5 ms Half-sine, Velocity Change 15.4 feet/second (Condition F) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Resistance to Solvents | tance to MIL-STD-202 Add Aqueous wash chemical OKEMCLEAN Ivents Method 215 Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents. | | Visual Inspection 10X Readable marking, no decoloration or stains. No physical damage. |

Environmental Compliance



Lead (Pb)-free, RoHS, and REACH compliant without exemptions.

Land Pattern Design Recommendations per IPC-7351 (mm)

| Chip Number | Mounting | EIA SIZE Code | METRIC SIZE CODE | END TERMINATION | I | Median (Nominal) Land Protrusion | | ł | |
|----------------|----------|------------------|---------------------|--------------------|------|-------------------------------------|------|------|------|
| | | | | | C | Y | X | V1 | V2 |
| 2 | Ctondord | 1812 4532 | 4532 | Standard | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 |
| 2 | Stanuaru | | | Flexible | 2.00 | 1.60 | 3.50 | 6.10 | 4.00 |
| 2 | Ctondord | Standard 2220 | 5750 | Standard | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 |
| 2 | Standard | | | Flexible | 2.75 | 1.90 | 5.40 | 7.90 | 5.90 |





Soldering Process

Recommended Reflow Soldering Profile

KEMET's KONNEKT family of high density surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with convection and IR reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Drofile Feature | Termination Finish | Т _Р | |
|--|---------------------------|---------------------|--|
| r tome r catare | 100% matte Sn | - - | Maximum Ramp-up Rate = 3 C/second Maximum Ramp-down Rate = 6°C/second |
| Preheat/Soak | | ່ ອ [່] | / |
| Temperature Minimum (T _{smin}) | 150°C | ∣ <mark>af</mark> r | |
| Temperature Maximum (T _{smax}) | 200°C | | |
| Time (t_s) from T_{smin} to T_{smax} | 60 - 120 seconds | | tt |
| Ramp-Up Rate $(T_{L} to T_{P})$ | 3°C/second maximum | | ° · |
| Liquidous Temperature (T_L) | 217°C | 25 | 25°C to Peak |
| Time Above Liquidous (t _L) | 60 – 150 seconds | | Time |
| Peak Temperature (T _P) | 260°C | | |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 30 seconds maximum | | |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | | |
| Time 25°C to Peak Temperature | 8 minutes maximum | | |

Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.

Hand Soldering and Removal of KONNEKT Capacitors

The preferred method of attachment for KEMET's KONNEKT Capacitors is IR or convection reflow where temperature, time and air flow are well controlled.

However, it is understood that the manual attachment of KONNEKT capacitors is necessary for prototype and lab testing. In these instances, care must be taken not to introduce excessive temperature gradients in the KONNEKT part type that may lead to cracking in the ceramic or separation of the TLPS material.

Please see KEMET's KONNEKT Soldering Guidelines here.



Storage & Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. In addition, temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years upon receipt.

Construction – Standard Termination





Construction – Flexible Termination




Tape & Reel Packaging Information

KEMET offers X7R with KONNEKT technology capacitors packaged in 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems.



Table 4 – Carrier Tape Configuration, Embossed Plastic (mm)

| | Number of | | | Embosse | ed Plastic |
|---|-----------|--------------------------------|---------|----------------------------------|------------|
| EIA Case Size Number of Chip Thickness Ta | | Tape Size (W) ¹ | 7" Reel | 13" Reel | |
| | | (11) | Pitch | 1 (P ₁) ² | |
| | 2 | ≤ 3.5 mm | 16 | 8 | 8 |
| KUNNEKT 1812 | Z | > 3.5 mm | 10 | 12 | 12 |
| | 2 | ≤ 3.5 mm >5.0 mm & ≤ 5.3 mm | 10 | 8 | 8 |
| KUNNEKT 2220 | 2 | > 3.5 mm ≤ 5.0 | 10 | 12 | 12 |

1. Refer to Figures 1 and 2 for W and P, carrier tape reference locations.

2. Refer to Tables 4 and 5 for tolerance specifications.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 5 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | | (| Constant Din | nensions — N | Aillimeters (In | ches) | | | |
|---------|---------------------|------------------------|---------------|----------------|-----------------|-------------|------------------------|---------|----------------|
| Таре | п | D ₁ Minimum | E | р | р | R Reference | S ₁ Minimum | Т | T ₁ |
| Size | D ₀ | Note 1 | L 1 | F ₀ | F 2 | Note 2 | Note 3 | Maximum | Maximum |
| 16 mm | 1.5 +0.10/-0.0 | 1.5 | 1.75±0.10 | 4.0±0.10 | 2.0±0.05 | 30 | 0.600 | 0.600 | 0.100 |
| 10 1111 | (0.059 +0.004/-0.0) | (0.059) | (0.069±0.004) | (0.157±0.004) | (0.079±0.002) | (1.181) | (0.024) | (0.024) | (0.004) |

| | | | | Variable D | imensions | — Millimeter | s (Inches) | | | |
|------|----------|--------|------------------|------------------------|----------------|---------------|----------------------------|----------------|---------|-----------------------|
| Case | Number | Таре | Ditch | B ₁ Maximum | E ₂ | E | D | Τ ₂ | W | A B & K |
| Size | of Chips | Size | FILCH | Note 4 | Minimum | I | г ₁ | Maximum | Maximum | $A_0, D_0 \alpha R_0$ |
| 1812 | 2 | 16 mm | Triple (12mm) | 7.9 (0.311) | 14.25 | 7.5±0.05 | 12.0±0.10 (0.472±0.004) | 6.5 | 16.3 | Note 5 |
| 1012 | 2 | To min | Double (8mm) | 7.5 (0.295) | (0.561) | (0.138±0.002) | 8.0±0.10 (0.315±0.004) | (0.256) | (0.642) | Note 5 |
| 2220 | 2 | 16 mm | Triple (12mm) | 8.5 (0.335) | 14.25 | 7.5±0.05 | 12.0±0.10 (0.472±0.004) | 6.5 | 16.3 | Noto 5 |
| 2220 | 2 | | Double (8mm) | 9.2 (0.363) | (0.561) | (0.138±0.002) | 8.0±0.10 (0.315±0.004) | (0.256) | (0.642) | Note 5 |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6).

3. If S₁ < 1.0 mm, there may not be enough area for cover tape to be properly applied. See EIA Document 481, Paragraph 4.3 (b).

4. B_1 dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{n} , B_{n} and K_{n} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3).

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 mm and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4).

(e) For KPS product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see Addendum in EIA Document 481 for standards relating to more precise taping requirements.



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|------------|----------------------------------|
| 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300±10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 2 – Maximum Component Rotation



Figure 3 – Maximum Lateral Movement





Figure 5 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 6 – Reel Dimensions

Metric will govern

| | Constant | Dimensions — Millimete | rs (Inches) | |
|-----------|---|---------------------------------------|--|--|
| Tape Size | А | B Minimum | С | D Minimum |
| 16 mm | 178±0.20 (7.008±0.008) or 330±0.20 (13.000±0.008) | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) |
| | Variable | Dimensions — Millimeter | rs (Inches) | |
| Tape Size | N Minimum See Note 2, Tables 2-3 | W ₁ | W ₂ Maximum | W ₃ |
| 16 mm | 50 (1.969) | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | Shall accommodate tape width without interference |



Figure 6 – Tape Leader & Trailer Dimensions



Figure 7 – Maximum Camber







Overview

KEMET's X8G Class I dielectric features a 150°C maximum operating temperature, offering the latest in high temperature dielectric technology and reliability for extreme temperature applications and under the hood applications. X8G exhibits no change in capacitance with respect to voltage and boasts a minimal change in capacitance with reference to ambient temperature. It is a suitable replacement for higher capacitance and larger footprint devices that fail to offer capacitance stability. Capacitance change is limited to ±30ppm/°C from -55°C to +150°C.

Driven by the demand for a more robust and reliable component, X8G dielectric capacitors were developed for critical applications where reliability and capacitance stability at higher operating temperatures are a concern. These capacitors are widely used in automotive for under the hood and harsh environment as well as general high temperature applications.

In addition to commercial grade, automotive grade devices are available and meet Automotive Electronics Council's AEC-Q200 qualification requirements. Also available with flexible termination technology which inhibits the transfer of board stress to the rigid ceramic body, therefore mitigating flex cracks which can result in low IR or short circuit failures.

Benefits

- -55°C to +150°C operating temperature range
- Lead (Pb)-Free, RoHS and REACH compliant
- EIA 0402, 0603, 0805, 1206, 1210, 1812 & 2220 case sizes
- DC voltage ratings of 10V, 16V, 25V, 50V, 100V, 200V & 250V
- Capacitance offerings ranging from 0.5pF to $0.47\mu F$
- Available capacitance tolerances of ±0.10pF, ±0.25pF, ±0.5pF, ±1%, ±2%, ±5%, ±10% & ±20%,
- Extremely low ESR and ESL
- High thermal stability
- High ripple current capability
- No capacitance change with respect to applied rated DC voltage
- Non-polar device, minimizing installation concerns
- · Commercial and Automotive (AEC-Q200) grades available
- 100% pure matte tin-plated termination finish that allowing for excellent solderability.
- Flexible Termination option available

Applications

- Decoupling
- Bypass
- Filtering
- Under the hood
- · Transient voltage suppression
- · Safety relevant circuits





Ordering Information

| C | 1210 | C | 184 | K | 3 | Т | Α | C | AUTO |
|---------|--|---|--|--|---|------------|------------------------|---|--|
| Ceramic | Case Size (L" x W") | Specification/ Series ¹ | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/Design | Termination Finish ² | Packaging/ Grade (C-Spec) |
| | 0402 0603 0805 1206 1210 1812 2220 | C = Standard X = Flexible Termination | Two significant digits and number of zeros | $B = \pm 0.10 \text{ pF}$ $C = \pm 0.25 \text{ pF}$ $D = \pm 0.5 \text{ pF}$ $F = \pm 1\%$ $G = \pm 2\%$ $J = \pm 5\%$ $K = \pm 10\%$ $M = \pm 20\%$ | 8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 2 = 200 A = 250 | T = X8G | A = N/A | C = 100% Matte Sn L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ The flexible termination option is not available on EIA 0402 case size product. "C" must be used in the 6th character position when ordering this case size.

² Additional termination finish options may be available. Contact KEMET for details.

² SnPb termination finish option is not available on automotive grade product.

Packaging C-Spec Ordering Options Table

| Packaging Type | Packaging/Grade Ordering Code (C-Spec) |
|---|---|
| Commerc | ial Grade ¹ |
| Bulk Bag | Not Required (Blank) |
| 7" Reel/Unmarked | TU |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2 mm pitch ² | 7081 |
| 13" Reel/Unmarked/2 mm pitch ² | 7082 |
| Automoti | ve Grade ³ |
| 7" Reel | AUTO |
| 13" Reel/Unmarked | AUTO7411 (EIA 0603 and smaller case sizes) AUTO7210 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2 mm pitch ² | 3190 |
| 13" Reel/Unmarked/2 mm pitch ² | 3191 |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked.

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

³ Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information".

³ For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information".

³ All Automotive packaging C-Specs listed exclude the option to laser mark components. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking".



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | tion Due To: | Days Prior To |
|-----------------------------|----------------------------------|---------------|------------------|
| C-Spec | Process/Product change | Obsolescence* | Implementation |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum |
| AUTO | Yes (without approval) | Yes | 90 days minimum |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | | PPAP (Product | Part Approval | Process) Leve | I |
|-----------------------------|---|---------------|---------------|---------------|---|
| C-Spec | 1 | 2 | 3 | 4 | 5 |
| KEMET assigned ¹ | • | • | • | • | • |
| AUTO | | | 0 | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)



Standard Termination

| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|---------------|---------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|----------------------------|---------------------------------|
| 0402 | 1005 | 1.00 (0.040) ±0.05 (0.002) | 0.50 (0.020) ±0.05 (0.002) | | 0.30 (0.012) ±0.10 (0.004) | 0.30 (0.012) | Solder Reflow Only |
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | |
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave or Solder Reflow |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | See Table 2 for Thickness | 0.50 (0.02) ±0.25 (0.010) | | |
| 1210 | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | N1/A | |
| 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | | 0.60 (0.024) ±0.35 (0.014) | IN/A | Solder Reflow Only |
| 2220 | 5650 | 5.70 (0.224) ±0.40 (0.016) | 5.00 (0.197) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | |

Flexible Termination

| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|---------------|---------------------|-------------------------------|-------------------------------|-----------------|-------------------------------|----------------------------|---------------------------|
| 0603 | 1608 | 1.60 (0.063) ±0.17 (0.007) | 0.80 (0.032) ±0.15 (0.006) | | 0.45 (0.018) ±0.15 (0.006) | 0.58 (0.023) | Calder Wave |
| 0805 | 2012 | 2.00 (0.079) ±0.30 (0.012) | 1.25 (0.049) ±0.30 (0.012) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Or Or Colder Deflow |
| 1206 | 3216 | 3.30 (0.130) ±0.40 (0.016) | 1.60 (0.063) ±0.35(0.013) | See Table 2 for | 0.60 (0.024) ±0.25 (0.010) | | Soluel Reliow |
| 1210 | 3225 | 3.30 (0.130) ±0.40 (0.016) | 2.60(0.102) ±0.30(0.012) | Thickness | 0.60 (0.024) ±0.25 (0.010) | | |
| 1812 | 4532 | 4.50 (0.178) ±0.40 (0.016) | 3.20 (0.126) ±0.30 (0.012) | _ | 0.70 (0.028) ±0.35 (0.014) | N/A | Solder Reflow Only |
| 2220 | 5650 | 5.90 (0.232) ±0.75 (0.030) | 5.00 (0.197) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | |



Table 1A – Standard Termination Capacitance Range/Selection Waterfall (0402 – 1206 Case Sizes)

| | Con | Case Size/Series | | CO | 4020 | ; | | | | C |)60 | 3C | | | | | С | 080 | 5C | | | | | C 1 | 120 | 5C | | |
|------------------|--------------------------------|-----------------------|----------------|----|----------------|--------|-----|----|-----|---------------|------|----------------|-----------------|----------------|--|------|----|-----|-----|----------|-----|----|----|------------|-----|------------|-----|-----|
| Capacitance | Code | Voltage Code | 8 4 | 3 | 5 ⁻ | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A |
| | Coue | Rated Voltage (VDC) | 16 15 | 25 | 50 | 200 | 250 | 9 | 16 | 25 | 50 | 100 | 200 | 250 | 9 | 16 | 25 | 50 | 100 | 200 | 250 | 9 | 16 | 25 | 50 | <u>1</u> 0 | 200 | 250 |
| | | Capacitance Tolerance | | | i | | | | Pro | oduc See 1 | t Av | vaila P 2 f | bility or Ci | / and hin T | d Chip Thickness Codes Thickness Dimensions | | | | | | | | | | | | | |
| 0.50 & 0.75 pF | 508 & 758 | B C D | BB BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | | | | | | | |
| 0.75 pF | 758 | B C D | BB BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | | DN | DN | | DN | DN | DN | FR | FR | FR | FR | FR | FR | FR |
| 10 pF | 109-919 | F G J K M | BB BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 11 pF | 110 | FGJKM | BB BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 12 pF | 120 | FGJKM | BB BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 13 pF 15 pF | 130 | FGJKM | BB BB | BB | BB B | | | | CF | CF | CF | | CF | CF | | | | | | | | EB | EB | EB | EB | EB | EB | EB |
| 16 pF | 160 | FGJKM | BB BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 18 pF | 180 | F G J K M | BB BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 20 pF | 200 | F G J K M | BB BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 22 pF | 220 | FGJKM | BB BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 24 µF 27 nF | 240 | F G J K M | BB BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | | | | | | | | FR | FR | FR | FR | FR | FR | FR |
| 30 pF | 300 | F G J K M | BB BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 33 pF | 330 | F G J K M | BB BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 36 pF | 360 | FGJKM | BB BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 39 pF | 390 | FGJKM | BB BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 43 pF 47 nF | 430 | F G J K M | BB BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | | | | | | | | FB | FB | FB | FB | FB | FB | FB |
| 51 pF | 510 | F G J K M | BB BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 56 pF | 560 | F G J K M | BB BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 62 pF | 620 | F G J K M | BB BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 68 pF 75 pF | 680 750 | FGJKM | BB BB | BB | BB | | | | CF | CF | CF | CF | CF | | | | | | | | | EB | EB | EB | EB | EB | EB | EB |
| 82 pF | 820 | F G J K M | BB BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 91 pF | 910 | F G J K M | BB BB | BB | BB | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 100 pF | 101 | F G J K M | BB BB | BB | BB B | BBB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 110 pF | 111 | FGJKM | BB BB | BB | BB B | BBE | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 120 pF | 121 | FGJKM | BB BB | BB | BB B | BBB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 130 µF 150 nF | 151 | FGJKM | BB BB | BB | BB B | | | CF | CF | CF | CF | CF | CF | CF | | | | | | | | FR | FR | FR | FR | ED | ED | ED |
| 160 pF | 161 | FGJKM | BB BB | BB | BB B | B BE | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 180 pF | 181 | FGJKM | BB BB | BB | BB B | BBB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 200 pF | 201 | F G J K M | BB BB | BB | BB B | BBB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 220 pF | 221 | FGJKM | BB BB | BB | BB B | BBB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 240 pF | 241 | FGJKM | BB BB | BB | BB B | 3 BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 270 pF 300 pF | 2/1 | FGJKM | BB BB | BB | BB B | | | | | | | | | | | | | | | | | EB | EB | EB | EB | EB | EB | EB |
| 330 pF | 331 | FGJKM | BB BB | BB | BB B | | BD | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 360 pF | 361 | F G J K M | BB BB | BB | BB B | B | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 390 pF | 391 | F G J K M | BB BB | BB | BB B | В | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 430 pF | 431 | F G J K M | BB BB | BB | BB B | B | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 470 pF | 471 | FGJKM | BB BB | BB | BB B | B | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DP | DP | EB | EB | EB | EB | EB | EB | EB |
| 510 pF | 511 | FGJKM | BB BB BB BB | BB | BB B BR R | B | | CF | CF | CF | CF | CF | CF | CF | | | | | | | | EB | EB | EB | EB | EB | EB | EB |
| 620 nF | 621 | F G J K M | BB BB | BB | BB B | B | | CF | CF | CF | CF | CF | CF | CF | | | | | | DN | DN | FB | FB | FB | FB | FB | FB | FB |
| 680 pF | 681 | F G J K M | BB BB | BB | BB B | B | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 750 pF | 751 | F G J K M | BB BB | BB | BB B | в | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 820 pF | 821 | F G J K M | BB BB | BB | BB B | В | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| 910 pF | 911 | FGJKM | BB BB | BB | BB B | B | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DP | DP | DP | EB | EB | EB | EB | EB | EB | EB |
| 1,000 pF | 102 | FGJKM | BB BB | BB | BB B | D | | CF | CF | CF | CF | CF | CH | CH | | | | | | DP ND | DP | FR | FR | FR | FR | EB | EE | FR |
| 1,200 pF | 122 | F G J K M | BB BB | BB | BB | | | CF | CF | CF | CF | CF | CH | CH | DN | DN | DN | DN | DP | DN | DN | EB | EB | EB | EB | EB | EB | EB |
| | | Rated Voltage (VDC) | 10 16 | 25 | 50 | 200 | 250 | 2 | 16 | 25 | 50 | 100 | 200 | 250 | 2 | 16 | 25 | 50 | 100 | 200 | 250 | 9 | 16 | 25 | 50 | 100 | 200 | 250 |
| Capacitance | Cap Code | Voltage Code | 8 4 | 3 | 5 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A |
| | Case Size/Series C0402C C0603C | | | | | | | C | 080 | 5C | | | | | C | 1206 | C | | | | | | | | | | | |



Table 1A - Standard Termination Capacitance Range/Selection Waterfall(0402 - 1206 Case Sizes) cont.

| | Con | | ;a | se | Si | ze | e/S | Se | rie | es | | | C | ;04 | 40: | 2C | | | | | | C | 060 | 3C | | | | | С | 080 | 5C | | | | | C | 120 | 6C | | |
|-------------|------|----|-------|-----|------|-------|-----|-----|--------|-----------|----|----|----|-----|-----|-----|-----|-----|---|----------|----|-----|------|-------|-------|------|------|-------|-------|-----|------|-----|-----|-------|----|----|-----|----|-----|-----|
| Capacitance | Cap | | | V | olta | ge | Co | ode | • | | 8 | 4 | 3 | | 5 | 1 | 2 | A | | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A |
| | Lode | F | Ra | ted | Vo | lta | ge | (۷ | DC |) | 10 | 16 | 35 | 2 | 50 | 100 | 200 | 50 | | 9 | 16 | 25 | 50 | 0 | 00 | 250 | 5 | 16 | 25 | 50 | 0 | 200 | 250 | 10 | 16 | 25 | 50 | 00 | 200 | 250 |
| | | h | Can | aci | tan | ce | То | ler | an | ce | | | | | | • | | | • | | Pr | odu | t A | /aila | bilit | y an | d Cl | nip 1 | hick | nes | s Co | des | | | | | | | | |
| 1000 5 | 100 | | | _ | | - | | | | | | | D | _ | | | | | | 0.5 | 5 | See | Tabl | e 2 f | or C | hip | Thic | kne | ss Di | men | | IS | DN | 1 5 0 | 50 | 50 | 50 | 50 | 50 | 50 |
| 1,300 pF | 132 | ł. | ٣ | | t i | | | J | K | M | BB | BB | B | 5 | RR | | | | | | CF | CF | CF | UF | CH | CH | | | | DP | | DN | DN | EB | EB | EB | EB | EC | EC | EC |
| 1,500 pF | 152 | | | | | | | J | r v | | | | | 5 | DD | | | | Ľ | | | | | | | | | | | | | | | | | | | | | |
| 1,000 pF | 102 | | | | | | | 1 | r v | M | | | | 5 | | | | | Ľ | | | | | | | | | | | | | | | | | | | | | |
| 1,800 pF | 182 | | | | | - / | | J | ĸ | | | | | 5 | | | | | Ľ | | | | | | | | | | | | | | | | ED | ED | ED | ED | | |
| 2,000 pF | 202 | | | | | - ; | 5 | J | ĸ | | BB | BB | B | 5 | | | | | Ľ | | | | | | | | | | | DN | | | | EB | EB | EB | EB | ED | ED | ED |
| 2,200 pF | 222 | ł | ÷ | ÷ | F | - (| j | J | K | M | RR | BB | B | 5 | | | | | | JF OF | CF | CF | CF | CF | CH | CH | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EE | EE | ED |
| 2,400 pF | 242 | | | | | | j l | J | ĸ | M | | | | | | | | | | JF AF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EC | EC | EC |
| 2,700 pF | 2/2 | | | | L F | - 19 | j | J | K | M | | | | | | | | | | JF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DN | DN | EB | EB | EB | EB | EC | EC | EC |
| 3,000 pF | 302 | | | | L F | - 19 | j | J | K | M | | | | | | | | | | JF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DN | DN | EC | EC | EC | EC | EC | EB | EB |
| 3,300 pF | 332 | | | | F | - (| 3 | J | K | Μ | | | | | | | | | | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DN | DN | EC | EC | EC | EC | EE | EB | EB |
| 3,600 pF | 362 | | 42 | | F | - (| 3 | J | K | М | | | | | | | | | | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DP | DP | EC | EC | EC | EC | EE | EB | EB |
| 3,900 pF | 392 | | | | F | - (| 3 | J | Κ | М | | | | | | | | | | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DP | DP | EC | EC | EC | EC | EF | EB | EB |
| 4,300 pF | 432 | | | | F | - (| 3 | J | Κ | М | | | | | | | | | 0 | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DP | DP | EC | EC | EC | EC | EC | EB | EB |
| 4,700 pF | 472 | | | | F | : (| 3 | J | Κ | М | | | | | | | | | | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DP | DP | EC | EC | EC | EC | EC | EB | EB |
| 5,100 pF | 512 | | | | F | : (| 3 | J | Κ | М | | | | | | | | | | CF | CF | CF | CF | | | | DN | DN | DN | DN | DN | DP | DP | ED | ED | ED | ED | ED | EB | EB |
| 5,600 pF | 562 | | | | F | = (| G | J | Κ | М | | | | | | | | | | CF | CF | CF | CF | | | | DN | DN | DN | DN | DN | DP | DP | ED | ED | ED | ED | ED | EB | EB |
| 6,200 pF | 622 | | | | F | = (| G | J | Κ | М | | | | | | | | | | CF | CF | CF | CF | | | | DN | DN | DN | DN | DN | DG | DG | EB | EB | EB | EB | EB | EB | EB |
| 6,800 pF | 682 | | | | F | = (| G | J | Κ | М | | | | | | | | | | CF | CF | CF | CF | | | | DN | DN | DN | DN | DN | DG | DG | EB | EB | EB | EB | EB | EB | EB |
| 7,500 pF | 752 | | | | F | = (| G | J | Κ | М | | | | | | | | | | CF | CF | CF | | | | | DN | DN | DN | DN | DN | DG | DG | EB | EB | EB | EB | EB | EB | EB |
| 8.200 pF | 822 | L | | | E | : (| G | J | К | М | | | | | | | | | | CF | CF | CF | | | | | DN | DN | DN | DN | DN | DG | DG | EB | EB | EB | EB | EB | EC | EC |
| 9.100 pF | 912 | L | | | F | = (| G | J | К | м | | | | | | | | | | CF | CF | CF | | | | | DN | DN | DN | DN | DN | | | EB | EB | EB | EB | EB | EC | EC |
| 10 000 pF | 103 | Т | Т | Т | E | : (| 3 | J | K | М | | | | Т | | | | 1 | | CF | CF | CF | _ | _ | | _ | DN | DN | DN | DN | DP | | | FB | FB | FB | FB | FB | FC | FC |
| 12 000 pF | 123 | | | | F | : 0 | 3 | Ĵ | ĸ | м | | | | | | | | | | CF | CF | CF | | | | | DN | DN | DN | DN | DF | | | FB | FB | FB | FB | FB | FD | FD |
| 15 000 pF | 153 | | | | F | : 1 | 3 | Ĵ | ĸ | м | | | | | | | | | | CF | CF | CF. | | | | | DN | | DN | DP | DG | | | FB | FB | FB | FR | FR | FF | FF |
| 18,000 pF | 183 | | | | Ē | : 1 | 2 | ĭ | ĸ | м | | | | | | | | | Т | 51 | 01 | | | | | | | | | DP | | | | FR | FR | FR | FR | FR | EH | EH |
| 22 000 pF | 223 | | | | | : 1 | | ĭ | ĸ | M | | | | | | | | | | | | | | | | | | | | | | | | FR | FR | FR | FR | FC | EH | EH |
| 27,000 pF | 273 | ł. | de la | | Ē | : (| 2 | 1 | K | M | | | | ÷ | | | | | | | | | | | | | | | DE | DI | | | | FR | EB | EB | EB | FF | | E11 |
| 27,000 pl | 273 | | | | | : | 2 | ï | ĸ | M | | | | | | | | | | | | | | | | | | | | | | | | FR | FR | FR | FR | FE | | |
| 20,000 pF | 202 | | | | | - 2 | 2 | 1 | N V | | | | | | | | | | | | | | | | | | | | | | | | | | EC | EC | | | | |
| 47.000 pF | 170 | | | | | | | 1 | K | IVI NA | | | | | | | | | | | | | | | | | | | | | | | | 50 | EC | EC | | EU | | |
| 47,000 pF | 4/3 | | | | | | 3 | 1 | Ň | IVI | | | | | | | | | | | | | | | | | 100 | DG | DG | | | | | | EU | EU | | EH | | |
| 56,000 pF | 503 | ł | ÷ | | | - 1 | J | J | ĸ | IVI | | | | ł | | | | | | | | | | | | | | | | | | | | ED | ED | ED | EF | | | |
| 68,000 pF | 683 | | | | | : (| 5 | J | ĸ | M | | | | | | | | | | | | | | | | | | | | | | | | EF | EF | EF | EH | | | |
| 82,000 pF | 823 | | | | | | j | J | ĸ | M | | | | | | | | | | | | | | | | | | | | | | | | EH | EH | EH | EH | | | |
| 100,000 pF | 104 | ╇ | | | F | - [(| j | J | ĸ | M | - | - | | - | _ | - | - | + | + | _ | | | - | - | - | - | - | - | | - | - | - | - | I EH | EH | EH | - | - | | - |
| | Can | | Ra | ted | Vo | lta | ge | (V | DC |) | 9 | 16 | 2 | 1 | 50 | 10 | 20(| 251 | 1 | 2 | 16 | 25 | 50 | ļ | 20(| 25(| 15 | 16 | 25 | 50 | 10 | 20(| 25(| 12 | 16 | 25 | 50 | ļ | 20(| 25(|
| Capacitance | Code | | | V | olta | ge | Co | de | • | | 8 | 4 | 3 | | 5 | 1 | 2 | A | | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A |
| | | | Ca | ase | e Si | ize | /S | er | ies | ; | | | | C0 | 402 | 2C | | | | | | C | 060 | 3C | | | | | C | 080 | 5C | | | | | C | 120 | 6C | | |



Table 1B – Standard Termination Capacitance Range/Selection Waterfall (1210 – 2220 Case Sizes)

| | Cap | Case Size/Series C1210C Voltage Code 8 4 3 5 1 2 A Rated Voltage (VDC) 2 2 3 2 2 3 3 Product Availability and the set of t | | | | | | | | | | | | | | C18 | 12C | | C | 2220 | C | | |
|----------------|-------------------------|--|-----|-------|------|------|------|------|---|------|-----|-----|-----------------|----------------|-------------------|------------------|-----------------|----------------|---------------|----------------|-----------|-----|-----|
| Capacitance | Code | | | Vol | tag | e Co | ode | _ | | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 5 | 1 | 2 |
| | | | Ra | ted \ | /olt | age | (VI | DC) | | 2 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | 50 | 100 | 200 |
| | | | Cap | acita | anco | e To | lera | ance | 9 | | | Pro | oduct See Ta | Avai able 2 | labili 2 for C | ty and Chip 1 | d Chij Fhick | p Thio ness | cknes Dime | is Co nsior | des Is | | |
| 1.0 - 9.1 pF* | 109 - 919* | В | С | D | _ | | | | | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 10 pF 11 nF | 100 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 12 pF | 120 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 13 pF | 130 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 15 pF 16 pF | 150 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 18 pF | 180 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 20 pF | 200 | | | | F | G | J | к | м | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 22 pF | 220 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 24 pF | 240 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 27 pF 30 pF | 300 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 33 pF | 330 | | | | F | G | Ĵ | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 36 pF | 360 | | | | F | G | J | K | М | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 39 pF | 390 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 43 p⊦ 47 pE | 430 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 51 pF | 510 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 56 pF | 560 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 62 pF | 620 | | | | F | G | J | K | М | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 68 pF | 680 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 75 pF 82 nF | 750 820 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 91 pF | 910 | | | | F | G | Ĵ | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 100 pF | 101 | | | | F | G | J | K | М | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 110 pF | 111 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 120 pF | 121 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 130 pF | 131 | | | | | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 160 pF | 161 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 180 pF | 181 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 200 pF | 201 | | | | F | G | J | K | М | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 220 pF | 221 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 240 pF | 241 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 270 pF | 2/1 | | | | F | G | J | K | M | I FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 330 pF | 331 | | | | F | G | J | ĸ | M | FR | FB | FB | FB | FB | FB | FB | | | | | | | |
| 360 pF | 361 | l I | | | F | G | Ĵ | ĸ | M | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 390 pF | 391 | | | | F | G | J | к | м | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 430 pF | 431 | | | | F | G | J | K | Μ | FB | FB | FB | FB | FB | FB | FB | | | | | | | |
| 470 pF | 471 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | | | |
| 510 pF | 511 | | | | F | G | J | K | M | I FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | | | |
| 620 pF | 621 | | | | F | G | J | ĸ | M | FB | FB | FB | FR | FB | FB | FB | GB | GB | GB | GB | | | |
| 680 pF | 681 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | | | |
| 750 pF | 751 | | | | F | G | J | K | М | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | | | |
| 820 pF | 821 | | | | F | G | J | K | М | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | | | |
| 910 pF | 911 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | | | |
| 1,000 pF | 102 | | | | F | G | J | K | M | FB | FB | FR | FR | FB | FR | FB | GB | GB | GB | GB | | | |
| 1,200 pF | 122 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | | | |
| 1,300 pF | 132 | | | | F | G | J | K | M | FB | FB | FB | FB | FB | FC | FC | GB | GB | GB | GB | | | |
| 1,500 pF | 152 | | | | F | G | J | K | М | FB | FB | FB | FB | FB | FE | FE | GB | GB | GB | GB | | | |
| | | L | Ra | ted \ | /olt | age | (VI | DC) | | 2 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | 50 | 100 | 200 |
| Capacitance | Cap Code | | | Vol | tag | e Co | ode | | | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 5 | 1 | 2 |
| | Case Size/Series C1210C | | | | | | | | | | C18 | 12C | | C | 2220 | C | | | | | | | |



Table 1B – Standard Termination Capacitance Range/Selection Waterfall (1210 – 2220 Case Sizes) cont.

| | 0 | Case Size/Series Voltage Code | | | | | | | | | С | 1210 | C | | | | C18 | 12C | | C | 2220 |)C |
|-------------|-------------|-------------------------------|-----|---------|------|------|------|---|----|----|------|------|------|--------|--------|-------|--------|-------|------|------|------|-----|
| Capacitance | Cap | | | Volta | je C | ode | | | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 5 | 1 | 2 |
| | Coue | | Rat | ed Vol | tage | e (V | DC) | | 5 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | 50 | 100 | 200 |
| | | C | apa | acitano | e To | oler | ance | 2 | | | Pro | duct | Avai | labili | ty and | d Chi | p Thio | cknes | s Co | des | | |
| 1 600 pE | 162 | | - | F | G | 1 | ĸ | м | FR | FR | FR | FR | FR | FE | FF | GR | GR | GR | GB | | | |
| 1,000 pT | 182 | | | F | G | | K | M | FR | FB | FB | FB | FB | FF | FF | GB | GB | GB | GB | | | |
| 2.000 pF | 202 | | | F | G | J | K | M | FB | FB | FB | FB | FC | FE | FE | GB | GB | GB | GB | | | |
| 2.200 pF | 222 | | | F | G | J | K | M | FB | FB | FB | FB | FC | FG | FG | GB | GB | GB | GB | | | |
| 2.400 pF | 242 | | | F | G | J | K | M | FB | FB | FB | FB | FC | FC | FC | | | | | | | |
| 2,700 pF | 272 | | | F | G | J | K | M | FB | FB | FB | FB | FC | FC | FC | GB | GB | GB | GB | | | |
| 3 000 pF | 302 | | | F | G | J | K | M | FB | FB | FB | FB | FC | FF | FF | | | 0.5 | 0.5 | | | |
| 3 300 pF | 332 | | | F | G | J | K | M | FB | FB | FB | FB | FF | FF | FF | GB | GB | GB | GB | | | |
| 3 600 pF | 362 | | | F | G | J | K | M | FB | FB | FB | FB | FF | FF | FF | 0.0 | | | | | | |
| 3 900 pF | 392 | | | F | G | J | K | M | FB | FB | FB | FB | FF | FF | FF | GB | GB | GB | GB | | | |
| 4 300 pF | 432 | | | F | G | J | K | м | FB | FB | FB | FB | FF | FF | FF | | | 00 | 00 | | | |
| 4 700 pF | 472 | | | F | G | J | K | M | FF | FF | FF | FF | FG | FG | FG | GB | GB | GD | GD | | | |
| 5.100 pF | 512 | | | F | G | J | K | M | FB | FB | FB | FB | FG | FG | FG | | | | | | | |
| 5.600 pF | 562 | | | F | G | J | K | M | FB | FB | FB | FB | FG | FG | FG | GB | GB | GH | GH | | | |
| 6.200 pF | 622 | | | F | G | J | K | M | FB | FB | FB | FB | FG | FB | FB | | | 0 | 0 | | | |
| 6.800 pF | 682 | | | F | G | J | K | M | FB | FB | FB | FB | FG | FB | FB | GB | GB | GJ | GJ | JE | JE | JB |
| 7.500 pF | 752 | | | F | G | J | K | M | FC | FC | FC | FC | FC | FB | FB | | | | | | | |
| 8.200 pF | 822 | | | F | G | J | K | M | FC | FC | FC | FC | FC | FB | FB | GB | GH | GB | GB | JE | JE | JB |
| 9.100 pF | 912 | | | F | G | J | K | M | FE | FE | FE | FE | FE | FB | FB | | | | | | | |
| 10.000 pF | 103 | | | F | G | J | K | M | FF | FF | FF | FF | FF | FB | FB | GB | GH | GB | GB | JE | JE | JB |
| 12.000 pF | 123 | | | F | G | J | K | M | FB | FB | FB | FB | FB | FB | FB | GB | GG | GB | GB | JE | JE | JB |
| 15.000 pF | 153 | | | F | G | J | K | M | FB | FB | FB | FB | FB | FC | FC | GB | GB | GB | GB | JE | JE | JB |
| 18.000 pF | 183 | | | F | G | J | K | M | FB | FB | FB | FB | FB | FC | FC | GB | GB | GB | GB | JE | JE | JB |
| 22,000 pF | 223 | | | F | G | J | ĸ | м | FB | FB | FB | FB | FB | FF | FF | GB | GB | GB | GB | JE | JB | JB |
| 27.000 pF | 273 | | | F | G | J | ĸ | м | FB | FB | FB | FB | FB | FG | FG | GB | GB | GB | GB | JE | JB | JB |
| 33,000 pF | 333 | | | F | G | J | к | м | FB | FB | FB | FB | FB | FH | FH | GB | GB | GB | GB | JB | JB | JB |
| 39,000 pF | 393 | | | F | G | J | K | Μ | FB | FB | FB | FB | FE | FH | FH | GB | GB | GB | GB | JB | JB | JB |
| 47,000 pF | 473 | | | F | G | J | K | М | FB | FB | FB | FB | FE | FJ | FJ | GB | GB | GD | GD | JB | JB | JB |
| 56,000 pF | 563 | | | F | G | J | К | М | FB | FB | FB | FB | FF | | | GB | GB | GD | GD | JB | JB | JB |
| 68,000 pF | 683 | | | F | G | J | К | М | FB | FB | FB | FC | FG | | | GB | GB | GK | GK | JB | JB | JB |
| 82,000 pF | 823 | | | F | G | J | К | М | FC | FC | FC | FF | FH | | | GB | GB | GM | GM | JB | JB | JB |
| 100,000 pF | 104 | | | F | G | J | K | М | FE | FE | FE | FG | FM | | | GB | GD | GM | GM | JB | JB | JD |
| 120,000 pF | 124 | | | F | G | J | K | М | FG | FG | FG | FH | | | | GB | GH | | | JB | JB | JD |
| 150,000 pF | 154 | | | F | G | J | K | М | FH | FH | FH | FM | | | | GD | GN | | | JB | JB | JG |
| 180,000 pF | 184 | | | F | G | J | K | M | FJ | FJ | FJ | | | | | GH | 1 | | | JB | JD | JG |
| 220,000 pF | 224 | | | F | G | J | K | М | 1 | | | | | | | GK | 1 | | | JB | JD | JL |
| 270,000 pF | 274 | | | F | G | J | K | Μ | | | | | | | | | | | | JB | JF | |
| 330,000 pF | 334 | | | F | G | J | K | Μ | | | | | | | | | | | | JD | JG | |
| 390,000 pF | 394 | | | F | G | J | K | M | | | | | | | | | | | | JG | | |
| 470,000 pF | 474 | | | F | G | J | K | Μ | | | | | | | | | | | | JG | | |
| | | | Rat | ed Vol | tage | e (V | DC) | | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | 50 | 100 | 200 |
| Capacitance | Cap Code | | | Volta | je C | ode | | | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 5 | 1 | 2 |
| | | Case Size/Series | | | | | | | | C | 1210 | С | | | | C18 | 12C | | C | 2220 | C | |



Table 1C – Flexible Termination Capacitance Range/Selection Waterfall (0603 – 1206 Case Sizes)

| | | | Ca | se | Si | ze/ | Se | rie | s | | | С | 060 | 3C | | | | | C | 080 | 5C | | | | | С | 1206 | 5C | | |
|------------------|------------|----------|--------|------|-------|------|------|------|-----|----|----------|-------|-------|------|-----|-------------|-----------------|------------------|------------------|----------------|---------------|-----------------|--------------|--------------|----------|-----------------|----------|----------|----------|------------------|
| Capacitance | Cap | | | Va | oltaç | ge C | ode | | | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A |
| | Coue | | Ra | ited | Vol | ltag | e (V | DC) | | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 10 | 16 | 25 | 50 | 100 | 200 | 250 |
| | | | Cap | oaci | tand | ce T | oler | anco | e | | | | | | I | rodu See | ict Av Table | vailab e 2 fo | ility : r Chi | and C o Thi | hip T ckne | 'hickı ss Di | ness mens | Code ions | S | | | | | |
| 0.50 & 0.75 pF | 508 & 758 | В | C | D | | | | | | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | | | | | | | |
| 1.0 - 9.1 pF* | 109 - 919* | B | C | D | | | | | | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 1.1 pF | 119 | B | C | D | | | | | | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | | | | | | | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 1.3 pF | 139 | B | C | D | Г | Т | | | | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 1.5 pF | 159 | B | C | D | | | | | | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 1.8 pF | 189 | B | C | D | | | | | | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 2.0 pF | 209 | В | C | D | L | _ | | | | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 2.2 pF 2.4 nF | 229 | B | C C | | | | | | | | CJ | CJ | CJ | CJ | CJ | CJ CJ | DR | DR | DR | DR | DR | DR | DR | EQ FO | EQ FO | EQ FO | EQ FO | EQ FO | EQ FO | EQ FO |
| 2.7 pF | 279 | B | C | D | | | | | | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 3.0 pF | 309 | B | C | D | | | | | | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | | | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 3.6 pF | 369 | B | C | D | Г | T | | | | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 3.9 pF | 399 | B | C | D | | | | | | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 4.3 pF 4.7 pF | 439 | B | C | D | | | | | | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 5.1 pF | 519 | В | С | D | L | | | | | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 5.6 pF | 569 629 | B | C | D | | | | | | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | EQ | EQ FO | EQ FO | EQ | EQ | EQ | EQ |
| 6.8 pF | 689 | B | C | D | | | | | | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 7.5 pF | 759 | B | C | D | | | | | | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 9.1 pF | 919 | B | C | D | T | T | | | | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 10 pF | 100 | | | | F | G | J | К | М | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 11 pF | 110 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 13 pF | 130 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 15 pF | 150 | | | | F | G | J | K | М | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 16 pF 18 pF | 160 | | | | F | G | J | K | M | | CJ | CJ | CI | CJ | CJ | CJ | | DR | DR | DR | DR | DR | | EQ FO | EQ FO | EQ FO | EQ E0 | EQ | EQ | EQ |
| 20 pF | 200 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 22 pF | 220 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 24 p⊦ 27 nF | 240 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | C.J | | DR | DR | | | | | EQ FO | EQ FO | EQ FO | EQ FO | EQ FO | EQ FO | EQ FO |
| 30 pF | 300 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 33 pF | 330 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 36 pF 39 pF | 360 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 43 pF | 430 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 47 pF | 470 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 56 pF | 560 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 62 pF | 620 | | | | F | G | J | K | М | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 68 pF | 680 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 82 pF | 820 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 91 pF | 910 | | | | F | G | J | К | М | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 100 pF | 101 | | | | F | G | J | K | M | CI | CI | CJ | CJ | CJ | CI | CJ | | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 120 pF | 121 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 130 pF | 131 | | | | F | G | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | EQ | EQ | EQ |
| 150 pF 160 pF | 151 | | | | F | G | J | K | M | CJ | CJ CJ | CJ | CJ | CJ | CJ | CJ CJ | DR | DR | DR | DR DR | DR | DR | DR | EQ FO | EQ | EQ FO | EQ FO | EQ | EQ FO | EQ FO |
| 100 pi | | \vdash | Ra | ted | Vol | Itag | e (V | DC) | 141 | 2 | 9 | 25 | 20 | 00 | 00: | 50 | 2 | 16 | 25 25 | 20 | 001 | 00 | 20 | 2 | 16 | 25 [[] | 20 2 | 100 | 00: | :50 ⁷ |
| Capacitance | Cap | \vdash | | Vo | oltar | ge C | ode | | | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A |
| | Code | \vdash | C | ase | e Si | ze/ | Seri | es | | Ē | | (| .0603 | BC . | | | | | C | 0805 | C | | | ١_ | | C | :1206 | | | |



Table 1C - Flexible Termination Capacitance Range/Selection Waterfall(0603 - 1206 Case Sizes) cont.

| | Con | C | as; | e Si | ze/ | Seri | es | | | С | 060 | 3C | - | | | | С | 080 | 5C | | | | | С | 1200 | 5C | | |
|------------------------|-------------|---|------|-------|------------|--------|------------|----|----|----|------|-----|-----|-------------|----------|-----------------|--------|----------------|---------------|----------------|--------------|----------|----------|----------|----------|----------|----------|----------|
| Capacitance | Cap | | | Volta | ge C | ode | | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A |
| | | | Rate | ed Vo | ltage | e (VD | C) | 2 | 16 | 25 | 50 | 100 | 200 | 250 | 2 | 9 | 25 | 20 | <u>ē</u> | 200 | 250 | 2 | 16 | 25 | 50 | 100 | 200 | 250 |
| | | C | ;apa | citan | ce T | olerar | ice | | | | | | | rodu See | ICT AV | allab e 2 fo | or Chi | and C p Thi | nıp i ckne | hicki ss Di | ness mens | code | S | | | | | |
| 180 pF | 181 | | | F | G | J | K M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ |
| 200 pF 220 pF | 201 | | | F | G | J | K M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ |
| 240 pF | 241 | | | F | G | J | КМ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ |
| 270 pF | 271 | | | F | G | J | KM | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ |
| 300 pF 330 pF | 301 | | | F | G | J | K M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ |
| 360 pF | 361 | | | F | G | J | K M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ |
| 390 pF | 391 | | | F | G | J | K M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ |
| 430 pF | 431 | | | F | G | J | K M | | CJ | CJ | CJ | CJ | CJ | CJ | | | | | | | | EQ |
| 510 pF | 511 | | | F | : G | J | KM | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ |
| 560 pF | 561 | | | F | G | J | K M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ |
| 620 pF | 621 | | _ | F | G | J | KM | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ |
| 080 pF 750 nF | 751 | | | F | - G | J | K M | | CJ | CJ | CJ | | | C.I | | | | | DR | DR | DR | EQ FO | EQ FO | EQ FO | EQ FO | EQ FO | EQ | EQ FO |
| 820 pF | 821 | | | F | G | J | K M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | EQ |
| 910 pF | 911 | | | F | G | J | КМ | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DD | DD | DD | EQ |
| 1,000 pF | 102 | | | F | G | J | K M | CJ | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DD | DD | DD | EQ |
| 1,100 pF | 112 | | | F | G | J | KM | CJ | CJ | CJ | CJ | CJ | CH | СН | DR | DR | DR | DR | DR | DR | DR | EQ |
| 1,300 pF | 132 | | | F | G | J | кМ | CJ | CJ | CJ | CJ | CJ | СН | СН | DD | DD | DD | DD | DD | DR | DR | EQ | EQ | EQ | EQ | ER | ER | ER |
| 1,500 pF | 152 | | | F | G | J | KM | CJ | CJ | CJ | CJ | CJ | CH | CH | DD | DD | DD | DD | DD | DR | DR | EQ | EQ | EQ | EQ | ES | ER | ER |
| 1,600 pF | 162 | | | F | G | J | K M | CJ | CI | CJ | CJ | CJ | CH | СН | עע חח | עע חח | ם סט | עע חח | עע חח | | | EQ | EQ | EQ | EQ | ES | ES | ES |
| 2,000 pF | 202 | | | F | : G | J | K M | CJ | CJ | CJ | CJ | CJ | CH | CH | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | ES | ES | ES |
| 2,200 pF | 222 | | | F | G | J | K M | CJ | CJ | CJ | CJ | CJ | СН | СН | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | ET | ET | ET |
| 2,400 pF | 242 | | | F | G | J | KM | CJ | CJ | CJ | CJ | CJ | | | DR | DR | DR | DR | DR | DR | DR | EQ | EQ | EQ | EQ | ER | ER | ER |
| 2,700 pF 3,000 pF | 302 | | | F | G | J | K M | | CJ | CJ | CJ | CJ | | | | | | DR | DR | DR | DR | FR | EQ | FR | FR | FR | ER FO | ER FO |
| 3,300 pF | 332 | | | F | G | J | K M | CJ | CJ | CJ | CJ | CJ | | | DD | DD | DR | DR | DR | DR | DR | ER | ER | ER | ER | ET | EQ | EQ |
| 3,600 pF | 362 | | | F | G | J | KM | CJ | CJ | CJ | CJ | CJ | | | DD | DD | DR | DR | DR | DD | DD | ER | ER | ER | ER | ET | EQ | EQ |
| 3,900 pF | 392 | | | F | G | J | KM | CJ | CJ | CJ | CJ | CJ | | | DS | DS | DR | DR | DR | DD | DD | ER | ER | ER | ER | EF | EQ | EQ |
| 4,300 pF | 432 | | | F | G | J | K M | CJ | CJ | CJ | CJ | CJ | | | DS | DS | DR | DR | DR | DD | DD | ER | ER | ER | ER | ER | EQ | EQ |
| 5,100 pF | 512 | | | F | G | J | K M | CJ | CJ | CJ | CJ | | | | DS | DS | DR | DR | DR | DD | DD | ES | ES | ES | ES | ES | EQ | EQ |
| 5,600 pF | 562 | | | F | G | J | KM | CJ | CJ | CJ | CJ | | | | DR | DR | DR | DR | DR | DD | DD | ES | ES | ES | ES | ES | EQ | EQ |
| 6,200 pF | 622 | | | F | G | J | K M | | CJ | CJ | CJ | | | | | | | DR | DR | DG | DG | EQ |
| 7,500 pF | 752 | | T | F | : G | J | K M | CJ | CJ | CJ | 00 | | | | DR | DR | DR | DR | DR | DG | DG | EQ |
| 8,200 pF | 822 | | | F | G | J | КМ | CJ | CJ | CJ | | | | | DR | DR | DR | DR | DR | DG | DG | ER | ER | EQ | EQ | EQ | ER | ER |
| 9,100 pF | 912 | | | F | G | J | KM | CJ | CJ | CJ | | | | | DR | DR | DR | DR | DR | | | ER | ER | EQ | EQ | EQ | ER | ER |
| 10,000 pF 12,000 pF | 103 | | | F | - G - G | J | K M | CJ | CJ | CJ | | | | | | | | | | | | FO | EQ FO | EQ FO | EQ FO | EQ FO | ER | ER ES |
| 15,000 pF | 153 | | | F | G | J | K M | CJ | CJ | CJ | | | | | DR | DR | DR | DD | DG | | | EQ | EQ | EQ | EQ | EQ | EF | EF |
| 18,000 pF | 183 | | | F | G | J | КМ | | | | | | | | DR | DR | DR | DD | | | | EQ | EQ | EQ | EQ | EQ | EH | EH |
| 22,000 pF | 223 | | | F | G | J | KM | | | | | | | | DD | DD | DD | DF | | | | EQ | EQ | EQ | EQ | ER | EH | EH |
| 33.000 pF | 333 | | | F | G | J | K M | | | | | | | | DF | DF | DF | | | | | EQ | EQ | EQ | EQ | ET | | |
| 39,000 pF | 393 | | Т | F | G | J | K M | | | | | | | | DG | DG | DG | | | | | ER | ER | ER | ET | EH | | |
| 47,000 pF | 473 | | | F | G | J | K M | | | | | | | | DG | DG | DG | | | | | ER | ER | ER | ET | EH | | |
| 56,000 pF | 563 683 | | | F | G | J | K∣M ĸ∣m | | | | | | | | | | | | | | | ES | ES | ES | EF FH | | | |
| 82,000 pF | 823 | | | F | G | J | K M | | | | | | | | | | | | | | | EH | EH | EH | EH | | | |
| 100,000 pF | 104 | | | F | G | J | K M | | | | | | | | | | | | | | | EH | EH | EH | | | | |
| | | | Rate | ed Vo | ltage | e (VD | C) | 9 | 16 | 25 | 50 | 100 | 200 | 250 | 9 | 16 | 25 | 50 | 100 | 200 | 250 | 9 | 16 | 25 | 50 | 100 | 200 | 250 |
| Capacitance | Cap Code | | | Volta | ge C | ode | | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A | 8 | 4 | 3 | 5 | 1 | 2 | A |
| | | | Ca | se Si | ize/S | Serie | S | | | C | 0603 | BC | | | | | C | 0805 | C | | | | | C | 1206 | C | | |



Table 1D – Flexible Termination Capacitance Range/Selection Waterfall (1210 – 2220 Case Sizes)

| | 0 | | Ca | se | Siz | :e/\$ | Sei | ries | 5 | | | С | 1210 | C | | | | C18 | 12C | | C | 2220 | C |
|------------------|-------------|------------------|-----|------|------|-----------|-------|------|-------|----|----|-----|-------|-------|--------|--------|--------|--------|------|-------|-----|------|-----|
| Capacitance | Cap | Г | | Vo | ltag | e Co | ode | | | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 5 | 1 | 2 |
| | Code | | Ra | ted | Volt | tage | e (VI | DC) | | 9 | 16 | 25 | 50 | 8 | 00 | 50 | 50 | 00 | 00 | 50 | 50 | 8 | 00 |
| | | F | Car | acit | 200 | - - Tr | lor | nce | | | | Pro | oduct | Avai | labili | ty and | d Chij | p Thio | knes | s Co | des | | ~ |
| 10.01.5+ | 100 010+ | | | | | | | | | | EN | S | ee Ta | ble 2 | for C | hip 1 | hick | ness | Dime | nsion | s | | |
| 1.0 - 9.1 pF* | 110 | B | C | D | | | | | | | | | | | | | | | | | | | |
| 1.1 µF 1.2 nF | 129 | B | C | | | | | | | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 1.3 pF | 139 | В | C | D | | | | | | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 1.5 pF | 159 | В | C | D | | | | | | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 1.6 pF | 169 | В | C | D | | | | | | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 1.8 pF | 189 | В | C | D | | | | | | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 2.0 pF | 209 | В | C | D | | | | | | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 2.2 pF | 229 | B | C | D | | | | | | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 2.4 pF | 249 | B | C | D | | | | | | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 2.7 pF 2.0 pE | 2/9 | | | ם | | | | | | | | | | | | | | | | | | | |
| 3.3 nF | 339 | B | C | D | | | | | | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 3.6 pF | 369 | В | C | D | | | | | | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 3.9 pF | 399 | В | C | D | | | | | | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 4.3 pF | 439 | В | С | D | | | | | | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 4.7 pF | 479 | В | C | D | | | | | | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 5.1 pF | 519 | В | C | D | | | | | | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 5.6 pF | 569 | В | C | D | | | | | | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 6.2 pF | 629 | B | C | D | | | | | | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 6.8 pF | 689 | B | C | D | | | | | | | | | | | | | | | | | | | |
| 7.5 µF | 759 | | | | | | | | | | | | | | | | | | | | | | |
| 0.2 pr 91 nF | 919 | B | C | D | | | | | | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 10 pF | 100 | ľ | ľ | | F | G | J | к | м | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 11 pF | 110 | | | | F | G | J | К | М | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 12 pF | 120 | | | | F | G | J | к | м | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 13 pF | 130 | | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 15 pF | 150 | | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 16 pF | 160 | | | | F | G | J | K | Μ | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 18 pF | 180 | | | | F | G | J | K | Μ | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 20 pF | 200 | | | | F | G | J | K | Μ | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 22 pF | 220 | | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 24 pF | 240 | | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 27 pF | 2/0 | | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 30 pr | 300 | | | | | 6 | J | K | | | | | | | | | | | | | | | |
| 36 pF | 360 | 1 | | | F | C | J | ĸ | M | | | | | | | | | | | | | | 1 |
| 30 pF 39 nF | 300 | | | | F | G | | K | M | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 43 nF | 430 | 1 | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | | | | | | | 1 |
| 47 pF | 470 | 1 | | | F | G | J | K | М | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 51 pF | 510 | | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 56 pF | 560 | | | | F | G | J | K | М | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| | | | Ra | ted | Volt | tage | e (VI | DC) | | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | 50 | 100 | 200 |
| Capacitance | Cap Code | | | Vo | ltag | e Co | ode | | | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 5 | 1 | 2 |
| | | Case Size/Series | | | | | | | ;1210 | C | | | | C18 | 12C | | C | 2220 | C | | | | |



Table 1D - Flexible Termination Capacitance Range/Selection Waterfall(1210 - 2220 Case Sizes) cont.

| | 0 | C | Case | e Siz | :e/ | Sei | ries | • | | | С | 1210 | C | | | | C18 | 12C | | C | 2220 | C |
|----------------------|-------------|-------------------------|-------|--------|------|-------|--------|---|----|-----|-----|-------|-------|--------|--------|--------|--------|------|-------|-----|------|-----|
| Capacitance | Cap | | ١ | /oltag | e Co | ode | | | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 5 | 1 | 2 |
| | Code | | Rate | d Vol | tage | e (VI | DC) | | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 500 | 250 | 50 | 100 | 200 |
| | | | Capad | itanc | e To | olera | ance | | | | Pro | duct | Avai | labili | ty and | l Chij | p Thio | knes | s Co | des | | |
| 60 mF | 600 | | | Г | C | - | K | M | | | | ee Ta | ble 2 | tor C | Thip 1 | hick | ness | Dime | nsion | | | |
| 62 pF | 620 | | | | G | J | ĸ | | | | | | | | | | | | | | | |
| 00 µF | 750 | | | | G | J | N V | M | | | | | | | | | | | | | | |
| 82 nF | 820 | | | F | G | | ĸ | M | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 91 nF | 910 | | | F | G | J | ĸ | м | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 100 pF | 101 | | | F | G | J | ĸ | м | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 110 pF | 111 | | | F | G | J | ĸ | м | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 120 pF | 121 | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 130 pF | 131 | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 150 pF | 151 | | | F | G | J | к | м | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 160 pF | 161 | | | F | G | J | К | М | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 180 pF | 181 | | | F | G | J | К | М | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 200 pF | 201 | | | F | G | J | K | М | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 220 pF | 221 | | | F | G | J | K | М | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 240 pF | 241 | | | F | G | J | K | М | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 270 pF | 271 | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 300 pF | 301 | | | F | G | J | K | М | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 330 pF | 331 | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 360 pF | 361 | | | F | G | J | K | Μ | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 390 pF | 391 | | | F | G | J | K | Μ | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 430 pF | 431 | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | | | | | | | |
| 470 pF | 471 | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | | | |
| 510 pF | 511 | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | | | |
| 560 pF | 561 | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | | | |
| 620 pF | 621 | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | | | |
| 680 pF | 681 | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | | | |
| 750 pF | 751 | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | | | |
| 820 pF | 821 | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | | | |
| 910 pF | 911 | | | | G | J | K | M | | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | | | |
| 1,000 pF | 102 | | | | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | GB | GB | GB | GB | | | |
| 1,100 pF | 112 | | | F | G | J | r v | | | | | | | | | | GB | GB | GB | | | |
| 1,200 pF | 122 | | | F | G | J | K | M | EN | EN | EN | EN | EN | FN | FIN | GB | GB | GB | GB | | | |
| 1,500 pr 1 500 pF | 152 | | | F | 6 | | ĸ | M | EN | EN | FN | FN | EN | FE | FE | GR | GR | GR | GB | | | |
| 1,500 pF | 162 | | | F | G | | K | M | FN | FN | FN | FN | FN | FF | FF | GB | GB | GB | GB | | | |
| 1,000 pT | 182 | | | F | G | J | ĸ | M | FN | FN | FN | FN | FN | FF | FF | GB | GB | GB | GB | | | |
| 2.000 pF | 202 | | | F | G | Ĵ | K | M | FN | FN | FN | FN | FO | FE | FE | GB | GB | GB | GB | | | |
| 2,200 pF | 222 | | | F | G | J | K | M | FN | FN | FN | FN | FO | FZ | FZ | GB | GB | GB | GB | | | |
| 2,400 pF | 242 | | | F | G | J | K | M | FN | FN | FN | FN | FQ | FQ | FQ | | | | | | | |
| 2,700 pF | 272 | | | F | G | J | K | М | FN | FN | FN | FN | FQ | FQ | FQ | GB | GB | GB | GB | | | |
| 3,000 pF | 302 | | | F | G | J | K | М | FN | FN | FN | FN | FQ | FA | FA | | | | | | | |
| 3,300 pF | 332 | | | F | G | J | K | Μ | FN | FN | FN | FN | FA | FA | FA | GB | GB | GB | GB | | | |
| | | | Rate | d Vol | tage | e (VI | DC) | | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | 50 | 100 | 200 |
| Capacitance | Cap Code | | ١ | /oltag | e Co | ode | | | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 5 | 1 | 2 |
| | | Case Size/Series C1210C | | | | | | | | C18 | 12C | | C | 2220 | C | | | | | | | |



Table 1D - Flexible Termination Capacitance Range/Selection Waterfall(1210 - 2220 Case Sizes) cont.

| | Can | C | ase | e Siz | :e/\$ | Sei | ries | 5 | | | C | 1210 | C | | | | C18 | 12C | | C | 2220 |)C |
|-------------|------|---|------|--------|-------|------|------|---|----|----|-----|-------|--------|--------|--------|-------|--------|------|-------|-----|------|-----|
| Capacitance | Code | | ١ | /oltag | e Co | ode | | | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 5 | 1 | 2 |
| | Coue | | Rate | d Volt | tage | (VI |)C) | | 9 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | 50 | 100 | 200 |
| | | C | apa | itanc | e To | lera | ance | | | | Pro | oduct | Avai | labili | ty an | l Chi | o Thio | knes | s Co | des | | |
| 0.000 F | 0(0 | | | | | | | | - | | S | ee Ta | able 2 | for C | Chip 1 | hick | ness | Dime | nsion | s | | |
| 3,600 pF | 362 | | | | 6 | J | K | | | FN | | FN | FA | FA | FA | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| 3,900 pF | 392 | | | | 6 | J | K | M | | FN | | FN | FA | FA | FA | GB | GB | GB | GB | | | |
| 4,300 pF | 432 | | | | G | J | K | M | FN | FN | | FN | FA | FA | FA | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| 4,700 pF | 4/2 | | | | G | J | K | M | FA | FA | FA | FA | FZ | FZ | FZ | GB | GB | GD | GD | | | |
| 5,100 pF | 512 | | | F | G | J | K | M | FN | FN | FN | FN | FZ | FZ | FZ | 0.0 | 0.0 | 011 | 011 | | | |
| 5,600 pF | 562 | | | F | G | J | K | M | | FN | FN | FN | FZ | FZ | FZ | GB | GB | GH | GH | | | |
| 6,200 pF | 622 | | | F | G | J | K | M | FN | FN | FN | FN | FZ | FN | FN | 0.0 | 0.0 | | | | 15 | |
| 6,800 pF | 682 | | | F | G | J | K | M | FN | FN | FN | FN | FZ | FN | FN | GB | GB | GJ | GJ | JE | JE | JB |
| 7,500 pF | /52 | | | F | G | J | K | M | FQ | FQ | FQ | FQ | FQ | FN | FN | | | | | | | |
| 8,200 pF | 822 | | | F | G | J | K | M | FQ | FQ | FQ | FQ | FQ | FN | FN | GB | GH | GB | GB | JE | JE | JB |
| 9,100 pF | 912 | | | | G | J | K | M | FE | FE | FE | FE | FE | FN | FN | | | | | | | |
| 10,000 pF | 103 | | | F | G | J | K | M | FA | FA | FA | FA | FA | FN | FN | GB | GH | GB | GB | JE | JE | JB |
| 12,000 pF | 123 | | | F | G | J | K | M | FN | FN | FN | FN | FN | FN | FN | GB | GG | GB | GB | JE | JE | JB |
| 15,000 pF | 153 | | | F | G | J | K | M | FN | FN | FN | FN | FN | FQ | FQ | GB | GB | GB | GB | JE | JE | JB |
| 18,000 pF | 183 | | _ | F | G | J | K | M | FN | FN | FN | FN | FN | FQ | FQ | GB | GB | GB | GB | JE | JE | JB |
| 22,000 pF | 223 | | | F | G | J | K | M | FN | FN | FN | FN | FN | FA | FA | GB | GB | GB | GB | JE | JB | JB |
| 27,000 pF | 273 | | | F | G | J | K | M | FN | FN | FN | FN | FN | FZ | FZ | GB | GB | GB | GB | JE | JB | JB |
| 33,000 pF | 333 | | | F | G | J | K | M | FN | FN | FN | FN | FN | FU | FU | GB | GB | GB | GB | JB | JB | JB |
| 39,000 pF | 393 | | | F | G | J | K | M | FN | FN | FN | FN | FE | FU | FU | GB | GB | GB | GB | JB | JB | JB |
| 47,000 pF | 473 | | | F | G | J | K | M | FN | FN | FN | FN | FE | FJ | FJ | GB | GB | GD | GD | JB | JB | JB |
| 56,000 pF | 563 | | | F | G | J | K | M | FN | FN | FN | FN | FA | | | GB | GB | GD | GD | JB | JB | JB |
| 68,000 pF | 683 | | | F | G | J | K | Μ | FN | FN | FN | FQ | FZ | | | GB | GB | GK | GK | JB | JB | JB |
| 82,000 pF | 823 | | | F | G | J | K | М | FQ | FQ | FQ | FA | FU | | | GB | GB | GM | GM | JB | JB | JB |
| 100,000 pF | 104 | | | F | G | J | K | М | FE | FE | FE | FZ | FM | | | GB | GD | GM | GM | JB | JB | JD |
| 120,000 pF | 124 | | | F | G | J | K | М | FZ | FZ | FZ | FU | | | | GB | GH | | | JB | JB | JD |
| 150,000 pF | 154 | | | F | G | J | K | Μ | FU | FU | FU | FM | | | | GD | GN | | | JB | JB | JG |
| 180,000 pF | 184 | | | F | G | J | K | Μ | FJ | FJ | FJ | | | | | GH | | | | JB | JD | JG |
| 220,000 pF | 224 | | | F | G | J | K | М | | | | | | | | GK | | | | JB | JD | JL |
| 270,000 pF | 274 | | | F | G | J | K | Μ | | | | | | | | | | | | JB | JF | |
| 330,000 pF | 334 | | | F | G | J | K | Μ | | | | | | | | | | | | JD | JG | |
| 390,000 pF | 394 | | | F | G | J | K | М | | | | | | | | | | | | JG | | |
| 470,000 pF | 474 | | | F | G | J | K | Μ | | | | | | | | | | | | JG | | |
| | Con | | Rate | d Volt | tage | (VI |)) | | 9 | 16 | 25 | 50 | 100 | 200 | 250 | 50 | 100 | 200 | 250 | 50 | 100 | 200 |
| Capacitance | Code | | 1 | /oltag | e Co | ode | | | 8 | 4 | 3 | 5 | 1 | 2 | A | 5 | 1 | 2 | A | 5 | 1 | 2 |
| | | | Cas | e Siz | e/S | eri | es | | | | C | 1210 | C | | | | C18 | 12C | | C | 2220 | C |



Performance and Reliability: Test Methods and Conditions

| Test | Reference | | Tes | st Condition | | Limits |
|---|-------------------|----------------|--|---|-----------------|---|
| Visual and Mechanical | KEMET Internal | No | defects that m | ay affect performance (1 | I0X) | Dimensions according KEMET Spec Sheet |
| Capacitance (Cap) | KEMET Internal | * See | (Frequen Voltag Freque Voltag part number s | C \leq 1,000 pF cy: 1 MHz ±100 kHz e*:1.0 V _{rms} ±0.2 V C > 1,000 pF ncy: 1 kHz ±50 Hz je: 1.0 V _{rms} ±0.2 V specification sheet for vo | oltage | Within Tolerance |
| Dissipation Factor (DF) | KEMET Internal | * See |) Frequen Voltag (Freque Voltag part number s | C ≤ 1,000 pF cy: 1 MHz ±100 kHz e*:1.0 V _{rms} ±0.2 V C > 1,000 pF ncy: 1 kHz ±50 Hz ge: 1.0 V _{rms} ±0.2 V specification sheet for vo | ltage" | Within Specification Dissipation factor (DF) maximum limit at 25°C = 0.1% |
| | | | | | | Within Specification |
| Insulation Resistance (IR) | KEMET Internal | Rateo | l voltage appli | ed for 120 ±5 seconds at | 25°C | To obtain IR limit, divide MΩ-μF value by the capacitance and compare to GΩ limit. Select the lower of the two limits. |
| | | | | | | 1,000 megaohm microfarads or 100 GΩ. |
| Temperature Coefficient of Capacitance | KEMET Internal | Capac * See | citance change V e part number s Step 1 | e with reference to +25°C /DC applied. specification sheet for vo Temperature (°C) +25°C | and 0 oltage | Within Specifcation ±30 ppm/°C *Except :1210 Cap Code >= 682; 1812 Cap Code >= 471; 2220 Cap Code >=682 ±30 ppm/°C from -55°C to +125°C: |
| (100) | | | 2 | -55°C | | ±60 ppm/°C from +125°C to +150°C |
| | | | 3 | +25°C (Reference) +150°C | | |
| Dielectric Withstanding Voltage (DWV) | KEMET Internal | | 250% (5 ±1 second not ea | of rated voltage s and charge/discharge cceeding 50 mA) | | Cap: Initial Limit DF: Initial Limit IR: Initial Limit Withstand test voltage without insulation breakdown or damage. |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | KEMET Internal | м | aximum % cap | acitance loss/decade ho | our | 0% Loss/Decade Hour |



Performance and Reliability: Test Methods and Conditions cont.

| Test | Reference | Test Condition | Limits |
|-----------------------------|---------------------------|--|---|
| Terminal Strength | KEMET Internal | Shear stress test per specific case size, Time: 60 ± 1 secondsCase SizeForce04023N06035N08059N ≥ 1206 18N | No evidence of mechanical damage |
| Board Flex | AEC-Q200-005 | 3.0 mm minimum Test time: 60± 5 seconds Ramp time: 1 mm/second | No evidence of mechanical damage |
| Solderability | J-STD-002 | Condition: 4 hours ± 15 minimum at 155°C dry bake apply all methods Test 245 ± 5°C (SnPb & Pb-Free) | Visual Inspection. 95% coverage on termination. No leaching |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to +150°C) 2 – 3 cycles per hour Soak Time 1 or 5 minutes | Measurement at 24 hours ±4 hours after test conclusion. Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and 200 VDC maximum. Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5% |
| Moisture Resistance | MIL-STD-202 Method 106 | Number of cycles required 10, 24 hours per cycle. Steps 7a and 7b not required | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5% |
| Thermal Shock | MIL-STD-202 Method 107 | Number of cycles required 5, (-55°C to 150°C) Dwell time 15 minutes. | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| High Temperature Life | MIL-STD-202 | 1,000 hours at 150°C with 2 X rated voltage applied | Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift |
| Storage Life | Method 108 | 1,000 hours at 150°C, Unpowered | IR: 10% of Initial Limit DF: 0.5% |



Performance and Reliability: Test Methods and Conditions cont.

| Test | Reference | Test Condition | Limits |
|---------------------------|---------------------------|---|---|
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Test from 10 – 2,000 Hz | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Mechanical Shock | MIL-STD-202 Method 213 | 1,500 g's 0.5 ms Half-sine, Velocity Change 15.4 feet/second (Condition F) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents. | Visual Inspection 10X Readable marking, no decoloration or stains. No physical damage. |

Table 2A – Standard Termination Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic (| Quantity |
|-----------|-------------------|-------------|---------|----------------------|-----------|----------|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| BB | 0402 | 0.50 ± 0.05 | 10,000 | 50,000 | 0 | 0 |
| BD | 0402 | 0.55 ± 0.05 | 10,000 | 50,000 | 0 | 0 |
| CF | 0603 | 0.80 ± 0.07 | 4,000 | 15,000 | 0 | 0 |
| СН | 0603 | 0.85 ± 0.07 | 4,000 | 10,000 | 0 | 0 |
| DN | 0805 | 0.78 ± 0.10 | 4,000 | 15,000 | 0 | 0 |
| DP | 0805 | 0.90 ± 0.10 | 4,000 | 15,000 | 0 | 0 |
| DE | 0805 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| DF | 0805 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EB | 1206 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| EC | 1206 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| ED | 1206 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| EE | 1206 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EH | 1206 | 1.60 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FB | 1210 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| FC | 1210 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| FE | 1210 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FF | 1210 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FG | 1210 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| FH | 1210 | 1.55 ± 0.15 | 0 | 0 | 2,000 | 8,000 |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FJ | 1210 | 1.85 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GD | 1812 | 1.25 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GH | 1812 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GG | 1812 | 1.55 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GK | 1812 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GJ | 1812 | 1.70 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GN | 1812 | 1.70 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GM | 1812 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| JB | 2220 | 1.00 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JD | 2220 | 1.30 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JE | 2220 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JF | 2220 | 1.50 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JG | 2220 | 1.70 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JL | 2220 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic | Quantity |

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

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Table 2B - Flexible Termination Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic (| Quantity |
|-----------|-------------------|-------------|---------|----------------------|-----------|----------|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| CJ | 0603 | 0.80 ± 0.15 | 4,000 | 15,000 | 0 | 0 |
| CH | 0603 | 0.85 ± 0.07 | 4,000 | 10,000 | 0 | 0 |
| DR | 0805 | 0.78 ± 0.20 | 0 | 0 | 4,000 | 10,000 |
| DD | 0805 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| DS | 0805 | 1.00 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| DF | 0805 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EQ | 1206 | 0.78 ± 0.20 | 0 | 0 | 4,000 | 10,000 |
| ER | 1206 | 0.90 ± 0.20 | 0 | 0 | 4,000 | 10,000 |
| ES | 1206 | 1.00 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| ET | 1206 | 1.10 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EH | 1206 | 1.60 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FN | 1210 | 0.78 ± 0.20 | 0 | 0 | 4,000 | 10,000 |
| FQ | 1210 | 0.90 ± 0.20 | 0 | 0 | 4,000 | 10,000 |
| FE | 1210 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FA | 1210 | 1.10 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| FZ | 1210 | 1.25 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| FU | 1210 | 1.55 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FJ | 1210 | 1.85 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GD | 1812 | 1.25 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GH | 1812 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GG | 1812 | 1.55 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GK | 1812 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GJ | 1812 | 1.70 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GN | 1812 | 1.70 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GM | 1812 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| JB | 2220 | 1.00 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JD | 2220 | 1.30 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JE | 2220 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JF | 2220 | 1.50 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JG | 2220 | 1.70 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JL | 2220 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic | Quantity |

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".



Table 2C – Bulk Packaging Quantities

| Deeke | ing Ture | Loose Packaging | | | | |
|----------|-------------------------|-------------------------------------|------------------|--|--|--|
| Раска | ging type | Bulk Bag (default) | | | | |
| Packagi | ing C-Spec ¹ | N, | N/A ² | | | |
| Cas | se Size | Packaging Quantities (pieces/unit p | | | | |
| EIA (in) | Metric (mm) | Minimum | Maximum | | | |
| 0402 | 1005 | | | | | |
| 0603 | 1608 | | | | | |
| 0805 | 2012 | | 50,000 | | | |
| 1206 | 3216 | | | | | |
| 1210 | 3225 | 1 | | | | |
| 1808 | 4520 | | | | | |
| 1812 | 4532 | | | | | |
| 1825 | 4564 | _ | 20,000 | | | |
| 2220 | 5650 | | | | | |
| 2225 | 5664 | | | | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial Grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive Grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3 – Standard Termination Chip Capacitor Land Pattern DesignRecommendations per IPC-7351

| EIA Size Code | Metric Size Code | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | |
|---------------------|------------------------|--|------|------|------|--|------|------|------|---|------|------|------|------|------|------|
| ooue | oouc | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | С | Y | X | V1 | V2 |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 |
| 1210 ¹ | 3225 | 1.50 | 1.60 | 2.90 | 5.60 | 3.90 | 1.40 | 1.40 | 2.80 | 4.70 | 3.30 | 1.30 | 1.20 | 2.70 | 4.00 | 3.00 |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 |
| 2220 | 5650 | 2.75 | 1.70 | 5.50 | 8.20 | 6.50 | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | 2.55 | 1.30 | 5.30 | 6.60 | 5.60 |

¹ Only for capacitance values $\geq 22 \ \mu F$.

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1210 case size.





Table 4 – Flexible Termination Chip Capacitor Land Pattern Design Recommendations per IPC-7351 (mm)

| EIA Size Code | Metric Size Code | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | |
|---------------------|------------------------|--|------|------|------|--|------|------|------|---|------|------|------|------|------|------|
| ooue | ooue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0603 | 1608 | 0.85 | 1.25 | 1.10 | 4.00 | 2.10 | 0.75 | 1.05 | 1.00 | 3.10 | 1.50 | 0.65 | 0.85 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 0.99 | 1.44 | 1.66 | 4.47 | 2.71 | 0.89 | 1.24 | 1.56 | 3.57 | 2.11 | 0.79 | 1.04 | 1.46 | 2.42 | 1.81 |
| 1206 | 3216 | 1.59 | 1.62 | 2.06 | 5.85 | 3.06 | 1.49 | 1.42 | 1.96 | 4.95 | 2.46 | 1.39 | 1.22 | 1.86 | 4.25 | 2.16 |
| 1210 | 3225 | 1.59 | 1.62 | 3.01 | 5.90 | 4.01 | 1.49 | 1.42 | 2.91 | 4.95 | 3.41 | 1.39 | 1.22 | 2.81 | 4.25 | 3.11 |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 |
| 1812 | 4532 | 2.10 | 1.80 | 3.60 | 7.00 | 4.60 | 2.00 | 1.60 | 3.50 | 6.10 | 4.00 | 1.90 | 1.40 | 3.40 | 5.40 | 3.70 |
| 2220 | 5650 | 2.85 | 2.10 | 5.50 | 8.80 | 6.50 | 2.75 | 1.90 | 5.40 | 7.90 | 5.90 | 2.65 | 1.70 | 5.30 | 7.20 | 5.60 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805, and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Terminat | ion Finish |
|--|-----------------------|-----------------------|
| Fiomereature | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate (T _L to T _P) | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T _L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T_p to T_L)$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.

Construction

Standard Termination





Construction cont.

Flex Termination



Capacitor Marking (Optional)

Laser marking option is not available on:

- COG, U2J, X8G, X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punched Paper | | |
|----------------------|--------------|---------|--------------------|--------------------------|----------|--|
| EIA Case Size | Size (W)* | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | | Pitch | (P ₁)* | Pitch (P ₁)* | | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 | |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | |
| Array 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions — Millimeters (Inches) | | | | | | | | | | | |
|--|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|--|--|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum | | | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | | |
| 16 mm | | (0.059) | | | | (1.181) | | | | | | |
| Variable Dimensions — Millimeters (Inches) | | | | | | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ | | | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | Note 5 | | | | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_n and B_n are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | | |
|--|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|--|--|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | | | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | | | | |
| Variable Dimensions — Millimeters (Inches) | | | | | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | | | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | | | | |
| 8 mm Single (4 mm) | | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | Note i | | | | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength | | | | |
|--------------|----------------------------------|--|--|--|--|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) | | | | |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) | | | | |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|-----------|--|---------------------------------------|--|--|--|--|--|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | | | | | |
| 8 mm | 178 ±0.20 | | | | | | | | | | |
| 12 mm | Or 220 10 20 | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | | | | | |
| 16 mm | (13.000 ±0.008) | | | · / | | | | | | | |
| | Variable Dimensions — Millimeters (Inches) | | | | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | | | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber



High Voltage Surface Mount Series, MIL-PRF-49467 Screened, 500 - 5,000 VDC (Industrial Grade)



Overview

KKEMET's High Voltage Surface Mount MIL-PRF-49467 Screened ceramic capacitors are designed with COG and X7R dielectrics which feature a 125°C maximum operating temperature. These devices are made using robust designs and screened to MIL-PRF-49467 Group A to meet the demands of higher reliability applications. Group B is available upon request. These devices are ideal for high voltage power supplies, DC/DC conversion and well suited for timing, resonant, bypass, and decoupling applications. These high voltage capacitors are widely used in industries related to semiconductors, telecommunications, test/ diagnostic equipment and power/grid.

The High Voltage Surface MIL-PRF-49467 Screened Series is part of KEMET's Harsh Environment PME (Precious Metal Electrode) portfolio which is ideal for industrial and high reliability applications.

Benefits

- Operating temperature range of -55°C to +125°C
- Capacitance range from 330 pF 2.9 μF in X7R
- Capacitance range from 12 pF 0.1 μF in C0G
- DC voltage ratings of 500 V, 1 kV, 2 kV, 3 kV, 4 kV, 5 kV
- High thermal stability



Applications

- · Downhole exploration and mining
- Aerospace engine compartments
- Switch mode power supplies
- DC/DC Converters
- · Measuring equipment
- · Inverters
- High voltage coupling



Ordering Information

| 45 | 4540 B 4 | | 472 | Μ | 202 | Р | Μ | |
|--|--|-----------------------------------|--|--|---|---|---|---|
| Case | e Size | Dielectric | Capacitance Code | Tolerance | Voltage | Terminal Material | Test Level | Packaging |
| 1515 1812 1825 2020 2225 2520 3333 | 3530 4040 4540 5440 5550 6560 | B, R = X7R N = C0G (NPO)/BP | Two significant digits and number of zeros | J = ±5% (COG Only) K = ±10% M = ±20% P = 0/+100% Z = -20%/+80% | Two significant digits and number of zeroes (i.e. 202 = 2,000 V) | P = PdAg S = Ag E = Ag/Ni/ SnPb Plated C = Ag/Ni/Sn Plated | Blank = No screening M = MIL-PRF-49467 Group A Screening (subgroup 1) except Corona | Blank = Waffle Tray 7189 = 7" Reel 7289 = 13" Reel |

¹ Additional capacitance tolerance offerings may be available. Contact KEMET for details.

² Please refer to the Construction section in the datasheet.

Dimensions – Inches (Millimeters)



| Series | Style/Size | L Length | W Width | T Thickness | B Bandwidth |
|--------|------------|----------------------------|---------------------------|----------------|---------------------------|
| ΗV | 1515 | 0.150 ±0.015 (3.81 ±0.38) | 0.150 ±0.015 (3.81 ±0.38) | 0.140 (3.55) | 0.020 ±0.010 (0.51 ±0.25) |
| | 1812 | 0.180 ±0.020 (4.57 ±0.51) | 0.120 ±0.015 (3.05 ±0.38) | 0.100 (2.54) | 0.025 ±0.015 (0.64 ±0.38) |
| | 1825 | 0.180 ±0.020 (4.57 ±0.51) | 0.250 ±0.020 (6.35 ±0.51) | 0.160 (4.07) | 0.025 ±0.015 (0.64 ±0.38) |
| | 2020 | 0.200 ±0.020 (5.08 ±0.51) | 0.200 ±0.020 (5.08 ±0.51) | 0.180 (3.55) | 0.025 ±0.015 (0.64 ±0.38) |
| | 2225 | 0.220 ±0.020 (5.59 ±0.51) | 0.250 ±0.020 (6.35 ±0.51) | 0.200 (5.08) | 0.025 ±0.015 (0.64 ±0.38) |
| | 2520 | 0.250 ±0.020 (6.35 ±0.51) | 0.200 ±0.020 (5.08 ±0.51) | 0.180 (4.57) | 0.045 ±0.015 (1.14 ±0.38) |
| | 3333 | 0.330 ±0.030 (8.38 ±0.76) | 0.330 ±0.030 (8.38 ±0.76) | 0.220 (5.59) | 0.045 ±0.015 (1.14 ±0.38) |
| | 3530 | 0.350 ±0.030 (8.89 ±0.76) | 0.300 ±0.030 (7.62 ±0.76) | 0.220 (5.59) | 0.045 ±0.015 (1.14 ±0.38) |
| | 4040 | 0.400 ±0.030 (10.2 ±0.76) | 0.400 ±0.030 (10.2 ±0.76) | 0.220 (5.59) | 0.045 ±0.015 (1.14 ±0.38) |
| | 4540 | 0.450 ±0.030 (11.43 ±0.76) | 0.400 ±0.030 (10.2 ±0.76) | 0.220 (5.59) | 0.045 ±0.015 (1.14 ±0.38) |
| | 5440 | 0.540 ±0.030 (13.7 ±0.76) | 0.400 ±0.030 (10.2 ±0.76) | 0.220 (5.59) | 0.045 ±0.015 (1.14 ±0.38) |
| | 5550 | 0.550 ±0.030 (14.0 ±0.76) | 0.500 ±0.030 (12.7 ±0.76) | 0.220 (5.59) | 0.045 ±0.015 (1.14 ±0.38) |
| | 6560 | 0.650 ±0.030 (16.5 ±0.76) | 0.600 ±0.030 (15.2 ±0.76) | 0.220 (5.59) | 0.045 ±0.015 (1.14 ±0.38) |


Table 1A – HV X7R Waterfall

| 0 | 0: | 1 | 151 | 5 | 1 | 181 | 2 | | 18 | 25 | | | 20 | 20 | | | 22 | 25 | | | 25 | 20 | | | 33 | 33 | | | 3 | 53 | 0 | |
|---------------------|---------------------|------------------|-------|-------|----------|----------|-------|-----|----------|-------|-------|-----|----------|-------|----------|-----|----------|-------|-------|-----|-------|-------|-------|--------|-------|-------|-------|-----|-------|-------|--------------|----------|
| Case | Size | | | | | | | | | | | | | | | Vo | olta | ge | | | | | | | | | | | | | | |
| Capacitance (pF) | Capacitance Code | 200 | 1,000 | 2,000 | 500 | 1,000 | 2,000 | 500 | 1,000 | 2,000 | 3,000 | 500 | 1,000 | 2,000 | 3,000 | 500 | 1,000 | 2,000 | 3,000 | 500 | 1,000 | 2,000 | 3,000 | 500 | 1,000 | 2,000 | 3,000 | 500 | 1,000 | 2,000 | 3,000 | 4,000 |
| 330 pF | 331 | X | Х | Х | | | | | | | | | | | | | | _ | | | | | | | | | | | | | | _ |
| 390 pF | 391 | Х | X | Х | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | |
| 470 pF | 471 | Х | X | X | 1 | | | Х | X | Х | Х | 1 | | | | | | | | | | | | | | | | | | | | |
| 560 pF | 561 | Х | Х | Х | | | | Х | X | X | Х | Х | X | X | X | | | | | | | | | | | | | | | | | |
| 680 pF | 681 | Х | Х | Х | | | | Х | X | X | Х | Х | X | X | X | | | | | Х | Х | Х | Х | | | | | | | | | |
| 820 pF | 821 | Х | Х | Х | | | | Х | Х | X | Х | Х | Х | X | X | Х | X | Х | Х | Х | Х | Х | Х | | | | | | | | | |
| 1,000 pF | 102 | Х | Х | Х | X | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | | | | | Х | Х | Х | Х | Х |
| 1,200 pF | 122 | Х | Х | Х | X | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | | | | | Х | Х | Х | Х | Х |
| 1,500 pF | 152 | Х | Х | Х | X | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | | | | | Х | Х | Х | Х | Х |
| 1,800 pF | 182 | Х | Х | Х | X | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | | | | | Х | Х | Х | Х | Х |
| 2,200 pF | 222 | Х | X | X | X | X | Х | Х | X | X | X | Х | X | X | X | Х | X | X | X | Х | Х | X | Х | Х | Х | Х | Х | Х | X | Х | Х | Х |
| 2,700 pF | 272 | Х | X | Х | X | X | Х | Х | X | X | Х | Х | X | X | X | Х | X | X | X | Х | Х | X | Х | Х | X | Х | X | Х | Х | X | Х | X |
| 3,300 pF | 332 | Х | X | X | Х | X | | Х | X | X | X | Х | X | X | X | Х | X | X | X | Х | X | X | X | Х | X | Х | X | Х | X | X | Х | X |
| 3,900 pF | 392 | Х | X | X | Х | X | | Х | X | X | | Х | X | X | X | Х | X | X | X | Х | X | X | X | Х | X | Х | X | Х | X | X | Х | X |
| 4,700 pF | 472 | Х | Х | | Х | X | | Х | X | Х | | Х | X | X | X | Х | X | X | X | Х | Х | Х | Х | Х | X | Х | X | Х | X | Х | Х | Х |
| 5,000 pF | 502 | Х | X | | X | X | | Х | X | X | | Х | X | X | X | Х | X | X | X | Х | Х | X | Х | Х | X | Х | X | Х | X | X | Х | Х |
| 5,600 pF | 562 | Х | X | | X | X | | Х | X | X | | Х | X | X | X | Х | X | X | X | Х | Х | X | Х | Х | X | Х | X | Х | X | X | Х | Х |
| 6,800 pF | 682 | Х | X | | X | X | | Х | X | X | | Х | X | X | | Х | X | X | X | Х | Х | X | | Х | X | Х | X | Х | X | X | Х | Х |
| 8,200 pF | 822 | Х | X | | X | X | | Х | X | X | | Х | X | X | | Х | X | X | | Х | Х | X | | Х | X | Х | X | Х | X | X | Х | |
| 10,000 pF | 103 | Х | X | | X | X | | Х | X | X | | Х | X | X | | Х | X | X | | Х | X | X | | Х | X | Х | X | Х | X | X | Х | |
| 12,000 pF | 123 | Х | X | | X | X | | Х | X | X | | Х | X | X | | Х | X | X | | Х | X | X | | Х | X | Х | X | Х | X | X | Х | |
| 15,000 pF | 153 | Х | X | | X | X | | Х | X | | | Х | X | X | | Х | X | X | | Х | X | X | | Х | X | X | X | Х | X | X | Х | |
| 18,000 pF | 183 | Х | X | | X | X | | Х | X | | | Х | X | | | Х | X | | | Х | X | | | Х | X | X | | Х | X | X | Х | |
| 22,000 pF | 223 | Х | X | | X | | | Х | X | | | Х | X | | | X | X | | | Х | X | | | X | X | X | | X | X | X | | L |
| 27,000 pF | 273 | Х | | | X | | | Х | X | | | Х | X | | | Х | X | | | Х | X | | | Х | X | Х | | Х | X | X | | |
| 33,000 pF | 333 | X | | | X | | | X | X | | | Х | X | | | X | X | | | X | X | | | X | X | Х | | Х | X | X | | |
| 39,000 pF | 393 | X | | | X | | | Х | X | | | Х | X | | | X | X | | | X | X | | | X | X | X | | Х | X | X | | |
| 47,000 pF | 473 | X | | | X | <u> </u> | | X | X | | | X | X | | | X | X | | | X | X | | | X | X | | | X | X | | | |
| 56,000 pF | 563 | X | | | X | <u> </u> | | X | X | | | X | X | | | X | X | | | X | X | | | X | X | | | X | X | | | |
| 68,000 pF | 683 | X | | | | | | X | | | | X | X | | | X | X | | | X | X | | | X | X | | | X | X | | | |
| 82,000 pF | 823 | Х | | | | <u> </u> | | Х | <u> </u> | | | Х | X | | | Х | X | | | X | X | | | X | X | | | X | X | | | <u> </u> |
| 0.10 µF | 104 | X | | | <u> </u> | | | X | | | | X | | | | X | X | | | X | X | | | X | X | | | X | X | | | |
| 0.12 µF | 124 | | - | | | | | X | | | | X | | | | X | | | | X | | | | X | X | | | X | X | | ' | |
| 0.15 µF | 154 | | | | | | | X | | | | X | | | | X | | | | X | | | | X | X | | | X | X | | \vdash | |
| 0.18 µF | 184 | | | | | | | X | | | | X | | | | X | | | | X | | | | X | X | | | X | X | | | |
| 0.22 µF | 224 | | | | _ | | | X | <u> </u> | | | X | <u> </u> | | <u> </u> | X | <u> </u> | | | X | | | | X | X | | | X | X | | | |
| 0.27 µF | 2/4 | | | | <u> </u> | | | - | | | | X | | | | X | | | | X | | | | X | | | | X | X | | | |
| 0.33 µF | 334 | | | | <u> </u> | | | - | | | | | | | | X | | | | | | | | X | | | | X | | | | |
| 0.39 µF | 394 | | | | <u> </u> | | | - | | | | | | | | X | | | | | | | | X | | | | X | | | | |
| 0.4/μΕ | 4/4 | | | | | | | | | | | | | | | | | | | | | | | X | | | | X | | | | |
| 0.50 µF | 504 | - | - | | - | | | | | | | | | | | - | | | | | | | | Ň | | | | × | | | | - |
| 0.08 µF | 824 | $\left \right $ | - | | | | | | | | | - | | | | | | | | | | | | X Y | | | | ^ | | | | - |
| Conceitones | Conseitenes | | • | 0 | | • | • | | • | • | 0 | - | • | 0 | • | | • | • | 0 | - | 0 | 0 | 0 | Ê | 0 | 0 | 0 | - | • | 0 | 0 | 0 |
| (pF) | Capacitance Code | 500 | 1,00 | 2,00 | 500 | 1,00 | 2,00 | 500 | 1,00 | 2,00 | 3,00 | 500 | 1,00 | 2,00 | 3,00 | 500 | 1,00 | 2,00 | 3,00 | 500 | 1,00 | 2,00 | 3,00 | 500 | 1,00 | 2,00 | 3,00 | 500 | 1,00 | 2,00 | 3,00 | 4,00 |
| C | Sizo | | | | | | | | | | | | | | | V | olta | ge | | | | | | | | | | | | | | |
| Case | Size 1515 1812 18 | | | 25 | | | 20 |)20 | | | 22 | 25 | | | 25 | 20 | | | 33 | 33 | | | | 3530 |) | | | | | | | |



Table 1A – HV X7R Waterfall cont.

| 0 | 0: | | 4 | 104 | 0 | | | | 45 | 40 | | | | 5 | 54 4 | 0 | | | | 55 | 50 | | | | | 65 | 60 | | |
|---------------------|---------------------|-----|----------|----------|-------|-------|-----|-------|-------|----------|-------|-------|-----|-------|-------------|-------|-------|-----|-------|-------|-------|----------|-------|-----|-------|-------|-------|-------|----------|
| Case | Size | | | | | | | | | | | | | ١ | /olt | tage | e | | | | | | | | | | | | |
| Capacitance (pF) | Capacitance Code | 500 | 1,000 | 2,000 | 3,000 | 4,000 | 500 | 1,000 | 2,000 | 3,000 | 4,000 | 5,000 | 500 | 1,000 | 2,000 | 3,000 | 4,000 | 500 | 1,000 | 2,000 | 3,000 | 4,000 | 5,000 | 500 | 1,000 | 2,000 | 3,000 | 4,000 | 5,000 |
| 1,000 pF | 102 | X | Х | Х | х | х | х | Х | х | х | х | х | | | | | | х | Х | х | Х | Х | Х | | | | | | |
| 1,200 pF | 122 | Х | Х | X | X | Х | Х | Х | Х | X | X | Х | | | | | | Х | Х | Х | Х | Х | Х | | | | | | |
| 1,500 pF | 152 | Х | Х | X | X | Х | Х | Х | Х | X | X | Х | | | | | | Х | Х | Х | Х | Х | Х | | | | | | |
| 1,800 pF | 182 | Х | Х | X | X | Х | Х | Х | Х | X | X | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | | | | | | |
| 2,200 pF | 222 | Х | Х | X | X | Х | Х | Х | Х | X | X | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | X | X | | | | | | |
| 2,700 pF | 272 | X | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | | | | | | |
| 3,300 pF | 332 | X | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | | | | | | |
| 3,900 pF | 392 | X | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х |
| 4,700 pF | 472 | X | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х |
| 5,000 pF | 502 | X | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х |
| 5,600 pF | 562 | X | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | X | Х | Х |
| 6.800 pF | 682 | X | X | X | X | X | х | X | X | X | X | X | х | Х | Х | Х | Х | х | Х | Х | Х | X | X | х | Х | Х | X | Х | X |
| 8.200 pF | 822 | X | X | X | X | X | х | X | X | X | X | | х | Х | Х | Х | Х | х | Х | Х | Х | X | X | х | Х | Х | X | Х | X |
| 10.000 pF | 103 | X | X | X | X | X | х | X | X | X | X | | х | Х | Х | Х | Х | х | Х | Х | Х | X | X | х | Х | Х | X | Х | X |
| 12,000 pF | 123 | Х | Х | Х | X | Х | Х | Х | Х | X | X | | Х | Х | Х | Х | Х | Х | Х | Х | Х | X | X | Х | Х | Х | X | Х | X |
| 15,000 pF | 153 | X | Х | Х | Х | | Х | Х | Х | Х | | | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х |
| 18,000 pF | 183 | X | X | Х | Х | | Х | Х | Х | Х | 1 | | Х | Х | Х | Х | | Х | Х | Х | Х | Х | 1 | Х | Х | Х | Х | Х | |
| 22.000 pF | 223 | X | X | X | X | | х | X | Х | X | 1 | | Х | Х | Х | Х | | X | Х | Х | Х | X | 1 | х | Х | Х | Х | Х | |
| 27.000 pF | 273 | X | X | X | X | | х | Х | Х | X | 1 | | Х | Х | Х | Х | | X | Х | Х | Х | Х | 1 | х | Х | Х | Х | Х | |
| 33.000 pF | 333 | X | X | X | 1 | | х | Х | Х | X | 1 | | Х | Х | Х | Х | | X | Х | Х | Х | <u> </u> | 1 | х | Х | Х | Х | Х | |
| 39.000 pF | 393 | X | Х | Х | | | х | Х | Х | Х | | | х | Х | Х | | | х | Х | Х | Х | | | х | Х | Х | X | Х | |
| 47.000 pF | 473 | X | X | X | 1 | | х | X | X | 1 | 1 | | х | Х | Х | | | х | Х | Х | Х | | 1 | х | Х | Х | X | | <u> </u> |
| 56.000 pF | 563 | X | X | X | 1 | | х | X | X | 1 | 1 | | х | Х | Х | | | х | Х | Х | Х | | 1 | х | Х | X | X | | <u> </u> |
| 68.000 pF | 683 | X | X | X | 1 | | х | X | X | 1 | 1 | | х | Х | Х | | | х | Х | Х | Х | | 1 | х | Х | X | X | | <u> </u> |
| 82.000 pF | 823 | X | X | X | 1 | | х | X | X | 1 | 1 | | х | Х | Х | | | х | Х | Х | | | 1 | х | Х | X | X | | <u> </u> |
| 0.10 µF | 104 | X | Х | | | | Х | Х | Х | | | | Х | Х | | | | Х | Х | Х | | | | Х | Х | Х | Х | | |
| 0.12 µF | 124 | X | X | <u> </u> | 1 | | X | Х | | <u> </u> | 1 | | Х | Х | | | | X | Х | Х | | <u> </u> | 1 | х | Х | Х | | | |
| 0.15 µF | 154 | X | X | <u> </u> | 1 | | X | Х | | <u> </u> | 1 | | Х | Х | | | | X | Х | | | <u> </u> | 1 | х | Х | Х | | | |
| 0.18 µF | 184 | X | X | <u> </u> | 1 | | X | Х | | <u> </u> | 1 | | Х | Х | | | | X | Х | | | <u> </u> | 1 | х | Х | Х | | | |
| 0.22 µF | 224 | X | X | <u> </u> | 1 | | х | X | | <u> </u> | 1 | | Х | Х | | | | X | Х | | | <u> </u> | 1 | х | Х | | | | |
| 0.27 µF | 274 | X | Х | | | | х | Х | | | | | Х | Х | | | | х | Х | | | | | х | Х | | | | |
| 0.33 µF | 334 | X | X | | | | X | X | | | | | X | X | | | | X | X | | | | | X | X | | | | |
| 0.39 µF | 394 | X | X | 1 | 1 | | х | X | | 1 | 1 | | х | Х | | | | х | Х | | | | 1 | х | Х | | | | <u> </u> |
| 0.45 uF | 454 | X | | 1 | 1 | | X | X | | 1 | 1 | | X | X | | | | X | X | | | | | X | X | | | | <u> </u> |
| 0.47 uF | 474 | X | | 1 | 1 | | X | X | | 1 | 1 | | X | X | | | | X | X | | | | | X | X | | | | <u> </u> |
| 0.56 µF | 564 | Х | | | | | Х | | | | | | Х | Х | | | | Х | Х | | | | | Х | Х | | | | |
| 0.68 µF | 684 | X | | | | | х | | | | | | Х | | | | | Х | Х | | | | | Х | Х | | | | |
| 0.82 µF | 824 | X | | | | | х | | | | | | Х | | | | | Х | Х | | | | | Х | Х | | | | |
| 1.0 µF | 105 | Х | | | | | Х | | | | | | Х | | | | | х | | | | | | Х | Х | | | | |
| 1.2 µF | 125 | | <u> </u> | <u> </u> | 1 | | х | | | <u> </u> | 1 | | х | | | | | х | | | | <u> </u> | 1 | х | | | | | |
| 1.5 µF | 155 | | | | | | Х | | | | | | Х | | | | | х | | | | | | х | | | | | |
| 1.8 µF | 185 | | | 1 | 1 | | | | | 1 | 1 | | | | | | | х | | | | | 1 | х | | | | | |
| 2.2 µF | 225 | | | 1 | 1 | | | | | 1 | 1 | | | | | | | | | | | | 1 | х | | | | | |
| 2.7 µF | 275 | | | 1 | 1 | | | | | 1 | 1 | | | | | | | | | | | | 1 | Х | | | | | |
| 2.9 µF | 295 | | | | | | | | | | | | | | | | | | | | | | | Х | | | | | |
| Capacitance (pF) | Capacitance Code | 500 | 000'1 | 2,000 | 3,000 | 1,000 | 500 | 1,000 | 2,000 | 3,000 | 1,000 | 5,000 | 500 | 1,000 | 2,000 | 3,000 | 1,000 | 500 | 1,000 | 2,000 | 3,000 | 1,000 | 5,000 | 500 | 1,000 | 2,000 | 3,000 | 1,000 | 5,000 |
| | | | | | | | | - | | | | | | | Vola | | • | | • | | | | | | | | ., | - | |
| Case | Size | | | 4040 |) | | | | 45 | 40 | | | | | 5440 |) | | | | 55 | 50 | | | | | 65 | 60 | | |



Table 1B - HV COG Waterfall

| Coord | Cine | | 15 | 515 | | | 18 | 12 | | | 18 | 25 | | | 20 | 20 | | | 22 | 25 | | | 25 | 20 | | | 3 | 33 | 3 | | | 3 | 53 | 0 | |
|---------------------|---------------------|-----|-------|-------|-------|-----|-------|----------|-------|-----|-------|-------|----------|-----|-------|-------|----------|------|-------|-------|----------|----------|-------|-------|-------|-----------|-------|-------|-------|----------|-----|-------|--|----------|--------------------|
| Case | size | | | | | | | | | | | | | | | | ١ | /olt | tag | е | | | | | | | | | | | | | | | |
| Capacitance (pF) | Capacitance Code | 500 | 1,000 | 2,000 | 3,000 | 500 | 1,000 | 2,000 | 3,000 | 500 | 1,000 | 2,000 | 3,000 | 500 | 1,000 | 2,000 | 3,000 | 500 | 1,000 | 2,000 | 3,000 | 500 | 1,000 | 2,000 | 3,000 | 500 | 1,000 | 2,000 | 3,000 | 4,000 | 500 | 1,000 | 2,000 | 3,000 | 4,000 |
| 12 pF | 120 | Х | Х | Х | Х | Х | Х | Х | Х | | | | | | _ | _ | | | | | | | | | | | | | | | | | | | |
| 15 pF | 150 | Х | X | X | X | х | Х | X | Х | | | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| 18 pF | 180 | Х | X | X | Х | Х | Х | Х | Х | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 22 pF | 220 | Х | Х | X | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | X | Х | Х | | | | | | | | | | | | | | | | | | |
| 27 pF | 270 | Х | Х | X | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | X | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | X |
| 33 pF | 330 | Х | X | Х | X | Х | Х | Х | Х | X | Х | X | X | X | X | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х |
| 39 pF | 390 | Х | Х | Х | Х | Х | Х | Х | Х | X | Х | Х | Х | X | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | X | Х | Х | Х | Х | Х | Х | Х | Х | Х |
| 47 pF | 470 | Х | X | Х | X | Х | Х | Х | Х | X | Х | X | X | X | X | Х | X | Х | Х | Х | Х | Х | Х | Х | X | X | X | Х | Х | Х | Х | Х | Х | Х | Х |
| 56 pF | 560 | Х | X | Х | X | Х | Х | Х | Х | X | Х | X | X | X | X | Х | X | Х | Х | Х | Х | Х | Х | Х | X | X | X | Х | Х | Х | Х | Х | Х | Х | Х |
| 68 pF | 680 | Х | X | Х | X | Х | Х | Х | Х | X | Х | X | X | X | X | Х | X | Х | X | X | X | Х | X | Х | X | Х | X | X | X | X | Х | Х | Х | Х | X |
| 82 pF | 820 | Х | X | X | X | Х | X | X | X | Х | X | X | X | Х | X | Х | X | Х | X | X | X | Х | X | X | X | Х | X | X | X | X | Х | X | Х | Х | X |
| 100 pF | 101 | Х | X | X | X | Х | X | X | X | Х | X | X | X | Х | X | Х | X | Х | X | X | X | Х | X | X | X | Х | X | X | X | X | Х | X | Х | Х | X |
| 120 pF | 121 | Х | X | X | X | Х | X | X | X | Х | X | X | X | X | X | Х | X | Х | X | X | X | Х | X | X | X | Х | X | X | X | X | Х | X | Х | Х | X |
| 150 pF | 151 | Х | X | X | X | Х | Х | X | Х | Х | Х | X | X | Х | X | Х | X | Х | X | X | X | Х | X | X | X | Х | X | X | X | X | Х | X | Х | Х | X |
| 180 pF | 181 | Х | X | X | X | Х | X | X | Х | Х | X | X | X | X | X | Х | X | Х | X | X | X | Х | X | X | X | Х | X | X | X | X | Х | X | Х | Х | X |
| 220 pF | 221 | Х | X | X | X | Х | Х | X | Х | X | Х | X | X | X | X | Х | X | Х | Х | Х | X | Х | Х | X | X | X | Х | X | X | Х | Х | X | Х | Х | X |
| 270 pF | 271 | Х | X | X | X | Х | Х | X | | X | Х | X | X | X | X | Х | X | Х | Х | Х | X | Х | Х | X | X | X | Х | X | X | Х | Х | X | Х | Х | Х |
| 330 pF | 331 | X | X | X | | Х | X | X | | X | X | X | X | X | X | Х | X | Х | X | X | X | X | X | X | X | X | X | X | X | X | Х | X | Х | Х | Х |
| 390 pF | 391 | X | X | X | | Х | X | X | | X | X | X | X | X | X | Х | X | Х | X | X | X | X | X | X | X | X | X | X | X | X | Х | X | Х | Х | X |
| 470 pF | 471 | X | X | X | | Х | X | X | | X | X | X | X | X | X | Х | X | Х | X | X | X | X | X | X | X | X | X | X | X | X | Х | X | Х | Х | X |
| 560 pF | 561 | Х | X | X | | Х | X | X | | X | X | X | | X | X | Х | X | Х | X | X | X | X | X | X | X | X | X | X | X | X | Х | X | X | X | X |
| 680 pF | 681 | Х | X | X | | Х | X | X | | X | X | X | | X | X | Х | X | Х | X | X | X | X | X | X | X | X | X | X | X | X | Х | X | X | X | X |
| 820 pF | 821 | X | X | X | | Х | X | | | X | X | X | | X | X | X | X | Х | X | X | | X | X | X | X | X | X | X | X | | Х | X | X | X | |
| 1000 pF | 102 | X | X | | | Х | X | | | X | X | X | | X | X | X | X | Х | X | X | | X | X | X | X | X | X | X | X | | Х | X | X | X | |
| 1200 pF | 122 | Х | X | | | Х | X | | | X | X | X | | X | X | Х | | Х | X | X | | X | X | X | X | X | X | X | X | | Х | X | X | Х | |
| 1500 pF | 152 | X | X | | | X | X | | | X | X | | <u> </u> | X | X | X | <u> </u> | X | X | X | | X | X | X | | X | X | X | X | <u> </u> | X | X | X | X | |
| 1800 pF | 182 | X | X | | | X | X | <u> </u> | | X | X | | <u> </u> | X | X | X | <u> </u> | X | X | X | <u> </u> | X | X | X | | X | X | X | ļ | <u> </u> | X | X | X | X | |
| 2200 pF | 222 | X | X | | | X | X | | | X | X | | | X | X | X | | X | X | X | | X | X | X | | X | X | X | | | X | X | X | X | |
| 2700 pF | 272 | X | X | | | X | | | | X | X | | | X | X | X | | X | X | | | X | X | X | | X | X | X | | | X | X | X | | |
| 3300 pF | 332 | | | | | X | | | | X | X | | | X | X | | | X | X | | | X | X | X | | X | X | X | | | X | X | X | | |
| 3900 pF | 392 | | | | | X | | | | X | X | | | X | X | | | X | X | | | X | X | | | X | X | X | | | X | X | X | | |
| 4/00 pF | 4/2 | - | | | | | | | | X | X | - | | X | X | | | X | X | - | | X | X | | | X | X | X | | | X | X | X | | |
| 5600 pF | 562 | | | | | | | | | X | | | | X | X | | | X | X | | | X | X | | | X | X | X | | | X | X | X | <u> </u> | |
| 6800 pF | 682 | | | | | | | | | X | | | | X | | | | X | X | | | X | X | | | X | X | X | | | X | X | \mid | | |
| 7500 pF | /52 | | | | | | | | | X | | | | X | | | | X | X | | | X | | | | X | X | X | | | X | X | | | |
| 8200 pF | 822 | | | | | | | | | X | | | | X | | | | X | X | | | X | | | | X | X | X | | | X | X | | | |
| 12000 pF | 103 | | | | | | | | | X | | | | X | | | | X | | | | X | | | | X | X | X | | | X | X | | | |
| 12000 pF | 123 | | | | | | | | | | | | | | | | | X | | | | X | | | | X | X | X | | | X | X | | | |
| 19000 pF | 153 | | | | | | | | | | | | | | | | | X | | | | X | | | | X | | | | | X | X | | | |
| 22000 pF | 183 | | | | | | | | | | | | | | | | | X | | | | X | | | | X | | | | | X | X | | | |
| 22000 pF | 223 | | | | | | | | | | | | | - | | | | | | | | <u> </u> | | | | | | | | | Ň | | <u> </u> | | $\left - \right $ |
| 27000 pF | 2/3 | | | | | | | | | | | | | - | | | | | | | | <u> </u> | | | | ⊢^ | | | | | Ň | | \vdash | | |
| 33000 pF | 333 | | • | 0 | 0 | | 0 | • | • | | 0 | • | • | | 0 | • | • | | 0 | • | • | | • | 0 | | | 0 | 0 | 0 | 0 | _ | 0 | 0 | 0 | 0 |
| Capacitance (pF) | Capacitance Code | 500 | 1,00(| 2,00(| 3,00(| 500 | 1,00(| 2,00(| 3,00(| 500 | 1,00(| 2,00(| 3,00(| 500 | 1,00(| 2,00(| 3,00(| 500 | 1,00(| 2,00(| 3,00(| 500 | 1,00(| 2,00(| 3,00(| 500 | 1,00 | 2,00 | 3,00 | 4,00 | 500 | 1,00 | 2,00 | 3,00 | 4,00 |
| _ | 0: | | | | | | | | | | | | | | | | | Voli | tage | | | | | | | | | | | | | | | | |
| Case | SIZE | | 15 | 515 | | | 18 | 12 | | | 18 | 25 | | | 20 | 20 | | | 22 | 25 | | | 25 | 20 | | | : | 333: | 3 | | | ; | 3530 |) | |



Table 1B – HV COG Waterfall cont.

| 0 | Cine | | 4 | 404 | 0 | | | | 45 | 40 | | | | Ę | 544(| 0 | | | | 55 | 50 | | | | | 65 | 60 | | |
|---------------------|---------------------|-----|--------|--------|-------|-------|--------|--------|--------|--------|-------|-------|--------|--------|--------|--------|-------|-----|--------|--------|--------|-------|-------|--------|--------|--------|--------|--------|-------|
| Case | SIZE | | | | | | | | | | | | | | Volt | tage |) | | | | | | | | | | | | |
| Capacitance (pF) | Capacitance Code | 500 | 1,000 | 2,000 | 3,000 | 4,000 | 500 | 1,000 | 2,000 | 3,000 | 4,000 | 5,000 | 500 | 1,000 | 2,000 | 3,000 | 4,000 | 500 | 1,000 | 2,000 | 3,000 | 4,000 | 5,000 | 500 | 1,000 | 2,000 | 3,000 | 4,000 | 5,000 |
| 18 pF | 180 | X | Х | X | Х | X | | | | | | | | | | | | | | | | | | | | | | _ | |
| 22 pF | 220 | Х | Х | X | Х | Х | | | | | | | | | | | | | | | | | | | | | | | |
| 27 pF | 270 | Х | Х | X | X | Х | Х | Х | Х | Х | Х | X | Х | Х | Х | Х | Х | | | | | | | | | | | | |
| 33 pF | 330 | Х | Х | X | X | Х | Х | Х | Х | Х | Х | X | Х | Х | Х | Х | Х | | | | | | | | | | | | |
| 39 pF | 390 | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | | | | | | | | | | | | |
| 47 pF | 470 | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | | | | | | |
| 56 pF | 560 | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | | | | | | |
| 68 pF | 680 | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | | | | | | |
| 82 pF | 820 | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | | | | | | |
| 100 pF | 101 | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х | Х |
| 120 pF | 121 | Х | X | X | X | X | Х | Х | Х | Х | Х | X | Х | Х | X | X | Х | Х | X | Х | Х | X | X | Х | Х | Х | Х | Х | Х |
| 150 pF | 151 | Х | X | X | X | X | Х | Х | Х | Х | X | X | Х | X | X | X | X | Х | X | X | X | X | X | Х | Х | Х | Х | Х | Х |
| 180 pF | 181 | Х | X | X | X | X | Х | Х | Х | Х | X | X | Х | X | X | X | X | Х | X | X | X | X | X | Х | Х | Х | Х | Х | Х |
| 220 pF | 221 | Х | X | X | X | X | Х | Х | Х | Х | X | X | Х | X | X | X | X | Х | X | X | X | X | X | Х | Х | Х | Х | Х | Х |
| 270 pF | 271 | Х | X | X | X | X | Х | Х | X | Х | X | X | Х | X | X | X | X | Х | X | X | X | X | X | Х | Х | Х | Х | Х | Х |
| 330 pF | 331 | Х | X | X | X | X | Х | Х | Х | Х | Х | X | Х | X | X | X | X | Х | X | Х | X | X | X | Х | Х | Х | Х | Х | Х |
| 390 pF | 391 | Х | X | X | X | Х | Х | Х | Х | Х | Х | X | Х | X | Х | X | X | Х | Х | Х | X | X | X | Х | Х | Х | Х | Х | Х |
| 470 pF | 471 | Х | X | X | X | X | Х | Х | Х | Х | X | X | Х | X | X | X | X | Х | X | Х | X | X | X | Х | X | Х | X | Х | Х |
| 560 pF | 561 | Х | X | X | X | X | Х | Х | Х | Х | X | X | Х | X | X | X | X | Х | X | X | X | X | X | Х | X | Х | X | Х | Х |
| 680 pF | 681 | Х | X | X | X | X | Х | X | X | Х | X | X | Х | X | X | X | X | X | X | X | X | X | X | Х | X | X | X | X | Х |
| 820 pF | 821 | Х | X | X | X | X | Х | X | Х | X | X | X | Х | X | X | X | X | X | X | X | X | X | X | Х | X | X | X | X | X |
| 1000 pF | 102 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 1200 pF | 122 | X | X | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 1500 pF | 152 | X | X | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 1800 pF | 182 | X | X | X | X | | X | X | X | X | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 2200 pF | 222 | X | X | X | X | | X | X | X | X | | | X | X | X | X | | X | X | X | X | | | X | X | X | X | X | X |
| 2700 pF | 272 | X | X | X | X | | X | X | X | X | | | X | X | X | X | | X | X | X | X | | | X | X | X | X | X | X |
| 3300 pF | 332 | | X | X | X | | A V | X | X | × × | | | × × | A V | A V | X | | | X | × × | X | | | × × | X | X | X | A V | X |
| 3900 pF | 392 | | X | X | X | | A V | X | X | × × | | | × × | A V | A V | X | | | X | X | X | | | × × | X | X | X | | Χ. |
| 4700 pF | 562 | | A V | A V | ^ | | A V | × | A V | ^ | | | ^ V | A V | ∧ V | A V | | Ŷ | A V | A V | A V | | | ^ V | A V | A V | A V | | |
| 6900 pF | 692 | Ŷ | × × | v | | | ^ V | × × | × × | | | | Ŷ | × × | × × | v v | | Ŷ | v | v | ^ | | | Ŷ | × × | × × | ^ V | | |
| 7500 pF | 752 | v | X Y | ^ | | | Ŷ | A Y | Y | | | | Ŷ | × × | Y | ~ | | Ŷ | X Y | Y | | | | Ŷ | Y | A Y | Y | | |
| 8200 pF | 822 | X | X | | | | X | X | X | | | | X | X X | X | | | x | X | X | | | | X | X | X | X | | |
| 10000 pF | 103 | X | X | | | | X | X | X | | | | X | X | X | | | X | X | X | | | | X | X | X | ~ | | |
| 12000 pF | 123 | X | X | | | | X | X | ~ | | | | X | X | X | | | X | X | X | | | | X | X | X | | | |
| 15000 pF | 153 | X | X | | | | X | X | | | | | X | X | X | | | X | X | ~ | | | | X | X | X | | | |
| 18000 pF | 183 | | | | | | X | X | | | | | X | X | | | | X | X | | | | | X | X | X | | | |
| 22000 pF | 223 | | | | | | X | X | | | | | X | X | | | | X | X | | | | | X | X | X | | | |
| 27000 pF | 273 | | | | | | Х | Х | | | | | Х | X | | | | X | X | | | | | Х | Х | | | | |
| 33000 pF | 333 | | | | | | Х | Х | | | | | Х | X | | | | х | X | | | | | х | Х | | | | |
| 39000 pF | 393 | | | | | | Х | Х | | | | | Х | | | | | Х | X | | | | | Х | Х | | | | |
| 47000 pF | 473 | | | | | | Х | Х | | | | | Х | | | | | Х | Х | | | | | Х | Х | | | | |
| 56000 pF | 563 | | | | | | Х | | | | | | Х | | | | | | | | | | | Х | Х | | | | |
| 68000 pF | 683 | | | | | | Х | | | | | | Х | | | | | | | | | | | Х | Х | | | | |
| 82000 pF | 823 | | | | | | | | | | | | Х | | | | | | | | | | | Х | | | | | |
| 0.10 µF | 104 | | | | | | | | | | | | | | | | | | | | | | | Х | | | | | |
| Capacitance (pF) | Capacitance Code | 500 | 000' | 000 | 3,000 | 1,000 | 500 | 000' | 000 | 3,000 | 1,000 | 000 | 500 | 000' | 000 | 3,000 | 1,000 | 500 | 000' | 000 | 3,000 | 1,000 | 000 | 500 | ,000 | ,000 | 000' | 1,000 | 000 |
| (P.) | | | | N | | 4 | | - | ~ | (7) | 4 | - 27 | | - | Volt | tage | 4 | | - | | | 4 | - 27 | | - | ~ | .0 | 4 | 47 |
| Case | Size | | | 4040 |) | | | | 45 | 40 | | | | | 5440 |) | | | | 55 | 50 | | | | | 65 | 60 | | |



Soldering Process

Recommended Soldering Technique:

- Solder Wave
- Hand Soldering (Manual)

Recommended Soldering Profile:

Optimum Wave Solder Profile



• Hand Soldering (Manual)

Manual Solder Profile with Pre-heating



KEMET recommends following the guidelines and techniques outlined in technical bulletins F2103 and F9207.



Table 2 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test or Inspection Method | Limits |
|--|---------------------------|--|---|
| Visual and Mechanical | KEMET Internal | No defects that may affect performance (10X) | Dimensions according KEMET Spec Sheet |
| Capacitance (Cap) | MIL-STD-202 Method 305 | C ≤ 100 pF: 1 MHz ± 100 kHz and 1.0 ±0.2 Vrms C > 100 pF: 1 kHz ±100 Hz and 1.0 ±0.2 Vrms | Dimensions according KEMET Spec Sheet |
| Dissipation Factor (DF) | KEMET Internal | C ≤ 100 pF: 1 MHz ± 100 kHz and 1.0 ±0.2 Vrms C > 100 pF: 1 kHz ±100 Hz and 1.0 ±0.2 Vrms | X7R: 2.5% C0G: 0.15% |
| Insulation Resistance (IR) | MIL-STD-202 Method 302 | Test potential: 500 V dc between capacitor element terminals Surge current: limited to 30mA Special condition: If failure at relative humidity of ≥ 50%, IR may be measured again at a relative humidity of less than 50% | Within Specification To obtain IR limit, divide MΩ-μF value by the capacitance and compare to GΩ limit. Select the lower of the two limits. At 25°C: 100,000 megohms or 1,000 Megohm-microfarad, whichever is less. At 125°C: 10,000 megohms or 100 Megohm- microfarad, whichever is less. |
| Temperature Coefficient of Capacitance (TCC) | KEMET Internal | COG (P): 0 ppm/°C ±30 ppm/°C X7R (R or Z): ±15% | Within Specification |
| Temperature Coefficient of Capacitance at Applied Voltage (TCVC) | KEMET Internal | COG (P): 0 ppm/°C ±30 ppm/°C X7R (R or Z): +15%/-70% | COG: Within Specification X7R: Within KEMET Specification limits |
| Dielectric Withstanding Voltage (DWV) | KEMET Internal | 150% of rated voltage for voltage rating of 500 V ≤ V < 1,000 V 120% of rated voltage for voltage rating of ≥ 1,000 V (5 ±1 seconds and charge/discharge not exceeding 50 mA at 25°C) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit Withstand test voltage without insulation breakdown or damage. |
| Aging Rate (Maximum % Capacitance Loss/ Decade Hour) | KEMET Internal | Capacitance measurements (including tolerance) are indexed to a referee time of 48 or 1,000 hours. Please refer to a part number specific datasheet for referee time details. | Please refer to a part number specification sheet for specific Aging rate |
| Terminal Strength | MIL-STD-202 Method 211 | Applied force: 5 pounds (2.3 kg) | No evidence of mechanical damage |
| Solderability | MIL-STD-202 Method 208 | Condition: 4 hours ± 15 minutes at 155°C dry bake apply all methods Test 245 ± 5°C (SnPb & Pb-Free) | Visual Inspection. 95% coverage on termination. No leaching |
| Temperature Cycling | JESD22 Method JA-104 | Test condition A (5 cycles) except that in step 3, sample units shall be tested at +125°C. | Measurement at 24 hours ±4 hours after test conclusion. Cap: Initial Limit DF: Initial Limit IR: Initial Limit |



Table 2 – Performance & Reliability: Test Methods and Conditions cont.

| Stress | Reference | Test or Inspection Method | Limits |
|---------------------------|---------------------------|--|---|
| Moisture Resistance | MIL-STD-202 Method 106 | Number of cycles required 10, 24 hours per cycle. Steps 7a and 7b not required | Visual examination: No mechanical damage. Marking shall remain legible Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: X7R: Change not to exceed ±10% of initial measured value Cap: COG: ±0.5 percent or 5 pF, whichever is greater, of initial measured value IR: 10% of Initial Limit of the initial +25°C requirement |
| Thermal Shock | MIL-STD-202 Method 107 | Number of cycles required 5, (-55°C to 125°C) Dwell time 15 minutes. | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| High Temperature Life | MIL-STD-202 Method 108 | 1,000 hours at 125°C with 2 X rated voltage applied excluding the following: | Within Post Environmental Limits Visual examination: No mechanical damage. Marking shall remain legible. IR: (at +25°C): Shall not be less than 30 percent of the value specified IR: (at elevated ambient temperature): Shall not be less than 30 percent of the value |
| Storage Life | | 1,000 hours at 125°C, Unpowered | specified |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Test from 10 – 2,000 Hz | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Mechanical Shock | MIL-STD-202 Method 213 | 1,500 g's 0.5 ms Half-sine, Velocity Change 15.4 feett/second (Condition F) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents | Capacitors shall be visually examined for evidence of mechanical damage and marking. |

Packaging Quantities

| Style | Waffle Pack Quantity | Style | Waffle Pack Quantity |
|-------|----------------------|-------|----------------------|
| 1515 | 50 | 3530 | 50 |
| 1812 | 50 | 4040 | 50 |
| 1825 | 50 | 4540 | 50 |
| 2020 | 50 | 5440 | 50 |
| 2225 | 50 | 5550 | 50 |
| 2520 | 50 | 6560 | 50 |
| 3333 | 50 | | |



Storage & Handling

The un-mounted storage life of a leaded ceramic capacitor is dependent upon storage and atmospheric conditions as well as packaging materials. While the ceramic chips enveloped under the epoxy coating themselves are quite robust in most environments, solderability of the wire lead on the final epoxy-coated product will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature and exposure to direct sunlight-reels may soften or warp, and tape peel force may increase.

KEMET recommends storing the un-mounted capacitors in their original packaging, in a location away from direct sunlight, and where the temperature and relative humidity do not exceed 40 degrees centigrade and 70% respectively. For optimum solderability, capacitor stock should be used promptly, preferably within 18 months of receipt. For applications requiring pre-tinning of components, storage life may be extended if solderability is verified. Before cleaning, bonding or molding these devices, it is important to verify that your process does not affect product quality and performance. KEMET recommends testing and evaluating the performance of a cleaned, bonded or molded product prior to implementing and/or qualifying any of these processes.

Construction



Environmental Compliance

Industrial PME (precious metal electrode) part types are not RoHS compliant.

High Voltage, High Temperature 150°C, X8G Dielectric, 500 – 2,000 VDC (Commercial & Automotive Grade)





Overview

KEMET's X8G HV Class I dielectric features a 150°C maximum operating temperature, offering the latest in high temperature dielectric technology and reliability for extreme temperature applications and under the hood applications. X8G exhibits no change in capacitance with respect to voltage and boasts a minimal change in capacitance with reference to ambient temperature. It is a suitable replacement for higher capacitance and larger footprint devices that fail to offer capacitance stability. Capacitance change is limited to ±30ppm/°C from -55°C to +150°C.

Driven by the demand for a more robust and reliable component, X8G dielectric capacitors were developed for critical applications where reliability and capacitance stability at higher operating temperatures are a concern. These capacitors are widely used in automotive for under the hood and harsh environment as well as general high temperature applications.

In addition to commercial grade, automotive grade devices are available and meet Automotive Electronics Council's AEC-Q200 qualification requirements. Also available with flexible termination technology which inhibits the transfer of board stress to the rigid ceramic body, therefore mitigating flex cracks which can result in low IR or short circuit failures.

Benefits

- Operating temperature range of -55°C to +150°C
- Capacitance offerings ranging from 1.0pF to 0.10µF
- EIA 0603, 0805, 1206, 1210, 1812 and 2220 case sizes
- DC voltage ratings of 500V, 630V, 1 KV, 1.5 KV and 2 KV
- Extremely low ESR and ESL
- · High thermal stability
- High ripple current capability
- No capacitance shift with voltage
- · Negligible capacitance shift with respect to temperature
- No piezoelectric noise
- · Lead (Pb)-Free, RoHS and REACH compliant

Applications

- · High frequency power converters
- Wide bandgap (WBG), silicon carbide (SiC) and gallium nitride (GaN) systems
- Snubber (high dV/dT)
- Resonant circuits (LLC, Wireless Charging, etc.)
- Timing
- Filtering





Ordering Information

| С | 2220 | С | 104 | K | В | Т | Α | C | AUTO |
|---------|--|---|--|--|--|------------|------------------------|---|--|
| Ceramic | Case Size (L" x W") | Specification/ Series ¹ | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/Design | Termination Finish ² | Packaging/ Grade (C-Spec) |
| | 0603 0805 1206 1210 1812 2220 | C = Standard X = Flexible Termination | Two significant digits and number of zeros | $B = \pm 0.10 \text{ pF}$ $C = \pm 0.25 \text{ pF}$ $D = \pm 0.5 \text{ pF}$ $F = \pm 1\%$ $G = \pm 2\%$ $J = \pm 5\%$ $K = \pm 10\%$ $M = \pm 20\%$ | C= 500 B = 630 D = 1,000 F = 1,500 G = 2,000 | T = X8G | A = N/A | C = 100% Matte Sn L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ The flexible termination option is not available on EIA 0402 case size product. "C" must be used in the 6th character position when ordering this case size.

² Additional termination finish options may be available. Contact KEMET for details.

² SnPb termination finish option is not available on automotive grade product.

Packaging C-Spec Ordering Options Table

| Packaging Type | Packaging/Grade Ordering Code (C-Spec) |
|---|---|
| Commerc | ial Grade ¹ |
| Bulk Bag | Not Required (Blank) |
| 7" Reel/Unmarked | TU |
| 13" Reel/Unmarked | 7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2 mm pitch ² | 7081 |
| 13" Reel/Unmarked/2 mm pitch ² | 7082 |
| Automoti | ve Grade ³ |
| 7" Reel | AUTO |
| 13" Reel/Unmarked | AUTO7411 (EIA 0603 and smaller case sizes) AUTO7210 (EIA 0805 and larger case sizes) |
| 7" Reel/Unmarked/2 mm pitch ² | 3190 |
| 13" Reel/Unmarked/2 mm pitch ² | 3191 |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked.

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

³ Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information".

³ For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information".

³ All Automotive packaging C-Specs listed exclude the option to laser mark components. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking".



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | tion Due To: | Days Prior To |
|-----------------------------|----------------------------------|---------------|------------------|
| C-Spec | Process/Product change | Obsolescence* | Implementation |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum |
| AUTO | Yes (without approval) | Yes | 90 days minimum |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | | PPAP (Product | Part Approval | Process) Leve | I |
|-----------------------------|---|---------------|---------------|---------------|---|
| C-Spec | 1 | 2 | 3 | 4 | 5 |
| KEMET assigned ¹ | • | • | • | • | • |
| AUTO | | | 0 | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)



Standard Termination

| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|---------------|---------------------|-------------------------------|-------------------------------|-----------------|-------------------------------|----------------------------|------------------------------------|
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) | Colder Weve |
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave Or Solder Deflow |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | See Table 2 for | 0.50 (0.02) ±0.25 (0.010) | | Soluel Reliow |
| 1210 | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | Thickness | 0.50 (0.02) ±0.25 (0.010) | N1/A | |
| 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | | 0.60 (0.024) ±0.35 (0.014) | N/A | Solder Reflow Only |
| 2220 | 5650 | 5.70 (0.224) ±0.40 (0.016) | 5.00 (0.197) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | |

Flexible Termination

| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|---------------|---------------------|-------------------------------|-------------------------------|-----------------|-------------------------------|----------------------------|------------------------------------|
| 0603 | 1608 | 1.60 (0.063) ±0.17 (0.007) | 0.80 (0.032) ±0.15 (0.006) | | 0.45 (0.018) ±0.15 (0.006) | 0.58 (0.023) | Colder Weve |
| 0805 | 2012 | 2.00 (0.079) ±0.30 (0.012) | 1.25 (0.049) ±0.30 (0.012) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave Or Solder Deflow |
| 1206 | 3216 | 3.30 (0.130) ±0.40 (0.016) | 1.60 (0.063) ±0.35(0.013) | See Table 2 for | 0.60 (0.024) ±0.25 (0.010) | | Soluel Reliow |
| 1210 | 3225 | 3.30 (0.130) ±0.40 (0.016) | 2.60(0.102) ±0.30(0.012) | Thickness | 0.60 (0.024) ±0.25 (0.010) | N / A | |
| 1812 | 4532 | 4.50 (0.178) ±0.40 (0.016) | 3.20 (0.126) ±0.30 (0.012) | | 0.70 (0.028) ±0.35 (0.014) | N/A | Solder Reflow Only |
| 2220 | 5650 | 5.90 (0.232) ±0.75 (0.030) | 5.00 (0.197) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | |



Environmental Compliance



Lead (Pb)-free, RoHS, and REACH compliant without exemptions (excluding SnPb termination finish option).

Dielectric Withstanding Voltage (DWV)

| EIA Case Size | 500V | 630V | ≥ 1000V |
|---------------|---------------|--|---------------|
| 0603 | | 130% of rated voltage | |
| 0805 | | < 620pF 150% of rated voltage ≥ 620pF 130% of rated voltage | |
| 1206 | | < 5.1nF 150% of rated voltage ≥ 5.1nF 130% of rated voltage | |
| 1210 | | < 7.5nF 150% of rated voltage | |
| 1808 | 150% of rated | Similar 100% of rated voltage $< 5.1 \text{nF} 150\%$ of rated voltage $\geq 5.1 \text{nF} 130\%$ of rated voltage | 120% of rated |
| 1812 | vonage | < 12nF 150% of rated voltage ≥ 12nF 130% of rated voltage | vonage |
| 1825 | | < 22nF 150% of rated voltage ≥ 22nF 130% of rated voltage | |
| 2220 | | < 27nF 150% of rated voltage ≥ 27nF 130% of rated voltage | |
| 2225 | | < 33nF 150% of rated voltage ≥ 33nF 130% of rated voltage | |



Table 1A - Standard Termination Capacitance Range/Selection Waterfall(0603 - 2220 Case Sizes)

| | | Case | Siz | ze/ | Se | ries | С | 060 | 3C | C | 080 | 5C | | C | 1200 | 5C | | | C | 1210 | OC | | | C | 181: | 2C | | | C2 | 222 | DC | |
|--------------------------------|--------------------------|--------|--------|------|-------|------|-----|-----|-------|-----|-----|-------|----------|----------|----------|-------|--------------|------|---------------|----------------|-------|-------|--------------|------------|-------|-------|---------|-----|-----|----------|----------|-------|
| Capacitance | Сар | Vo | oltag | je C | ode | | C | В | D | С | В | D | С | В | D | F | G | С | В | D | F | G | C | В | D | F | G | С | В | D | F | G |
| | Code | Rateo | d Voli | tage | e (VC |)C) | 500 | 630 | 1,000 | 500 | 630 | 1,000 | 500 | а 630 | 1,000 | 1,500 | 2,000 | 200 | 630 | 1 Ch | 1,500 | 2,000 | 200 | 630 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 |
| | | Capaci | itanc | e To | oler | ance | | | | | | | | F | See | Tabl | <u>e 2 f</u> | or C | y an hip 1 | n cin Thick | (nes | s Din | iess iens | ions | 5 | | | | | | | |
| 1.0 - 9.1 pF* 10 nF - 47nF* | 109 - 919* 100 - 470* | BCD | DF | G | .1 | ĸN | | | | | DG | DG | FD | FD | FD | FD | FD | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | ЛК | ЛК | ЛК | ЛК | .ік |
| 11 pF | 110 | | F | G | J | KM | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 12 pF | 120 | | F | G | J | KN | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 13 pF 15 nF | 130 | | F | G | J | KN | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 16 pF | 160 | | F | G | J | KN | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 18 pF | 180 | | F | G | J | ĸN | | | | DG | DG | DG | ED | ED | ED | ED | ED | FΜ | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 20 pF | 200 | | F | G | J | KN | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 22 pF | 220 | | F | G | J | KN | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 24 pr 27 nF | 240 | | F | G | J | KN | | | | DG | DG | DG | FD | FD | FD | FD | FD | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 30 pF | 300 | | F | G | J | KN | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 33 pF | 330 | | F | G | J | KN | | | | DG | DG | DG | ED | ED | ED | ED | ED | FΜ | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 36 pF | 360 | | F | G | J | KN | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 39 pF 43 pF | 390 | | | G | J | KN | | | | | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | | JK | JK | JK |
| 47 pF | 470 | | F | G | J | KM | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 51 pF | 510 | | F | G | J | K | | | | DG | DG | DG | ED | ED | ED | ED | ED | FΜ | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 56 pF | 560 | | F | G | J | KN | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 62 pF | 620 | | F | G | J | KN | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 75 pF | 750 | | F | G | J | KN | | | | DG | DG | DG | ED | ED | ED | ED | EF | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 82 pF | 820 | | F | G | J | KN | | | | DG | DG | DG | ED | ED | ED | ED | EF | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 91 pF | 910 | | F | G | J | KN | | | | DG | DG | DG | ED | ED | ED | ED | EF | FΜ | FM | FM | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 100 pF | 101 | | F | G | J | KN | CG | CG | CG | DG | DG | DG | ED | ED | ED | ED | EF | FM | FM | FM | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 110 pF 120 pF | 111 | | F | G | J | KN | | | | | | | ED | ED FD | ED FD | ED | EG | FM | FM | FM | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 130 pF | 131 | | F | G | J | KW | CG | CG | CG | DG | DG | DG | ED | ED | ED | ED | EG | FG | FG | FG | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 150 pF | 151 | | F | G | J | ки | CG | CG | CG | DG | DG | DG | ED | ED | ED | EF | EG | FG | FG | FG | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 160 pF | 161 | | F | G | J | K | CG | CG | CG | DG | DG | DG | ED | ED | ED | EF | EG | FG | FG | FG | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 180 pF | 181 | | F | G | J | KM | CG | CG | CG | DG | DG | DG | ED | ED | ED | EF | EG | FG | FG | FG | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 200 pF | 201 | | F | G | J | KN | CG | CG | CG | DG | DG | DG | ED | ED | ED | EF | EG | FG | FG | FG | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 220 pF 240 nF | 221 | | F | G | J | KN | | | 6 | | DG | DG | ED FD | FD | FD | FG | FG | FG | FG | FG | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK JK | JK JK | JK |
| 270 pF | 271 | | F | G | J | KN | CG | CG | | DG | DG | DG | ED | ED | ED | EG | EG | FG | FG | FG | FK | FK | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 300 pF | 301 | | F | G | J | ĸN | CG | CG | | DG | DG | DN | ED | ED | EF | EG | | FG | FG | FG | FK | FK | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 330 pF | 331 | | F | G | J | K | CG | CG | | DG | DG | DN | ED | ED | EF | EG | | FG | FG | FG | FK | FK | GB | GB | GB | GB | GB | JE | JE | JE | JE | JE |
| 360 pF | 361 | | F | G | J | KN | CG | CG | | DG | DG | DN | ED | ED | EF | EG | | FG | FG | FG | FK | FS | GB | GB | GB | GB | GD | JE | JE | JE | JE | JE |
| 390 pF | 391 | | F | G | J | KN | | CG | | DG | DG | DN | ED | ED | EF | EG | | FG | FG | FG | FK | FS | GB | GB | GB | GB | GD | JE | JE | JE | JE | JE |
| 430 pF 470 nF | 431 | | F | G | J | KN | | CG | | | DG | DP | FD | FD | FG | FG | | FG | FM | FM | FS | FS | GB | GB | GB | GB | GD | JE | JE | JE | JE | JE |
| 510 pF | 511 | | F | G | J | KM | CG | CG | | DG | DG | DP | ED | ED | EG | EG | | FG | FM | FM | FS | FS | GB | GB | GB | GD | GH | JK | JK | JK | JK | JK |
| 560 pF | 561 | | F | G | J | KN | CG | CG | | DG | DG | DG | ED | ED | EG | EG | | FG | FM | FM | FS | FS | GB | GB | GB | GD | GH | JK | JK | JK | JK | JK |
| 620 pF | 621 | | F | G | J | KN | CG | CG | | DG | DG | DG | ED | ED | EG | | | FG | FM | FM | FS | FS | GB | GB | GB | GD | GH | JK | JK | JK | JK | JK |
| 680 pF | 681 | | F | G | J | KM | CG | CG | | DG | DG | DG | ED | ED | EG | | | FG | FM | FM | FS | FS | GB | GB | GB | GD | GH | JE | JE | JE | JK | JK |
| /50 pF | /51 | | | G | J | KN | | | | DG | DG | DG | ED | | EG | | | FG | FM | FM | FM | | GB | GB | GB | GD | GK | JE | | JE | JK | JK |
| ο20 μF 910 nF | 911 | | F | G | J | KW | | | | DN | DN | 00 | ED | EF | EG | | | FM | FM | FM | FW | | GR | GB | GB | GH | GM | JF | JK | JK | JK | JK |
| 1,000 pF | 102 | | F | G | J | KN | | | | DN | DN | | ED | EF | EG | | | FM | FM | FM | FY | | GB | GB | GB | GH | GM | JE | JK | JK | JK | JK |
| 1,100 pF | 112 | | F | G | J | KN | | | | DN | DN | | EF | EG | ED | | | FM | FK | FK | FS | | GB | GB | GB | GH | GO | JE | JK | JK | JK | JK |
| 1,200 pF | 122 | | F | G | J | KN | | | 0 | DN | DN | 0 | EF | EG | ED | 9 | 0 | FM | FK | FK | FS | 0 | GB | GB | GB | GH | GO S | JE | JK | JK | JK | JK |
| Capacitance | Cap | Rated | l Volt | tage | e (V | DC) | 20(| 63(| 1,00 | 20(| 63(| 1,00 | 20(| 63(| 1,00 | 1,50 | 2,00 | 20(| 63(| 1,00 | 1,50 | 2,00 | 20(| 63(| 1,00 | 1,50 | 2,00 | 20(| 63(| 1,00 | 1,50 | 2,00 |
| | Code | V | oltag | je C | ode | | C | B | D | l c | B | D | C | B | D | F | G | C | B | D | F | G | C | B | D | F | G | | B | U | F | G |
| | | Case | e Siz | ze/S | Seri | es | 0 | 060 | 3C | C | 080 | 5C | | C | 1206 | C | | | C | 1210 |)C | | | C | 1812 | 2C | | 1 | C | 2220 | IC | |



Table 1A - Standard Termination Capacitance Range/Selection Waterfall(0603 - 2220 Case Sizes) cont.

| | | | Ca | se | Si | ze | /S | er | es | C | 06 | 03 | BC | C |)80 |)5C | | | C1 | 206 | 5C | | | С | 121(| C | | | C | 181: | 2C | | | C | 222 | C | |
|-------------|------|----|--|------|----------------|------|----------|-------|-----|-----|-----|-----|-------|-----|-----|-------|------------|--------|-----------|-------|-------|-------|----------|------|--------|-------|-------|------|------|-------|-------|-------|------|-----|-------|----------|-------|
| Canacitance | Сар | | | Vo | Ita | ge (| Co | de | | C | E | 3 | D | C | В | D | | c | в | D | F | G | C | В | D | F | G | C | В | D | F | G | C | В | D | F | G |
| Capacitance | Code | | Ra | ated | Vo | ltaç | je (| VD | ;) | 500 | 003 | 020 | 1,000 | 500 | 630 | 1,000 | 001 | 000 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 |
| | | | Cap | aci | tan | ce ' | Tol | era | nce | | | | | | | | | | Pı | rodu | ct A | vaila | bilit | y an | d Chi | p Th | ickn | ess | Code | es | | | | | | | |
| 1 000 - 5 | 100 | | | | Г | 0 | | | | _ | | | | DN | DN | | Tr | · - | FO | See | lab | e 21 | or C | hip | I hick | nes | s Din | nens | IONS | 0.0 | 011 | 00 | L IE | 11/ | 11/ | | 15 |
| 1,300 pF | 152 | | | | | 0 | , I , | JI | | | | | | | | | | | | ED | | | | F3 | F3 | | | | GB | GB | GH | 60 | JE | JK | JK | JK | JE |
| 1,500 pF | 152 | | | | | 0 | , I , | JI | | | | | | | | | | | | ED | | | | F3 | F3 | | | | GB | GB | GK | GO | JE | JK | JK | JK | JE |
| 1,600 pF | 102 | Ł | | | F | 6 | , , | JI | | | | | | DP | DP | | | | EG | ED | | | FK | F5 | F5 | | | GB | GD | GD | GK | | JE | JK | JK | JK | JE |
| 1,800 pF | 182 | | | | | 6 | , · | J I | | | | | | | | | | | EG | EF | | | FK | 15 | 15 | | | GB | GD | GD | GM | | JE | JK | JK | JK | JE |
| 2,000 pF | 202 | | | | | 6 | <u>'</u> | J 1 | | | | | | DG | DG | | | 6 | EB | EF | | | FK | FL | 15 | | | GB | GH | GH | GM | | JE | JK | JK | JE | JK |
| 2,200 pF | 222 | | | | | 6 | , · | J I | | | | | | DG | | | | 6 | EB | EF | | | FK | FL | 15 | | | GB | GH | GH | 60 | | JE | JK | JK | JE | JK |
| 2,400 pF | 242 | | | | | 6 | j, | J I | | | | | | DG | DG | | | G | ER | EG | | | FS | FL | FS | | | GB | GH | GK | GO | | JK | JK | JK | JE | JL |
| 2,700 pF | 272 | ł. | | | F | 0 | י ו י | J I | | | | | | DG | DG | | | 6 D | EB | EG | | | 15 | FL | 15 | | | GB | GH | GK | GU | | JK | JK | JK | JE | JL |
| 3,000 pF | 302 | | | | | 0 | , · | J I | | | | | | | | | | B | EB | | | | 15 | FL | FF | | | GB | GH | GK | | | JK | JK | JK | JE | JL |
| 3,300 pF | 332 | | | | | 0 | , · | J I | | | | | | | | | | B | EB | | | | 15 | FM | FG | | | GB | GH | GK | | | JK | JK | JK | JK | JN |
| 3,600 pF | 362 | | | | | 0 | , · | J I | | | | | | | | | | | EC | | | | FL | FM | FG | | | GB | GH | GM | | | JK | JK | JK | JK | JN |
| 3,900 pF | 392 | | | | | 0 | , · | J I | | | | | | | | | | | | | | | FL | FY | FL | | | GB | GH | GM | | | JK | JK | JK | JK | JN |
| 4,300 pF | 432 | Ł | | | E F | 0 | , r | JI | | | | | | | | | | D | ED | | | | FM | FY | FL | | | GH | GH | 60 | | | JK | JK | JK | JK | |
| 4,700 pF | 4/2 | | | | | 6 | j, | J I | | ! | | | | | | | | | ED | | | | FM | FY | FM | | | GH | GH | GO | | | JK | JK | JK | JL | |
| 5,100 pF | 512 | | | | | 6 | j, | J I | | ! | | | | | | | | E | EE | | | | FY | FS | FM | | | GH | GK | GO | | | JK | JK | JK | JL | |
| 5,600 pF | 562 | | | | F | 6 | j , | J | | | | | | | | | | | EF | | | | FY | FS | FM | | | GH | GK | GO | | | JK | JK | JK | JN | |
| 6,200pF | 622 | | | | F | 6 | j , | J | | | | | | | | | | :F | EF | | | | FY | FE | FY | | | GH | GK | GH | | | JK | JE | JE | JN | |
| 6,800pF | 682 | ł. | | | F | 6 | j , | JI | | | | | | | | - | E | G | EG | _ | | | FY | FE | FY | | | GH | GM | GH | | | JK | JE | JK | JN | |
| 7,500pF | /52 | | | | F | 6 | j , | JI | | | | | | | | | E | G | EG | | | | FS | FF | FS | | | GH | GM | GK | | | JK | JE | JK | | |
| 8,200 pF | 822 | | | | F | G | i . | Jŀ | | | | | | | | | | G | EG | | | | FS | | FS | | | GK | GO | GK | | | JK | JE | JL | | |
| 9,100 pF | 912 | | | | F | G | ; . | Jŀ | | | | | | | | | E | G | EG | | | | FF | FF | FS | | | GM | GO | GM | | | JE | JE | JL | | |
| 10,000 pF | 103 | | F G J K F G J K | | | | | | | | | | | E | н | EH | | | | FG | FG | FS | | | GM | GO | GM | | | JE | JE | JL | | | | | |
| 12,000 pF | 123 | ł. | | | F | 0 | ; , | Jł | | | | | | | | | | | | | | | FG | FG | | | | GO | GH | GO | | | JE | JK | JN | | |
| 15,000 pF | 153 | | | | F | 0 | ; . | J | | | | | | | | | | | | | | | FM | FM | | | | GO | GH | GO | | | JE | JL | JE | | |
| 18,000 pF | 183 | | FGJK FGJK FGJK | | | | | | | | | | | | | | | | | FM | FM | | | | GH | GH | | | | JE | JL | JE | | | | | |
| 22,000 pF | 223 | | | | F | 0 | ; . | J | | | | | | | | | | | | | | | FY | FY | | | | GH | GH | | | | JK | JN | JK | | |
| 27,000 pF | 273 | | | | F | 0 | ; . | J | | | | | | | | | | | | | | | FS | FS | | | | GK | GK | | | | JL | JN | JL | | |
| 33,000 pF | 333 | ł. | - | | F | 0 | ; , | Jŀ | | | | | | | | - | | _ | _ | _ | | | FS | FS | | | | GM | GM | | | | JN | JE | JN | | |
| 39,000 pF | 393 | | | | F | 0 | ; , | J | | | | | | | | | | | | | | | | | | | | GO | GO | | | | JE | JE | | | |
| 47,000 pF | 473 | | | | F | 0 | ; , | J | | | | | | | | | | | | | | | | | | | | GO | GO | | | | JE | JE | | | |
| 56,000 pF | 563 | | | | F | 0 | ; , | J | | | | | | | | | | | | | | | | | | | | | | | | | JK | JK | | | |
| 68,000 pF | 683 | | | | F | G | ; , | J | | | | | | | | | | | | | | | | | | | | | | | | | JL | JL | | | |
| 82,000 pF | 823 | Ł | | | F | G |) , | Jł | | | | | | | | | | | | | | | | | | | | | | | | | JL | JL | | | |
| 0.1 µF | 104 | - | | | F | 0 | ; , | JI | | | - | _ | | | | _ | + | _ | _ | | | | <u> </u> | | | | | | | | | | JN | JN | | <u> </u> | |
| | Can | | Ra | ted | Vo | ltaç | ge | (VD | C) | 500 | 003 | 000 | 1,000 | 500 | 630 | 1,000 | 907 | 000 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 |
| Capacitance | Code | | | Vo | lta | ge (| Co | de | | C | F | 3 | D | C | В | D | (| C | B | D | F | G | C | В | D | F | G | C | В | D | F | G | C | В | D | F | G |
| | | | C | ase | se Size/Series | | | 0 | :06 | 03 | C | C | 080 | 5C | | | C 1 | 1206 | С | | | C | 1210 | C | | | C | 1812 | 20 | | | C | 2220 | C | | | |



Table 1B – Flexible Termination Capacitance Range/Selection Waterfall (0603 – 2220 Case Sizes)

| | | Case | Siz | e/\$ | Ser | ies | C | 060 | 3X | С | 080 | 5X | | C 1 | 1200 | 5X | | | C | 121(| DX | | | C | 181: | 2 X | | | C2 | 220 | ЭХ | |
|------------------------|-------------------|--------|--------|------|-------|------------------|-----|-----|-------|--------|-----|-------|----------|------------|-------------|--------------|----------|----------|---------------|---------------|-------------------|----------------|-------------|----------|-------|-------------------|---------|---------|----------|--------|-----------|-----------|
| Capacitance | Сар | Vo | oltage | e Co | ode | | C | B | D | C | B | D | C | В | D | F | G | C | B | D | F | G | C | В | D | F | G | C | В | D | F | G |
| | Code | Rated | l Volt | age | (VD | C) | 500 | 630 | 1,000 | 500 | 630 | 1,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 200 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 |
| | | Capaci | tance | e To | olera | nce | | | | | | | | Р | roau See | ct A Tabl | e 2 f | or C | y an hip 1 | a Ch Thick | ip in (nes | iickn s Din | ess 1ens | ions | es | | | | | | | |
| 1.0 - 9.1 pF* 10 pE | 109 - 169* 100 | B C D |) F | G | | км | | | | DG | DG | DG | FS | FS | FS | FS | FS | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | ік | ік | ІК | ік | ІК |
| 11 pF | 110 | | F | G | J | K M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 12 pF | 120 | | F | G | J | KM | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 13 pF 15 pF | 130 | | F | G | J | K M K M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 16 pF | 160 | | F | G | J | K M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 18 pF | 180 | | F | G | J | K M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 20 pF | 200 | | F | G | J | KM | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 22 pF | 220 | | F | G | J | K M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 24 pr 27 nF | 240 | | F | G | J | K M | | | | | | DG | ES | ES ES | ES | ES ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 30 pF | 300 | | F | G | J | K M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 33 pF | 330 | | F | G | J | кМ | 1 | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 36 pF | 360 | | F | G | JI | KM | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 39 pF | 390 | | | G | J | K M K M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 43 pr 47 pF | 470 | | F | G | J | KM | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 51 pF | 510 | | F | G | J | к м | | | | DG | DG | DG | ES | ES | ES | ES | ES | FΜ | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 56 pF | 560 | | F | G | J | KM | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 62 pF | 620 | | F | G | J | K M K M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM EM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 75 pF | 750 | | F | G | J | K M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 82 pF | 820 | | F | G | J | K M | | | | DG | DG | DG | ES | ES | ES | ES | EF | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 91 pF | 910 | | F | G | J | K M | | | | DG | DG | DG | ES | ES | ES | ES | EF | FM | FM | FM | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 100 pF | 101 | | F | G | J | KM | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | ES | EF | FM | FM | FM | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 110 pF 120 pF | 121 | | F | G | J | K M K M | | CI | CI | | | | ES FS | ES FS | ES FS | ES ES | EU | FM F7 | FM F7 | FM | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 130 pF | 131 | | F | G | J | K M | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | ES | EU | FZ | FZ | FZ | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 150 pF | 151 | | F | G | J | K M | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | EF | EU | FZ | FZ | FZ | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 160 pF | 161 | | F | G | J | K M | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | EF | EU | FZ | FZ | FZ | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 180 pF | 181 | | F | G | J | KM | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | EF | EU | FZ | FZ | FZ | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 200 pF | 201 | | | G | J | K M | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | EF | EU | FZ | FZ | | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 240 pF | 241 | | F | G | J | K M | C.J | CJ | 05 | DG | DG | DG | FS | FS | FS | FU | FU | FZ | F7 | F7 | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 270 pF | 271 | | F | G | J | K M | CJ | CJ | | DG | DG | DG | ES | ES | ES | EU | EU | FZ | FZ | FZ | FK | FK | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 300 pF | 301 | | F | G | J | к м | CJ | CJ | | DG | DG | DC | ES | ES | EF | EU | | FΖ | FZ | FZ | FK | FK | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 330 pF | 331 | | F | G | J | K M | CJ | CJ | | DG | DG | DC | ES | ES | EF | EU | | FΖ | FZ | FZ | FK | FK | GB | GB | GB | GB | GB | JE | JE | JE | JE | JE |
| 360 pF | 361 | | F | G | J | KM | CJ | CJ | | DG | DG | DC | ES | ES | EF | EU | | FZ | FZ | FZ | FK | FS | GB | GB | GB | GB | GD | JE | JE | JE | JE | JE |
| 390 pF 430 pF | 391 | | F | G | J | K M | | CI | | | DG | | ES | ES ES | EF | EU | | FZ | FZ | FZ | FK | FS | GB | GB | GB | GB | GD | JE | JE | JE | JE | JE |
| 470 pF | 471 | | F | G | J | KM | CJ | CJ | | DG | DG | DD | ES | ES | EU | EU | | FZ | FM | FM | FS | FS | GB | GB | GB | GB | GD | JE | JE | JE | JE | JE |
| 510 pF | 511 | | F | G | JI | K M | CJ | CJ | | DG | DG | DD | ES | ES | EU | EU | | FZ | FM | FM | FS | FS | GB | GB | GB | GD | GH | JK | JK | JK | JK | JK |
| 560 pF | 561 | | F | G | J | кМ | CJ | CJ | | DG | DG | DG | ES | ES | EU | EU | | FZ | FM | FM | FS | FS | GB | GB | GB | GD | GH | JK | JK | JK | JK | JK |
| 620 pF | 621 | | F | G | J | KM | CJ | CJ | | DG | DG | DG | ES | ES | EU | | | FZ | FM | FM | FS | FS | GB | GB | GB | GD | GH | JK | JK | JK | JK | JK |
| 680 pF | 681 | | F | G | J | K M | CJ | CJ | | DG | DG | DG | ES | ES | EU | | | FZ | FM | FM | FS | FS | GB | GB | GB | GD | GH | JE | JE | JE | JK | JK |
| 750 pF 820 pF | 821 | | F | G | J | K M | | | | | | | ES FS | FF | FII | | | FZ F7 | FM | FM | FM | | GB | GB | GB | GD | GK | JE | JE | JE | JK | JK |
| 910 pF | 911 | | F | G | J | K M | | | | DC | DC | | ES | EF | EU | | | FM | FM | FM | FY | | GB | GB | GB | GH | GM | JE | JK | JK | JK | JK |
| 1,000 pF | 102 | | F | G | J | кМ | | | | DC | DC | | ES | EF | EU | | | FM | FM | FM | FY | | GB | GB | GB | GH | GM | JE | JK | JK | JK | JK |
| 1,100 pF | 112 | | F | G | J | KM | | | | DC | DC | | EF | EU | ED | | | FM | FK | FK | FS | | GB | GB | GB | GH | GO | JE | JK | JK | JK | JK |
| 1,200 pF | 122 | Rated | Volt | G | | <u>к м</u> с) | 8 | 30 | 000 | 8 | ຄ | 000 | 8 | EU ee | ED | 500 | 000 | FM 8 | ⊦κ | FK 00 | FS 009 | 000 | GB | GB OS | GB | GH 005 | 60 8 | JE 8 | JK ee | JK | JK 009 | JK 000 |
| Capacitance | Cap Code | Vr | oltan | e Cr | ode | -, | C C | B | | ° C | B | | <u>с</u> | B | | ≓ F | 5'(D | C C | B | | ب ۲ | 5' 9 | ° C | ю В | | ب ج | ה' ק | ° C | B | ≓ ₽ | ≓ F | 5, D |
| | | Case | Siz | e/S | erie | es | C | 060 | 3X | C | 080 | 5X | | C | 1206 | X | | | C | :1210 |)X | | - | C | 1812 | 2X | | | C | 2220 | X | |



Table 1B - Flexible Termination Capacitance Range/Selection Waterfall(0603 - 2220 Case Sizes) cont.

| | | (| a | se | Si | ze | /S | er | ies | \$ | CO | 60 | 3X | С | 08 | 05 | X | | C | 120 | 6X | | | С | 121 | 0X | | | C | 181: | 2X | | | C | 222 | DX | |
|-------------|------|----|---|-----------------|-----|-------|----------|------|-------|-----|-----|-----|-------|-----|-----|----|-------|-----|-----|-------|-------|-------|-------|------|------------|-------|-------|------|------|-------|-------|-------|------|-----|-------|-------|-------|
| Canacitance | Сар | L | | Vo | lta | ge | Co | de | | | C | В | D | С | B | 3 | D | С | В | D | F | G | c | В | D | F | G | C | В | D | F | G | C | В | D | F | G |
| oupacitance | Code | | Ra | ted | Vo | ltaç | ge (| (VD | C) | | 500 | 630 | 1,000 | 500 | 630 | 2 | 1,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 |
| | | | Cap | acit | and | ce ' | Tol | lera | nce | | | | | | | | | | Ρ | rodu | ict A | vaila | bilit | y an | d Ch | ip Th | ickn | ess | Code | es | | | | | | | |
| 1.000 5 | 100 | ┝ | | | - | | | | | - | | | | | D | 0 | | | | See | Tab | le 2 | tor C | hip | Thick | cnes | s Din | nens | ions | 0.0 | 011 | 00 | 1 15 | 117 | 117 | 117 | 15 |
| 1,300 pF | 132 | L | | | | | j | J | | 1 | | | | DC | | | | EF | EU | ED | | | FM | FS | FS | | | GB | GB | GB | GH | GO | JE | JK | JK | JK | JE |
| 1,500 pF | 162 | | | | | | , , | J | KI | | | | | | | | | | EU | ED | | | FK | F5 | F5 | | | GB | GB | GB | GK | GO | JE | JK | JK | JK | JE |
| 1,000 pF | 102 | Ŀ | | | F | | י נ י | J | | | | | | | | | | EF | EU | ED | | | | F 5 | F 3 | | | | GD | GD | GK | | JE | JK | JK | JK | JE |
| 1,000 pF | 202 | | | | | | | J | | | | | | | | | | | EU | | | | | | го – го | | | | | | CM | | JE | | | JK | JE |
| 2,000 pF | 202 | | | | | | | J | | | | | | | | | | | | | | | | | г э с е | | | | СЦ | | CO | | JE | | | JE | |
| 2,200 pF | 242 | | | | | | | 1 | | | | | | | | | | | | | | | Ee | | E | | | CP | CL | GK | 60 | | | | | JL | JK |
| 2,400 pF | 242 | | | | | | | 1 | | | | | | | | | | | | | | | | | E | | | | CL | GK | 60 | | | | | JL | |
| 2,700 pr | 302 | Ŀ | | | F | | 2 | 1 | K | 4 | | | | 00 | | U | | FO | FO | LU | | | FS | FL | FF | | | GB | GH | GK | 00 | | IK | IK | IK | IE | |
| 3 300 pF | 332 | | | | F | | | | K N | 4 | | | | | | | | FO | FO | | | | FS | FM | FG | | | GB | GH | GK | | | JK | JK | JK | JK | .IN |
| 3 600 pF | 362 | | | | F | | | | K I | 4 | | | | | | | | FR | FR | | | | FI | FM | FG | | | GB | GH | GM | | | JK | JK | JK | JK | JN |
| 3 900 pF | 392 | L | | | F | | | J | K I | a l | | | | | | | | FR | FR | | | | FI | FY | FI | | | GB | GH | GM | | | JK | JK | JK | JK | JN |
| 4 300 pF | 432 | L | | | F | | | J | K I | a l | | | | | | | | FS | FS | | | | FM | FY | FI | | | GH | GH | GO | | | JK | JK | JK | JK | on |
| 4.700 pF | 472 | E | Г | I. | F | 6 | 3 | J | K I | и | | | | 1 | | Т | | ES | ES | | | | FM | FY | FM | | | GH | GH | GO | | _ | JK | JK | JK | JL | |
| 5.100 pF | 512 | L | | | F | | | J | ĸ | A I | | | | i i | | | | EE | EE | | | | FY | FS | FM | | | GH | GK | GO | | | JK | JK | JK | JL | |
| 5.200 pF | 562 | L | | | F | | | J | ĸ | A I | | | | i i | | | | EF | EF | | | | FY | FS | FM | | | GH | GK | GO | | | JK | JK | JK | JN | |
| 6.200pF | 622 | | | | F | | 3 | J | ĸ | N I | | | | 1 | | | | EF | EF | | | | FY | FE | FY | | | GH | GK | GH | | | JK | JE | JE | JN | |
| 6,800pF | 682 | İ. | | | F | 0 | 3 | J | кİ | и | | | | | | | | ΕU | EU | | | | FY | FE | FY | | | GH | GM | GH | | | JK | JE | JK | JN | |
| 7,500pF | 752 | Ĺ | | | F | | 3 | J | ĸ | И | | | | | | | | EU | EU | | | | FS | FF | FS | | | GH | GM | GK | | | JK | JE | JK | - | |
| 8,200pF | 822 | L | | | F | 6 | 3 | J | ĸI | 4 | | | | 1 | | | | ΕU | EU | | | | FS | FF | FS | | | GK | GO | GK | | | JK | JE | JL | | |
| 9,100 pF | 912 | L | | | F | 6 | 3 | J | ĸ | 4 | | | | 1 | | | | EU | EU | | | | FF | FF | FS | | | GМ | GO | GM | | | JE | JE | JL | | |
| 10,000 pF | 103 | | F G J K F G J K F G J K F G J K F G J K F G J K F G J K F G J K F G J K F G J K F G J K F G J K F G J K | | | K I | 4 | | | | | | | | EU | EU | | | | FG | FG | FS | | | GM | GO | GM | | | JE | JE | JL | | | | | |
| 12,000 pF | 123 | | | | F | 6 | 3 | J | ĸI | 4 | | | | | | | | | | | | | FG | FG | | | | GO | GH | GO | | | JE | JK | JN | | |
| 15,000 pF | 153 | | | | F | 6 | 3 | J | K I | И | | | | | | | | | | | | | FM | FM | | | | GO | GH | GO | | | JE | JL | JE | | |
| 18,000 pF | 183 | | FGJK FGJK FGJK | | | K I | И | | | | | | | | | | | | | FM | FM | | | | GH | GH | | | | JE | JL | JE | | | | | |
| 22,000 pF | 223 | | F G J K F G J K | | | K I | 4 | | | | | | | | | | | | | FY | FY | | | | GH | GH | | | | JK | JN | JK | | | | | |
| 27,000 pF | 273 | | F G J K F G J K | | | K M | И | | | | | | | | | | | | | FS | FS | | | | GK | GK | | | | JL | JN | JL | | | | | |
| 33,000 pF | 333 | | | | F | 0 | 3 | J | K M | И | | | | | | | | | | | | | FS | FS | | | | GМ | GM | | | | JN | JE | JN | | |
| 39,000 pF | 393 | | | | F | 0 | 3 | J | ĸI | 4 | | | | | | | | | | | | | | | | | | GO | GO | | | | JE | JE | | | |
| 47,000 pF | 473 | | | | F | 6 | 3 | J | K M | 4 | | | | | | | | | | | | | | | | | | GO | GO | | | | JE | JE | | | |
| 56,000 pF | 563 | | | | F | 6 | 3 | J | K M | 4 | | | | | | | | | | | | | | | | | | | | | | | JK | JK | | | |
| 68,000 pF | 683 | | | | F | 0 | 3 | J | K | N | | | | | | | | | | | | | | | | | | | | | | | JL | JL | | | |
| 82,000 pF | 823 | | | | F | 0 | 3 | J | KI | N | | | | | | | | | | | | | | | | | | | | | | | JL | JL | | | |
| 0.1 µF | 104 | | | | F | 0 | 3 | J | K I | И | | | | | | | | | | | | | | | | | | | | | | | JN | JN | | | |
| | Can | | Ra | ted | Vo | Ita | ge | (VC | C) | | 200 | 630 | 1,000 | 500 | 630 | 3 | 1,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 |
| Capacitance | Code | | | Vo | Ita | ge | Co | de | | | C | В | D | C | B | 3 | D | C | B | D | F | G | С | В | D | F | G | C | В | D | F | G | C | В | D | F | G |
| | | | Ca | ase Size/Series | | | T | C | 060 | 3X | C | 08 | 05) | (| | С | 120 | 5X | | | C | 1210 | X | | | C | 1812 | 2X | | | C | 2220 | X | | | | |



Table 1C – Automotive Standard Termination Capacitance Range/Selection Waterfall (0603 – 2220 Case Sizes)

| | | Case | Siz | ze/ | Se | rie | 5 | C0 | 60 | 3C | C | 080 | 5C | | C1 | 1200 | 5C | | | C | 1210 | DC | | | C | 181: | 2C | | | C2 | 220 | C | |
|------------------|------------|-------|-------|-------|------|----------|-------|----------|-------|--------|-----|-------|-------|-----|----------|-------------|--------------|----------------|---------------|---------------|----------------|---------------|----------------|--------------|-------|--------|-------|-------|-----|-------|-------|-------|-------|
| Capacitance | Сар | v | oltag | je C | ode | <u>.</u> | | C | В | D | С | В | D | C | В | D | F | G | С | В | D | F | G | C | В | D | F | G | С | В | D | F | G |
| | Code | Rate | d Vol | tage | e (V | DC) | | 200 | 630 | 1,000 | 500 | 630 | 1,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 |
| | | Capac | itanc | e T | ole | rance | | | | | | | | | Р | rodu See | ct A Tabl | vaila e 2 f | bilit or C | y an hip 1 | d Chi Fhick | ip Th (nes | lickn s Din | iess nens | Code | es | | | | | | | |
| 1.0 - 9.1 pF* | 109 - 919* | BCI | | _ | | V | | | | | DG | DG | DG | | | | ED. | ED. | ГМ | ГМ | ГМ | ГМ | ГМ | | CD | CD | CD | CD | | 11/2 | | 11/ | |
| 51 pF | 510 | | F | G | J | K | N N | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 56 pF | 560 | | F | G | J | K | N | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 62 pF | 620 | | F | G | J | K | И | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 68 pF | 680 | | F | G | J | K | M | | | | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 75 pF | 750 | | F | G | J | K | M | | | | DG | DG | DG | ED | ED | ED | ED | EF | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 82 pF 91 nF | 820 910 | | F | G | J | K | | | | | | | | | ED FD | | ED | FF | FM | FM | FM | FIM | FIVI | | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 100 pF | 101 | | F | G | J | K | йlа | G | CG | CG | DG | DG | DG | ED | ED | ED | ED | EF | FM | FM | FM | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 110 pF | 111 | | F | G | J | K | M C | G | CG | CG | DG | DG | DG | ED | ED | ED | ED | EG | FM | FM | FM | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 120 pF | 121 | | F | G | J | K | N O | G | CG | CG | DG | DG | DG | ED | ED | ED | ED | EG | FG | FG | FG | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 130 pF | 131 | | F | G | J | K | N O | G | CG | CG | DG | DG | DG | ED | ED | ED | ED | EG | FG | FG | FG | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 150 pF | 151 | | F | G | J | K | | CG | CG | CG | DG | DG | DG | ED | ED | ED | EF | EG | FG | FG | FG | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 160 pF | 101 | | F | G | J | K | | 3G 2G | CG | CG | DG | DG | DG | ED | ED | ED | EF | EG | FG | FG | FG | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 200 pF | 201 | | F | G | J | K | | 26 | | CG | | | | | | | FF | FG | FG | FG | FG | FM | FM | | GD | GD | GD | GD | IK | JK | JK | JK | JK |
| 220 pF | 221 | | F | G | J | K | u c | G | CG | CG | DG | DG | DG | ED | ED | ED | EG | EG | FG | FG | FG | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 240 pF | 241 | | F | G | J | K | иl | G | CG | | DG | DG | DG | ED | ED | ED | EG | EG | FG | FG | FG | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 270 pF | 271 | | F | G | J | K | иl | G | CG | | DG | DG | DG | ED | ED | ED | EG | EG | FG | FG | FG | FK | FK | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 300 pF | 301 | | F | G | J | K | M 0 | G | CG | | DG | DG | DN | ED | ED | EF | EG | | FG | FG | FG | FK | FK | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 330 pF | 331 | | F | G | J | K | | CG | CG | | DG | DG | DN | ED | ED | EF | EG | | FG | FG | FG | FK | FK | GB | GB | GB | GB | GB | JE | JE | JE | JE | JE |
| 360 pF 200 pE | 301 | | | G | J | ĸ | | 0 | | | | | | | ED | | EG | | FG | FG | FG | FK | F5 | | GB | GB | GB | GD | JE | JE | JE | JE | JE |
| 430 pF | 431 | | F | G | J | K | й I с | 2G | CG | | DG | DG | DP | FD | FD | FF | FG | | FG | FM | FM | FS | FS | GB | GB | GB | GB | GD | JF | JE | JE | JE | JE |
| 470 pF | 471 | | F | G | J | K | N C | G | CG | | DG | DG | DP. | ED | ED | EG | EG | | FG | FM | FM | FS | FS | GB | GB | GB | GB | GD | JE | JE | JE | JE | JE |
| 510 pF | 511 | | F | G | J | K | иlс | G | CG | | DG | DG | DP | ED | ED | EG | EG | | FG | FM | FM | FS | FS | GB | GB | GB | GD | GH | JK | JK | JK | JK | JK |
| 560 pF | 561 | | F | G | J | K | иlс | G | CG | | DG | DG | DG | ED | ED | EG | EG | | FG | FM | FM | FS | FS | GB | GB | GB | GD | GH | JK | JK | JK | JK | JK |
| 620 pF | 621 | | F | G | J | K | N O | G | CG | | DG | DG | DG | ED | ED | EG | | | FG | FM | FM | FS | FS | GB | GB | GB | GD | GH | JK | JK | JK | JK | JK |
| 680 pF | 681 | | F | G | J | K | M C | G | CG | | DG | DG | DG | ED | ED | EG | | | FG | FM | FM | FS | FS | GB | GB | GB | GD | GH | JE | JE | JE | JK | JK |
| 750 pF | 751 | | F | G | J | K | M | | | | DG | DG | DG | ED | EF | EG | | | FG | FM | FM | FM | | GB | GB | GB | GD | GK | JE | JE | JE | JK | JK |
| 820 pF | 821 | | | G | J | K | | | | | DG | DG | DG | ED | | EG | | | FG | FM | FM | FM | | GB | GB | GB | GD | GK | JE | JE | JE | JK | JK |
| 910 pF | 102 | | | G | J | K | | | | | | | | | FF | EG | | | FIVI | FIVI | FIVI | FI | | GB | GB | GB | СН | GM | | | JK | | JK |
| 1,000 pr | 102 | | F | G | J | K | Ň. | | | | | DN | | FF | FG | FD | | | FM | FK | FK | FS | | GB | GB | GB | GH | GO | JF | JK | JK | JK | JK |
| 1.200 pF | 122 | | F | G | J | K | M I | | | | DN | DN | - | EF | EG | ED | | | FM | FK | FK | FS | | GB | GB | GB | GH | GO | JE | JK | JK | JK | JK |
| 1,300 pF | 132 | | F | G | J | K | и | | | | DN | DN | | EF | EG | ED | | | FΜ | FS | FS | | | GB | GB | GB | GH | GO | JE | JK | JK | JK | JE |
| 1,500 pF | 152 | | F | G | J | K | И | | | | DP | DP | | EF | EG | ED | | | FK | FS | FS | | | GB | GB | GB | GK | GO | JE | JK | JK | JK | JE |
| 1,600 pF | 162 | | F | G | J | K | м | | | | DP | DP | | EF | EG | ED | | | FK | FS | FS | | | GB | GD | GD | GK | | JE | JK | JK | JK | JE |
| 1,800 pF | 182 | | F | G | J | K | И | | | | DG | DG | | EF | EG | EF | | | FK | FS | FS | | | GB | GD | GD | GM | | JE | JK | JK | JK | JE |
| 2,000 pF | 202 | | F | G | J | K | M | | | | DG | DG | | EG | EB | EF | | | FK | FL | FS | | | GB | GH | GH | GM | | JE | JK | JK | JE | JK |
| 2,200 pF | 222 | | F | G | J | K | M | | | | DG | DG | | EG | EB | EF | | | FK | FL | FS | | | GB | GH | GH | GO | | JE | JK | JK | JE | JK |
| 2,400 pF | 242 | | | G | J | K | | | | | | | | EG | EB | EG | | | FS EQ | FL | F5 | | | GB | GH | GK | 60 | | JK | JK | JK | JE | JL |
| 2,700 pF | 302 | | F | G | | K | | | | | | 00 | | FR | FR | 10 | | | FS | FL | FF | | | GB | GH | GK | 00 | | IK | IK | IK | JE | |
| 3.300 pF | 332 | | F | G | J | K | v. | | | | | | | EB | EB | | | | FS | FM | FG | | | GB | GH | GK | | _ | JK | JK | JK | JK | JN |
| 3,600 pF | 362 | | F | G | J | K | N | | | | | | | EC | EC | | | | FL | FM | FG | | | GB | GH | GM | | | JK | JK | JK | JK | JN |
| 3,900 pF | 392 | | F | G | J | K | и | | | | | | | EC | EC | | | | FL | FY | FL | | | GB | GH | GM | | | JK | JK | JK | JK | JN |
| 4,300 pF | 432 | | F | G | J | K | И | | | | | | | ED | ED | | | | FM | FY | FL | | | GH | GH | GO | | | JK | JK | JK | JK | |
| 4,700 pF | 472 | | F | G | J | K | N | | | | | | | ED | ED | | | | FM | FY | FM | | | GH | GH | GO | | | JK | JK | JK | JL | |
| 5,100 pF | 512 | | F | G | J | K | N | | | | | | | EE | EE | | | | FY | FS | FM | | | GH | GK | GO | | | JK | JK | JK | JL | |
| 5,600 pF | 562 | | F | G | J | K | N | | _ | 0 | | - | 0 | EF | EF | 0 | 0 | 6 | FY | FS | FM | 0 | 6 | GH | GK | GO | 0 | 9 | JK | JK | JK | JN | 9 |
| Capacitance | Cap | Rateo | l Vol | tag | e (V | /DC) | | 20 | 1 63(| , 1,00 | 500 | 1 63(| 1,00 | 500 | 1 63(| 1,00 | 1,50 | , 2,00 | 500 | 1 63(| , 1,00 | 1,50 | 2,00 | 500 | 1 63(| , 1,00 | 1,50 | 2,00 | 200 | 1 63(| 1,00 | 1,50 | 2,00 |
| | Code | V | oltag | je C | ode |) | + | 0 | B | D |) C | B | D | C | B | D | F | G | C | B | D | F | G | | B | D | F | G | C | B | D | F | G |
| | | Cas | e 512 | 2e/\$ | ser | ies | | U | 1003 | 56 | Ľ | 080 | 56 | | U | 1206 | 1 | | | C | 1210 | il. | | | C | 1012 | 26 | | | C: | 2220 | | |



Table 1C - Automotive Standard Termination Capacitance Range/Selection Waterfall(0603 - 2220 Case Sizes) cont.

| | | С | as | e S | iz | e/ | Se | rie | es | C | 060 | 3C | C | 80 | 805 | С | | C | 120 | 60 | ; | | | C | 121 | 0C | | | C | 181 | 2C | | | C | 222 | 0C | |
|-------------|------------|---|------|------|------|-----------|------|--------|----|-----|-----|-------|-----|-----|------|-------|-----|-----|-------|-------|-------|-------|-------|------|-------|-------------|-------|----------|----------|-------|----------|----------|-----|-----|-------|----------|-------|
| Canacitanco | Сар | | ١ | /olt | age | e C | ode | ; | | C | В | D | C | | B | D | С | В | D | 1 | F | G | C | В | D | F | G | C | В | D | F | G | C | В | D | F | G |
| Capacitance | Code | | Rate | ed V | /olt | age | • (V | DC) | | 500 | 630 | 1,000 | 500 | | 630 | 1,000 | 500 | 630 | 1,000 | 1 500 | 00¢'I | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 |
| | | c | apa | cita | nce | e To | olei | ran | ce | | | | | | | | | Ρ | rod | uct | Av | aila | bilit | y an | d Ch | ip Tł | nickr | iess | Code | es | | | | | | | |
| (000-5 | (00 | ┝ | | | г | 0 | | 1/ | | | | | - | | | | FF | FF | See | 2 1 8 | IDIE | 21 | | nip | | <u>cnes</u> | s Dir | nens | lons | 011 | | | | 15 | 15 | | 1 |
| 6,200pF | 602 | | | | | 6 | J | K | | | | | | | | | EF | EF | | | | | FY | FE | FY | | | GH | GK | GH | | | JK | JE | JE | | |
| 0,800µF | 08Z 752 | | | | | G | J | r v | | | | | | | | | EG | EG | | | | | FI | | FI | | | | GM | GR | | | | JE | | JN | |
| 8 200 pF | 822 | | | | F | G | J | K | M | | | | | T | | | EG | EG | | | | | FS | FF | FS | | | GK | GO | GK | | | IK | IF | II | | |
| 9 100 pF | 912 | | | | F | G | .1 | ĸ | м | | | | | | | | FG | FG | | | | | FF | FF | FS | | | GM | GO | GM | | | JE | JE | | | |
| 10.000 pF | 103 | | | | F | G | J | ĸ | м | | | | | | | | EH | EH | | | | | FG | FG | FS | | | GM | GO | GM | | | JE | JE | JL | | |
| 12.000 pF | 123 | | | | F | G | J | K | м | | | | | | | | | | | | | | FG | FG | | | | GO | GH | GO | | | JE | JK | JN | | |
| 15,000 pF | 153 | | | | F | G | J | K | м | | | | | | | | | | | | | | FM | FM | | | | GO | GH | GO | | | JE | JL | JE | | |
| 18,000 pF | 183 | 1 | | | F | G | J | K | М | | | | | | | | | | | | | | FM | FM | | | | GH | GH | | | | JE | JL | JE | | |
| 22,000 pF | 223 | | | | F | G | J | K | м | | | | | | | | | | | | | | FY | FY | | | | GH | GH | | | | JK | JN | JK | | |
| 27,000 pF | 273 | | | | F | G | J | K | м | | | | | | | | | | | | | | FS | FS | | | | GK | GK | | | | JL | JN | JL | | |
| 33,000 pF | 333 | | | | F | G | J | K | М | | | | | | | | | | | | | | FS | FS | | | | GM | GM | | | | JN | JE | JN | | |
| 39,000 pF | 393 | | | | F | G | J | K | Μ | | | | | | | | | | | | | | | | | | | GO | GO | | | | JE | JE | | | |
| 47,000 pF | 473 | | | | F | G | J | K | М | | | | | | | | | | | | | | | | | | | GO | GO | | | | JE | JE | | | |
| 56,000 pF | 563 | | | | F | G | J | K | М | | | | | | | | | | | | | | | | | | | | | | | | JK | JK | | | |
| 68,000 pF | 683 | | | | F | G | J | K | Μ | | | | | | | | | | | | | | | | | | | | | | | | JL | JL | | | |
| 82,000 pF | 823 | | | | F | G | J | K | M | | | | | | | | | | | | | | | | | | | | | | | | JL | JL | | | |
| 0.1 µF | 104 | - | | | F | G | J | K | M | | | | _ | _ | _ | | | | | _ | _ | | | | | | | <u> </u> | <u> </u> | | <u> </u> | <u> </u> | JN | JN | | <u> </u> | |
| | Can | | Rate | ed V | olt | age | e (V | DC |) | 500 | 630 | 1,000 | 500 | | 630 | 1,000 | 500 | 630 | 1,000 | 1 500 | nnc'i | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 |
| Capacitance | Code | | ١ | /olt | ag | e C | ode | ; | | C | В | D | C | | B | D | C | В | D | 1 | F | G | С | В | D | F | G | С | В | D | F | G | С | В | D | F | G |
| | | | Cas | se S | Siz | e/S | Ser | ies | ; | C | 060 | 3C | (| 208 | 8050 | ; | | C | 120 | 6C | | | | C | 1210 | C | | | C | 181 | 2C | | 1 | C | 2220 | C | - |



Table 1D – Automotive Flexible Termination Capacitance Range/Selection Waterfall (0603 – 2220 Case Sizes)

| | | Case | e Si | ze | /S | eri | es | C | 060 | 3X | С | 080 | 5X | | C | 1200 | 5X | | | C | 121(| DX | | | C | 181: | 2X | | | C2 | 220 | ЭХ | |
|------------------------|-------------------|----------|---------|---------------|-------|------------|----|-----|-----|-------|--------|-----|-------|----------|----------|----------|---------------|----------------------|--------|---------------|-----------------------|---------------|--------|--------------|------|---------|-------------------|---------|----------|-----------|----------|-----------|-----------|
| Capacitance | Сар | <u>'</u> | Volta | ge | Cod | le | | C | B | D | C | В | D | C | В | D | F | G | C | В | D | F | G | C | B | D | F | G | С | В | D | F | G |
| | Code | Rate | ed Vo | ltag | ge (' | VDC |) | 500 | 630 | 1,000 | 500 | 630 | 1,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 200 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 |
| | | Capa | citan | ce ' | Tol | eran | ce | | | | | | | | P | See | CT AV Tabl | vana <u>e 2 f</u> | or C | y an hip 1 | a Chi <u>Chick</u> | ip in (nes | s Din | iess nens | ions | es : | | | | | | | |
| 1.0 - 9.1 pF* 10 pF | 109 - 169* 100 | B C | DF | : 6 | | I K | м | | | | | DG | DG | ES | ES | FS | ES | FS | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | лк | .ік | ЛК | .ІК | .ік |
| 11 pF | 110 | | F | = G | 3 | I K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 12 pF | 120 | | F | 0 | 3 | I K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 13 pF 15 nF | 130 | | F | : U | | IK | M | | | | DG | DG | DG | ES | ES | ES | ES ES | ES ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK JK | JK .IK | JK JK | JK .IK | JK .IK |
| 16 pF | 160 | | F | : 0 | 3 | I K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 18 pF | 180 | | F | - 0 | 3 | ΙK | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 20 pF | 200 | | F | - 0 | 3 . | JK | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 22 pF 24 pF | 220 | | F | - 6 - 6 | j . | JK | M | | | | | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 27 pF | 270 | | F | : 6 | | , κ Ι κ | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 30 pF | 300 | | F | - 0 | 3 | JК | M | 1 | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 33 pF | 330 | | F | - 0 | 3 . | J К | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 36 pF | 360 | | F | - G |) . | IK | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 39 pF 43 nF | 390 430 | | F | ין י 1 נ | | I K | M | | | | | | DG | ES FS | ES ES | ES FS | ES | ES ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK JK | JK | JK | JK | JK |
| 47 pF | 470 | | F | : 0 | 3 | I K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 51 pF | 510 | | F | : 0 | 3 | I K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 56 pF | 560 | | F | - 0 | 3 . | I K | M | | | | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 68 pF | 680 | | F | | | IK | M | | | | | DG | DG | ES | ES | ES ES | ES | ES ES | FM | FM | FIVI | FM | FM | GB | GB | GB | GB | GB | JK JK | JK | JK | JK | JK |
| 75 pF | 750 | | F | : 0 | 3 | J K | M | | | | DG | DG | DG | ES | ES | ES | ES | EF | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 82 pF | 820 | | F | - 6 | 3 | JК | М | 1 | | | DG | DG | DG | ES | ES | ES | ES | EF | FM | FM | FM | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 91 pF | 910 | | F | - 0 | 3. | JK | M | | | | DG | DG | DG | ES | ES | ES | ES | EF | FM | FM | FM | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 100 pF | 101 | | | - 0 | j . | J∣K I k | M | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | ES | EL | | FM | FM | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 120 pF | 121 | | F | : 0 | | J K | M | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | ES | EU | FZ | FZ | FZ | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 130 pF | 131 | | F | : G | 3 | I K | M | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | ES | EU | FZ | FZ | FZ | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 150 pF | 151 | | F | : 6 | 3 | I K | М | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | EF | EU | FZ | FZ | FZ | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 160 pF | 161 | | F | 6 | 3 | IK | M | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | EF | EU | FZ | FZ | FZ | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 180 pF | 181 | | F | · (: | j | IK | M | CJ | CJ | CJ | DG | DG | DG | ES | ES | ES | EF | EU | | FZ | | FM | FM | GD | GD | GD | GD | GD | JK | JK | JK | JK | JK |
| 200 pF 220 nF | 201 | | F | : C | | I K | M | CJ | CJ | CJ | DG | DG | DG | FS | ES ES | FS | FU | FU | FZ | FZ | FZ | FM | FM | GB | GB | GB | GB | GB | JK | JK JK | JK | JK JK | JK |
| 240 pF | 241 | | F | - 6 | 3 | I K | M | CJ | CJ | | DG | DG | DG | ES | ES | ES | EU | EU | FZ | FZ | FZ | FM | FM | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 270 pF | 271 | | F | - 6 | 3 | J K | М | CJ | CJ | | DG | DG | DG | ES | ES | ES | EU | EU | FZ | FZ | FZ | FK | FK | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 300 pF | 301 | | F | - 6 | 3 | I K | М | CJ | CJ | | DG | DG | DC | ES | ES | EF | EU | | FZ | FZ | FZ | FK | FK | GB | GB | GB | GB | GB | JK | JK | JK | JK | JK |
| 330 pF | 331 | | F | | 3 . | JK | M | CJ | CJ | | DG | DG | DC | ES | ES | EF | EU | | FZ | FZ | FZ | FK | FK | GB | GB | GB | GB | GB | JE | JE | JE | JE | JE |
| 360 pF | 361 | | | - - | | J K I ⊮ | M | CJ | CJ | | | DG | | ES | ES | | EU | | | | | FK | FS | GB | GB | GB | GB | GD | JE | JE | JE | JE | JE |
| 430 pF | 431 | | F | : 6 | 3 | J K | M | CJ | CJ | | DG | DG | DD | ES | ES | EF | EU | | FZ | FM | FM | FS | FS | GB | GB | GB | GB | GD | JE | JE | JE | JE | JE |
| 470 pF | 471 | | F | : G | 3 | I K | M | CJ | CJ | | DG | DG | DD | ES | ES | EU | EU | | FZ | FM | FM | FS | FS | GB | GB | GB | GB | GD | JE | JE | JE | JE | JE |
| 510 pF | 511 | | F | : G | 3 | IК | M | CJ | CJ | | DG | DG | DD | ES | ES | EU | EU | | FZ | FM | FM | FS | FS | GB | GB | GB | GD | GH | JK | JK | JK | JK | JK |
| 560 pF | 561 | | F | G | 3 | IK | M | CJ | CJ | | DG | DG | DG | ES | ES | EU | EU | | FZ | FM | FM | FS | FS | GB | GB | GB | GD | GH | JK | JK | JK | JK | JK |
| 620 pF | 621 | | F | G | i . | IK | M | CJ | CJ | | DG | DG | DG | ES | ES | EU | | | FZ | FM | FM | FS | FS | GB | GB | GB | GD | GH | JK | JK | JK | JK | JK |
| 750 nF | 751 | | | : C | | i k | M | | 00 | | DG | DG | DG | ES | ES | EII | | | | FM | FM | FM | гэ | GB | GB | GB | GD | GK | JF | JE | JE | JK | JK |
| 820 pF | 821 | | F | : 0 | | I K | M | | | | DG | DG | DG | ES | EF | EU | | | FZ | FM | FM | FM | | GB | GB | GB | GD | GK | JE | JE | JE | JK | JK |
| 910 pF | 911 | | F | = G | 3 | I K | М | | | | DC | DC | | ES | EF | EU | | | FM | FM | FM | FY | | GB | GB | GB | GH | GM | JE | JK | JK | JK | JK |
| 1,000 pF | 102 | | F | 6 | 3 | I K | М | | | | DC | DC | | ES | EF | EU | | | FM | FM | FM | FY | | GB | GB | GB | GH | GM | JE | JK | JK | JK | JK |
| 1,100 pF | 112 | | F | | | IK | M | | | | DC | DC | | EF | EU | ED | | | FM | FK | FK | FS | | GB | GB | GB | GH | GO | JE | JK | JK | JK | JK |
| 1,200 μ Γ | 122 | Rate | ed Vo | ltad | ge (| VDC |) | 8 | 330 | 000 | 8 | 30 | 000 | 00 | 330 | 000 | 500 | 000 | 005 | 30 | 000 | 500 | 000 | 00 | 30 | 000 | 200 | 000 | JU 005 | 30 1 | 000 | 500 2 | 000 |
| Capacitance | Cap Code | | Volta | ge | Cod | le | , | C C | B | | ۳ C | B | | C C | B | | | °, G | ۳ د | B | | | ° G | ۳ C | B | | ر F | ດ່ G | ۳ د | B | -` D | -* F | c' G |
| | | Cas | se Si | ize/ | /Se | ries | 5 | c | 060 | 3X | C | 080 | 5X | | C | 1206 | X | [| | C | 1210 |)X | | | C | 1812 | 2X | 1 | | C | 2220 | X | |



Table 1D – Automotive Flexible Termination Capacitance Range/Selection Waterfall (0603 – 2220 Case Sizes) cont.

| | | (| Cas | se | Si | ze | e/S | Se | rie | S | C |)60 | 3X | С | 08 | 05 | X | | C | 120 | 6X | | | | C | 121 | DX | | | C | 181: | 2X | | | C | 222 | OX | |
|-------------|------|---|---|------|---------------|-------|--------|-----|-----|-----|-----|-----|-------|-----|-----|-----|-------|-----|-----|-------|-------|-------|-----|--------|---------------|---------------|-------|-------|------|-----|-------|-------|-------|------|-----|-------|-------|-------|
| Canacitance | Сар | Г | | Vo | lta | ge | Co | de | | | C | В | D | C | B | 3 | D | С | В | D | F | G | | C | В | D | F | G | C | В | D | F | G | C | В | D | F | G |
| Capacitance | Code | | Ra | ited | Vo | lta | ge | (VC |)C) | | 500 | 630 | 1,000 | 500 | 630 | 2 | 1,000 | 500 | 630 | 1,000 | 1.500 | 2.000 | | 200 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 |
| | | | Cap | acit | tan | ce | То | ler | anc | e | | | | | | | | | Р | rodu | ICt / | Avai | lab | Dility | y an hin 1 | d Ch Chial | ip Th | | iess | Cod | es | | | | | | | |
| 1 300 pE | 132 | | | | F | : (| 2 | T | ĸ | м | | | | DC | D | r | | FF | FII | FD | Idi | | | FM | F S | FS | lies | ווע צ | | GR | GB | СH | 60 | IF | IK | IK | IK | IE |
| 1,500 pr | 152 | | | | L F | : . | 3 | .i | ĸ | м | | | | | | | | FF | FII | FD | | | | FK | FS | FS | | | GB | GB | GB | GK | GO | JE | JK | JK | JK | JE |
| 1,600 pF | 162 | | | | E F | : (| G | Ĵ | ĸ | м | | | | DD | D | D | | EF | EU | ED | | | | FK | FS | FS | | | GB | GD | GD | GK | | JE | JK | JK | JK | JE |
| 1.800 pF | 182 | Г | Г | Т | L F | : (| G | J | ĸ | м | | | | DG | D | G | | EF | EU | EF | | | Т | FK | FS | FS | | | GB | GD | GD | GM | | JE | JK | JK | JK | JE |
| 2.000 pF | 202 | | | | F | : (| G | J | ĸ | м | | | | DG | D | G | | EU | EO | EF | | | | FK | FL | FS | | | GB | GH | GH | GM | | JE | JK | JK | JE | JK |
| 2,200 pF | 222 | L | | | F | : (| G | J | к | м | | | | DG | D | G | | EU | EQ | EF | | | I | FK | FL | FS | | | GB | GH | GH | GO | | JE | JK | JK | JE | JK |
| 2,400 pF | 242 | L | | | F | : (| G | J | ĸ | м | | | | DG | D | G | | EU | EQ | EU | | | | FS | FL | FS | | | GB | GH | GK | GO | | JK | JK | JK | JE | JL |
| 2,700 pF | 272 | | | | F | : (| G | J | ĸ | м | | | | DG | D | G | | EU | EQ | EU | | | | FS | FL | FS | | | GB | GH | GK | GO | | JK | JK | JK | JE | JL |
| 3,000 pF | 302 | | | | F | : (| G | J | K | М | | | | | | | | EQ | EQ | | | | | FS | FL | FF | | | GB | GH | GK | | | JK | JK | JK | JE | JL |
| 3,300 pF | 332 | | | | F | : (| G | J | K | М | | | | | | | | EQ | EQ | | | | | FS | FΜ | FG | | | GB | GH | GK | | | JK | JK | JK | JK | JN |
| 3,600 pF | 362 | | | | F | : (| G | J | K | М | | | | | | | | ER | ER | | | | | FL | FΜ | FG | | | GB | GH | GM | | | JK | JK | JK | JK | JN |
| 3,900 pF | 392 | | | | F | : (| G | J | K | М | | | | | | | | ER | ER | | | | | FL | FY | FL | | | GB | GH | GM | | | JK | JK | JK | JK | JN |
| 4,300 pF | 432 | | | | F | : (| G | J | K | М | | | | | | | | ES | ES | | | | | FM | FY | FL | | | GH | GH | GO | | | JK | JK | JK | JK | |
| 4,700 pF | 472 | | | | F | : (| G | J | K | М | | | | | | | | ES | ES | | | | | FM | FY | FM | | | GH | GH | GO | | | JK | JK | JK | JL | |
| 5,100 pF | 512 | | | | F | - (| G | J | K | М | | | | | | | | EE | EE | | | | | FY | FS | FM | | | GH | GK | GO | | | JK | JK | JK | JL | |
| 5,200 pF | 562 | | | | F | - (| G | J | K | М | | | | | | | | EF | EF | | | | | FY | FS | FM | | | GH | GK | GO | | | JK | JK | JK | JN | |
| 6,200pF | 622 | | F G J F F F G J F F F G J F F F G J F F F G J F F F G J F F F G J F F F G J F F F G J F F F G J F F G J F F F G J F F G J F F F G J F F G J F F F G J F F F G F F F G F F F G F F F G F F F G F F F G F F F G F F F G F F F G F F F G F F F G F F F G F F F G F F F G F F F G F F F G F F F G F F F G F F F F G F | | | | K | М | | | | | | | | EF | EF | | | | | FY | FE | FY | | | GH | GK | GH | | | JK | JE | JE | JN | | | |
| 6,800pF | 682 | L | F G J | | | | K | M | | | | | | | | EU | EU | | | | ł | FY | FE | FY | | | GH | GM | GH | | | JK | JE | JK | JN | | | |
| 7,500pF | /52 | | F G J | | | | ĸ | M | | | | | | | | EU | EU | | | | | 13 | | F5 | | | GH | GM | GK | | | JK | JE | JK | | | | |
| 8,200 pF | 012 | | F G J | | | | r v | | | | | | | | | | EU | | | | | F3 | FF | F3 | | | | 60 | GK | | | JK | JE | JL | | | | |
| 10 000 pF | 103 | | F G J F G J < | | | | ĸ | м | | | | | | | | FII | FII | | | | | FG | FG | FS | | | GM | 60 | GM | | | IF | IF | | | | | |
| 12,000 pF | 103 | | F G J K F G K J K F G K F G K J K F G K F G K J K F G | | | | ĸ | м | | | | | | | | LU | | | | | | FG | FG | 15 | | | 60 | GH | 60 | | | IF | IK | | | | | |
| 15,000 pF | 153 | Г | F G J K F G J K F G J K F G J K F G J K F G J K F G J K F G J K F G J K F G J K F G J K F G J K | | | ĸ | м | | | | | | Т | | | | | | | Т | FM | FM | | | | GO | GH | GO | | | JE | | JE | | | | | |
| 18,000 pF | 183 | | F G J K F G J K F G J K F G J K | | | ĸ | м | | | | | | | | | | | | | | FM | FM | | | | GH | GH | 00 | | | JF | JI | JF | | | | | |
| 22.000 pF | 223 | | F G J K F G J K F G J K | | | ĸ | м | | | | | | | | | | | | | | FY | FY | | | | GH | GH | | | | JK | JN | JK | | | | | |
| 27.000 pF | 273 | | FGJK FGJK FGJK | | | ĸ | м | | | | | | | | | | | | | | FS | FS | | | | GK | GK | | | | JL | JN | JL | | | | | |
| 33,000 pF | 333 | L | | | F | : (| G | J | к | м | | | | | | | | | | | | | I | FS | FS | | | | GМ | GM | | | | JN | JE | JN | | |
| 39,000 pF | 393 | | | | F | : (| G | J | K | м | | | | | | | | | | | | | 1 | | | | | | GO | GO | | | | JE | JE | | | |
| 47,000 pF | 473 | | | | F | : (| G | J | ĸ | м | | | | 1 | | | | | | | | | | | | | | | GO | GO | | | | JE | JE | | | |
| 68,000 pF | 683 | | | | F | : (| G | J | K | м | | | | | | | | | | | | | | | | | | | | | | | | JL | JL | | | |
| 82,000 pF | 823 | | | | F | : (| G | J | K | м | | | | | | | | | | | | | | | | | | | | | | | | JL | JL | | | |
| 0.1 µF | 104 | | | | F | : (| G | J | Κ | М | | | | | | | | | | | | | | | | | | | | | | | | JN | JN | | | |
| | Can | | Ra | ted | Vo | lta | ge | (V | DC) | | 500 | 630 | 1,000 | 500 | 620 | 3 | 1,000 | 500 | 630 | 1,000 | 1.500 | 2.000 | | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1,000 | 1,500 | 2,000 |
| Capacitance | Code | L | Voltage Code Case Size/Series | | | | | С | В | D | c | B | 3 | D | C | В | D | F | G | | C | В | D | F | G | c | В | D | F | G | С | В | D | F | G | | | |
| | | | C | ase | e Size/Series | | | | C | 060 | 3X | C | 08 | 05) | (| | C | 120 | 5X | | | | C | 1210 | X | | | C | 1812 | 2X | | | C | 2220 | X | | | |



Performance and Reliability: Test Methods and Conditions

| Test | Reference | Test Condition | Limits |
|---|-------------------|--|---|
| Visual and Mechanical | KEMET Internal | No defects that may affect performance (10X) | Dimensions according KEMET Spec Sheet |
| Capacitance (Cap) | KEMET Internal | $\label{eq:constraint} \begin{array}{c} C \leq 1,000 \ \text{pF} \\ \text{Frequency: 1 MHz } \pm 100 \ \text{kHz} \\ \text{Voltage*:1.0 V}_{\text{rms}} \pm 0.2 \ \text{V} \\ C > 1,000 \ \text{pF} \\ \text{Frequency: 1 kHz } \pm 50 \ \text{Hz} \\ \text{Voltage: 1.0 V}_{\text{rms}} \pm 0.2 \ \text{V} \\ \text{* See part number specification sheet for voltage} \end{array}$ | Within Tolerance |
| Dissipation Factor (DF) | KEMET Internal | $\label{eq:constraint} \begin{array}{c} C \leq 1,000 \ \text{pF} \\ \text{Frequency: 1 MHz } \pm 100 \ \text{kHz} \\ \text{Voltage*:1.0 V}_{\text{rms}} \pm 0.2 \ \text{V} \\ C > 1,000 \ \text{pF} \\ \text{Frequency: 1 kHz } \pm 50 \ \text{Hz} \\ \text{Voltage: 1.0 V}_{\text{rms}} \pm 0.2 \ \text{V} \\ \end{array}$ * See part number specification sheet for voltage | Within Specification Dissipation factor (DF) maximum limit at 25°C = 0.1% |
| Insulation | KEMET | | Within Specification To obtain IR limit, divide MΩ-μF value by the capacitance and |
| Resistance (IR) | Internal | SUU VDC applied for 120 ±5 seconds at 25°C | compare to $\ensuremath{G\Omega}$ limit. Select the lower of the two limits. |
| | | | 1,000 megaohm microfarads or 100 G Ω . |
| Temperature Coefficient of Capacitance (TCC) | KEMET Internal | Capacitance change with reference to +25°C and 0 VDC applied. * See part number specification sheet for voltage $\frac{\hline Step}{1} \frac{\hline Temperature (°C)}{1} \frac{1}{+25°C} \frac{2}{2} \frac{-55°C}{3} \frac{2}{+25°C (Reference)}$ | Within Specifcation ±30 ppm/°C *Except 1812 ≥ 6.2 nF and 2220 ≥ 15 nF ±30 ppm/°C from -55°C to +125°C ±60 ppm/°C from +125°C to +150°C |
| | | 4 +150°C | |
| Dielectric Withstanding Voltage (DWV) | KEMET Internal | See Dielectric Withstanding Voltage (DWV) Table (5 ±1 seconds and charge/discharge not exceeding 50 mA) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit Withstand test voltage without insulation breakdown or damage. |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | KEMET Internal | Maximum % capacitance loss/decade hour | 0% Loss/Decade Hour |



Performance and Reliability: Test Methods and Conditions cont.

| Test | Reference | Test Condition | Limits |
|-----------------------------|---------------------------|--|---|
| Terminal Strength | KEMET Internal | Shear stress test per specific case size, Time: 60±1 secondsCase SizeForce04023N06035N08059N≥120618N | No evidence of mechanical damage |
| Board Flex | AEC-Q200-005 | 3.0 mm minimum Test time: 60± 5 seconds Ramp time: 1 mm/second | No evidence of mechanical damage |
| Solderability | J-STD-002 | Condition: 4 hours ± 15 minimum at 155°C dry bake apply all methods Test 245 ± 5°C (SnPb & Pb-Free) | Visual Inspection. 95% coverage on termination. No leaching. |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to +150°C) 2 – 3 cycles per hour Soak Time 1 or 5 minutes | Measurement at 24 hours ±4 hours after test conclusion. Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and 200 VDC maximum. Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5% |
| Moisture Resistance | MIL-STD-202 Method 106 | Number of cycles required 10, 24 hours per cycle. Steps 7a and 7b not required | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5% |
| Thermal Shock | MIL-STD-202 Method 107 | Number of cycles required 5, (-55°C to 150°C) Dwell time 15 minutes. | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| High Temperature Life | MIL-STD-202 | 1,000 hours at 150°C with 1.0 X rated voltage applied | Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift |
| Storage Life | Method 108 | 1,000 hours at 150°C, Unpowered | IR: 10% of Initial Limit DF: 0.5% |



Performance and Reliability: Test Methods and Conditions cont.

| Test | Reference | Test Condition | Limits |
|---------------------------|---------------------------|---|---|
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Test from 10 – 2,000 Hz | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Mechanical Shock | MIL-STD-202 Method 213 | 1,500 g's 0.5 ms Half-sine, Velocity Change 15.4 feet/second (Condition F) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents. | Visual Inspection 10X Readable marking, no decoloration or stains. No physical damage. |

Table 2A – Standard Termination Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic (| Quantity | |
|-----------|-------------------|-------------|---------|----------------------|------------------|----------|--|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| CG | 0603 | 0.80 ± 0.10 | 4000 | 15000 | 0 | 0 | |
| DN | 0805 | 0.78 ± 0.10 | 4000 | 15000 | 0 | 0 | |
| DP | 0805 | 0.90 ± 0.10 | 4000 | 15000 | 0 | 0 | |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | |
| EB | 1206 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 | |
| EC | 1206 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 | |
| ED | 1206 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 | |
| EE | 1206 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 | |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 | |
| EG | 1206 | 1.60 ± 0.15 | 0 | 0 | 2,000 | 8,000 | |
| EH | 1206 | 1.60 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| FE | 1210 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 | |
| FF | 1210 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 | |
| FG | 1210 | 1.25 ± 0.15 | 0 0 | | 2,500 | 10,000 | |
| FL | 1210 | 1.40 ± 0.15 | 0 0 | | 2,000 | 8,000 | |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| FY | 1210 | 2.00 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| FK | 1210 | 2.10 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1,000 | 4,000 | |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 | |
| GD | 1812 | 1.25 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| GH | 1812 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| GK | 1812 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 | |
| GM | 1812 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 | |
| GO | 1812 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 | |
| JE | 2220 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| JK | 2220 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 | |
| JL | 2220 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 | |
| JN | 2220 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 | |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic Quantity | | |

Package quantity based on finished chip thickness specifications.



Table 2B - Flexible Termination Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic (| Quantity | |
|-----------|-------------------|-------------|---------|----------------------|------------------|----------|--|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| CJ | 0603 | 0.80 ± 0.15 | 4000 | 15000 | 0 | 0 | |
| DC | 0805 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 | |
| DD | 0805 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 | |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | |
| EQ | 1206 | 0.78 ± 0.20 | 0 | 0 | 4,000 | 10,000 | |
| ER | 1206 | 0.90 ± 0.20 | 0 | 0 | 4,000 | 10,000 | |
| ED | 1206 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 | |
| ES | 1206 | 1.00 ± 0.20 | 0 | 0 | 2,500 | 10,000 | |
| EE | 1206 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 | |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 | |
| EU | 1206 | 1.60 ± 0.25 | 0 | 0 | 2,000 | 8,000 | |
| FZ | 1210 | 1.25 ± 0.20 | 0 | 0 | 2,500 | 10,000 | |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| FE | 1210 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 | |
| FF | 1210 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 | |
| FG | 1210 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | |
| FL | 1210 | 1.40 ± 0.15 | 0 | 0 | 2,000 | 8,000 | |
| FY | 1210 | 2.00 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| FK | 1210 | 2.10 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1,000 | 4,000 | |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 | |
| GD | 1812 | 1.25 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| GH | 1812 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| GK | 1812 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 | |
| GM | 1812 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 | |
| GO | 1812 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 | |
| JE | 2220 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | |
| JK | 2220 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 | |
| JL | 2220 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 | |
| JN | 2220 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 | |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic Quantity | | |

Package quantity based on finished chip thickness specifications.



Table 2C – Automotive Standard Termination Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic | Quantity |
|-----------|---------------------------|------------------------------------|---------|-----------------------|------------|----------|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| CG | 0603 | 0.80 ± 0.10 | 4000 | 15000 | 0 | 0 |
| DN | 0805 | 0.78 ± 0.10 | 4000 | 15000 | 0 | 0 |
| DP | 0805 | 0.90 ± 0.10 | 4000 | 15000 | 0 | 0 |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EB | 1206 | 0.78±0.10 | 0 | 0 | 4,000 | 10,000 |
| | 1200 | 0.90 ± 0.10 1.00 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| | 1200 | 1.00 ± 0.10 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FF | 1200 | 1.10 ± 0.10 1 20 + 0 15 | 0 | 0 | 2,500 | 10,000 |
| FG | 1200 | 1.60 + 0.15 | 0 | 0 | 2,000 | 8,000 |
| EH | 1206 | 1.60 ± 0.20 | 0 | 0 | 2.000 | 8,000 |
| FE | 1210 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FF | 1210 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FG | 1210 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| FL | 1210 | 1.40 ± 0.15 | 0 | 0 | 2,000 | 8,000 |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FY | 1210 | 2.00 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FK | 1210 | 2.10 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1,000 | 4,000 |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| | 1812 | 1.25 ± 0.15 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GK | 1012 | 1.40 ± 0.15 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GM | 1812 | 1.00 ± 0.20 2 00 + 0 20 | 0 | 0 | 500 | 4,000 |
| GO | 1812 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| JF | 2220 | 1.40 + 0.15 | 0 | 0 | 1.000 | 4,000 |
| JK | 2220 | 1.60 ± 0.20 | 0 | 0 | 1.000 | 4.000 |
| JL | 2220 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| JN | 2220 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| HG | 1825 | 1.60 ± 0.20 | 0 | 0 | 1,000 | |
| HJ | 1825 | 2.00 ± 0.20 | 0 | 0 | 500 | |
| НК | 1825 | 2.50 ± 0.20 | 0 | 0 | 500 | |
| JE | 2220 | 1.40 ± 0.15 | 0 | 0 | 1,000 | |
| JK | 2220 | 1.60 ± 0.20 | 0 | 0 | 1,000 | |
| JL | 2220 | 2.00 ± 0.20 2.50 ± 0.20 | 0 | 0 | 500 | |
| KE | 2220 | 2.30 ± 0.20 1 40 ± 0.15 | 0 | 0 | 1 000 | |
| KE | 2225 | 1.40 ± 0.15 | 0 | 0 | 1,000 | |
| КН | 2225 | 2.00 ± 0.20 | Ő | Ő | 500 | |
| KJ | 2225 | 2.50 ± 0.20 | 0 | 0 | 500 | |
| TA | 2824 | 1.40 ± 0.15 | 0 | 0 | 750 | |
| TB | 2824 | 2.00 ± 0.20 | 0 | 0 | 300 | |
| TC | 2824 | 2.50 ± 0.20 | 0 | 0 | 300 | |
| QB | 3040 | 1.40 ± 0.15 | 0 | 0 | 500 | |
| QC | 3040 | 2.00 ± 0.20 | 0 | 0 | 500 | |
| QD | 3040 | 2.50 ± 0.20 | 0 | 0 | 350 | |
| MA | 3040 | 1.40 ± 0.15 | 0 | | 250 | |
| MC MB | 3040 | 2.00 ± 0.20 2.50 ± 0.20 | 0 | | 20U 250 | |
| 50 | 4540 | 2.30 ± 0.20 | 0 | 0 | 200 | |
| SB | 4540 | 2.00 + 0.20 | 0 | 0 | 200 | |
| SC | 4540 | 2.50 ± 0.20 | 0 | 0 | 200 | |
| Thisland | 0 | Thiskey | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Case Size ¹ | Range (mm) | Paper Q | luantity ¹ | Plastic | Quantity |

Package quantity based on finished chip thickness specifications.



Table 2D – Automotive Flexible Termination Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic | Quantity | | |
|-----------|-------------------|-------------|----------------------------------|----------------------|---------|-------------|--|--|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | |
| CJ | 0603 | 0.80 ± 0.15 | 4000 | 15000 | 0 | 0 | | |
| DC | 0805 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 | | |
| DD | 0805 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 | | |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | | |
| EQ | 1206 | 0.78 ± 0.20 | 0 | 0 | 4,000 | 10,000 | | |
| ER | 1206 | 0.90 ± 0.20 | 0 | 0 | 4,000 | 10,000 | | |
| ED | 1206 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 | | |
| ES | 1206 | 1.00 ± 0.20 | 0 | 0 | 2,500 | 10,000 | | |
| EE | 1206 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 | | |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 | | |
| EU | 1206 | 1.60 ± 0.25 | 0 | 0 | 2,000 | 8,000 | | |
| FZ | 1210 | 1.25 ± 0.20 | 0 | 0 | 2,500 | 10,000 | | |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 | | |
| FE | 1210 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 | | |
| FF | 1210 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 | | |
| FG | 1210 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | | |
| FL | 1210 | 1.40 ± 0.15 | 0 | 0 | 2,000 | 8,000 | | |
| FY | 1210 | 2.00 ± 0.20 | 0 | 0 | 2,000 | 8,000 | | |
| FK | 1210 | 2.10 ± 0.20 | 0 | 0 | 2,000 | 8,000 | | |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1,000 | 4,000 | | |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 | | |
| GD | 1812 | 1.25 ± 0.15 | 0 | 0 | 1,000 | 4,000 | | |
| GH | 1812 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | | |
| GK | 1812 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 | | |
| GM | 1812 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 | | |
| GO | 1812 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 | | |
| JE | 2220 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | | |
| JK | 2220 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 | | |
| JL | 2220 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 | | |
| JN | 2220 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 | | |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | |
| Code | Size ¹ | Range (mm) | Paper Quantity ¹ Plas | | Plastic | ic Quantity | | |

Package quantity based on finished chip thickness specifications.



Table 2E – Bulk Packaging Quantities

| Deeke | ning Tuno | Loose Pa | ackaging | | |
|----------|------------------------|------------------------|------------------------|--|--|
| Раска | Jing Type | Bulk Bag | (default) | | |
| Packagi | ng C-Spec ¹ | N, | /A ² | | |
| Cas | e Size | Packaging Quantities (| pieces/unit packaging) | | |
| EIA (in) | Metric (mm) | Minimum | Maximum | | |
| 0402 | 1005 | | | | |
| 0603 | 1608 | | 50,000 | | |
| 0805 | 2012 | | | | |
| 1206 | 3216 | | | | |
| 1210 | 3225 | 1 | | | |
| 1808 | 4520 | | | | |
| 1812 | 4532 | | | | |
| 1825 | 4564 | | 20,000 | | |
| 2220 | 5650 | | | | |
| 2225 | 5664 | | | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial Grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive Grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3 – Standard Termination Chip Capacitor Land Pattern DesignRecommendations per IPC-7351

| EIA Metri Size Size Code Code | Metric Size Code | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | |
|-------------------------------------|------------------------|--|------|------|------|--|------|------|------|---|------|------|------|------|------|------|
| | oouc | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | С | Y | X | V1 | V2 |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 |
| 1210 ¹ | 3225 | 1.50 | 1.60 | 2.90 | 5.60 | 3.90 | 1.40 | 1.40 | 2.80 | 4.70 | 3.30 | 1.30 | 1.20 | 2.70 | 4.00 | 3.00 |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 |
| 2220 | 5650 | 2.75 | 1.70 | 5.50 | 8.20 | 6.50 | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | 2.55 | 1.30 | 5.30 | 6.60 | 5.60 |

¹ Only for capacitance values $\geq 22 \ \mu F$.

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1210 case size.





Table 4 – Flexible Termination Chip Capacitor Land Pattern Design Recommendations per IPC-7351 (mm)

| EIA Metric Size Size Code Code | Metric Size Code | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | |
|--------------------------------------|------------------------|--|------|------|------|------|--|------|------|------|---|------|------|------|------|------|
| | ooue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0603 | 1608 | 0.85 | 1.25 | 1.10 | 4.00 | 2.10 | 0.75 | 1.05 | 1.00 | 3.10 | 1.50 | 0.65 | 0.85 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 0.99 | 1.44 | 1.66 | 4.47 | 2.71 | 0.89 | 1.24 | 1.56 | 3.57 | 2.11 | 0.79 | 1.04 | 1.46 | 2.42 | 1.81 |
| 1206 | 3216 | 1.59 | 1.62 | 2.06 | 5.85 | 3.06 | 1.49 | 1.42 | 1.96 | 4.95 | 2.46 | 1.39 | 1.22 | 1.86 | 4.25 | 2.16 |
| 1210 | 3225 | 1.59 | 1.62 | 3.01 | 5.90 | 4.01 | 1.49 | 1.42 | 2.91 | 4.95 | 3.41 | 1.39 | 1.22 | 2.81 | 4.25 | 3.11 |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 |
| 1812 | 4532 | 2.10 | 1.80 | 3.60 | 7.00 | 4.60 | 2.00 | 1.60 | 3.50 | 6.10 | 4.00 | 1.90 | 1.40 | 3.40 | 5.40 | 3.70 |
| 2220 | 5650 | 2.85 | 2.10 | 5.50 | 8.80 | 6.50 | 2.75 | 1.90 | 5.40 | 7.90 | 5.90 | 2.65 | 1.70 | 5.30 | 7.20 | 5.60 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805, and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Termination Finish | | | | | |
|--|-----------------------|-----------------------|--|--|--|--|
| Fiomereature | SnPb | 100% Matte Sn | | | | |
| Preheat/Soak | | | | | | |
| Temperature Minimum (T _{smin}) | 100°C | 150°C | | | | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | | | | |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds | | | | |
| Ramp-Up Rate (T_L to T_p) | 3°C/second maximum | 3°C/second maximum | | | | |
| Liquidous Temperature (T _L) | 183°C | 217°C | | | | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | | | | |
| Peak Temperature (T _P) | 235°C | 260°C | | | | |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 30 seconds maximum | | | | |
| Ramp-Down Rate $(T_p to T_L)$ | 6°C/second maximum | 6°C/second maximum | | | | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | | | | |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.

Construction

Standard Termination





Construction cont.

Flex Termination



Capacitor Marking (Optional)

Laser marking option is not available on:

- COG, U2J, X8G, X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punche | d Paper | |
|----------------------|------|---------|--------------------|--------------------------|----------|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | (W)* | Pitch | (P ₁)* | Pitch (P ₁)* | | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 | |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | |
| Array 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P₁ carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions — Millimeters (Inches) | | | | | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|--|--|--|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum | | | | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | | | |
| 16 mm | | (0.059) | | | | (1.181) | | | | | | | |
| | Variable Dimensions — Millimeters (Inches) | | | | | | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ | | | | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | | | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | Note 5 | | | | | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | |
|--|---------------------------------------|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|
| Tape Size | D ₀ | E ₁ | Po | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) |
| Variable Dimensions — Millimeters (Inches) | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ |
| 8 mm | Half (2 mm) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 2.0 ±0.05 (0.079 ±0.002) | 1.1 (0.098) | 8.3 (0.327) | Note 1 |
| 8 mm | Single (4 mm) | | | 4.0 ±0.10 (0.157 ±0.004) | | 8.3 (0.327) | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)


Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|--|--|---------------------------------------|--|--|--|--|--|--|--|
| Tape Size | А | D Minimum | | | | | | | |
| 8 mm | 178 ±0.20 | | | | | | | | |
| 12 mm | Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0 521 +0 02/-0 008) | 20.2 (0.795) | | | | | |
| 16 mm | (13.000 ±0.008) | | X | | | | | | |
| | Variable Dimensions — Millimeters (Inches) | | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Application Guide

Solder Fluxes and Cleaning

The use of water-soluble fluxes provides advantages of excellent solderability due to high activation. However, these fluxes contain organic acids that can induce arcing under high DC or AC voltages. Notable problem areas are underneath the MLCC where flux can be trapped between the ceramic material and PCB. It is therefore critical that PCBs are properly cleaned to remove all flux residue to maintain reliability.

Coating for High Voltage MLCCs

For MLCC ratings \geq 1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

| Dielectric | CTE (ppm/°C) |
|----------------------------|--------------|
| Class II BaTiO₃ | 10.7 |
| Class I CaZrO ₃ | 9.8 |

Slits in PCB

It is recommended to apply a slit in the PCB under the MLCC to improve washing of flux residue that may get trapped underneath. In some cases, it is not possible to slit entirely through the PCB due to underlying metal planes. It is also acceptable to apply a recessed slit under the MLCC which will also promote cleaning.

- Recommended for case sizes ≥1206
- The width (w) of the slit should be 1mm
- Length of the slit should be as short as possible to prevent damaging the MLCC due to mechanical stress of the PCB.
- Slits also reduce the risk of solder balls under MLCC which decreased the creepage distance.



Solder Resist

If a slit cannot be applied as above, it is recommended to not use solder resist directly under the MLCC. The use of solder resist material reduces the distance between MLCC ceramic material and PCB thus making it difficult to clean.

Solder Balls

Improper reflow techniques and/or improper washing can induce solder balls under or adjacent to the MLCC. Solder balls reduce the creepage distance between the MLCC terminations and increase the risk of arcing or damage to the ceramic material. To reduce the risk of solder balls:

- Follow KEMET's solder recommendations as outlined in the datasheet.
- If performing a cleaning procedure, properly clean the PCB per KEMET's cleaning recommendations.
- Add slit to the PCB as shown above.







Overview

KEMET's COG with KONNEKT[™] technology surface mount capacitors are designed for high-efficiency and high-density power applications. KONNEKT high density packaging technology uses an innovative Transient Liquid Phase Sintering (TLPS) material to create a surface mount multichip solution for high density packaging. By utilizing KEMET's robust and proprietary COG base metal electrode (BME) dielectric system, these capacitors are well suited for power converters, inverters, snubbers, and resonators where high efficiency is a primary concern.

Benefits

- Extremely high-power density and ripple current capability
- Extremely low equivalent series resistance (ESR)
- Extremely low equivalent series inductance (ESL)
- Capacitance offerings ranging from 0.78 nF 940 nF
- DC voltage ratings from 50 3,000 V
- EIA sizes 1812 and 2220
- Operating temperature range of -55°C to +125°C
- No capacitance shift with voltage
- · No piezoelectric noise
- · High thermal stability
- · Surface mountable using standard MLCC reflow profiles



With an operating temperature range up to 125°C, these capacitors can be mounted close to fast switching semiconductors in high power density applications, which require minimal cooling. COG with KONNEKT technology also exhibits high mechanical robustness compared to other dielectric technologies, allowing the capacitor to be mounted without the use of metal frames.

COG with KONNEKT series compliments the KC-LINK with KONNEKT series by offering a wider voltage range and operating temperature range up to 125°C

Applications

- Wide bandgap (WBG), silicon carbide (SiC) and gallium nitride (GaN) systems
- Data centers
- EV/HEV (drive systems, charging)
- LLC resonant converters
- Switched tank converters
- · Wireless charging systems
- · Photovoltaic systems
- Power converters
- Inverters
- DC link
- Snubber





Ordering Information

| С | 1812 | C | 943 | K | С | G | L | С | XXXX |
|---------|-----------------------|--------------------------|---|--------------------------|--|------------|-------------------------|-----------------------|--|
| Ceramic | Case Size (L"x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (V) | Dielectric | Subclass Designation | Termination Finish | Orientation and Packaging (Suffix/C-Spec) |
| C | 1812 2220 | C = Standard | Two single digits + number of zeros. | K = ±10% | 5 = 50 V $1 = 100 V$ $2 = 200 V$ $A = 250 V$ $C = 500 V$ $B = 630 V$ $D = 1,000 V$ $F = 1,500 V$ $G = 2,000 V$ $Z = 2,500 V$ $H = 3,000 V$ | G = COG | L = KONNEKT | C = 100% matte Sn | See "Packaging and Orientation C-Spec Ordering Options Table" |

Additional termination finish options may be available. Contact KEMET for details.

Orientation and Packaging (Suffix/C-Spec) Options Table

| Mounting Orientation ¹ | Tape and Reel Illustration | Packaging Type | Packaging/Grade Ordering Code (C-Spec) | | | | | | | |
|-----------------------------------|----------------------------|-------------------|---|--|--|--|--|--|--|--|
| Commercial Grade | | | | | | | | | | |
| Standard | | 7" Reel/Unmarked | TU | | | | | | | |
| | | 13" Reel/Unmarked | 7210 | | | | | | | |
| | Automoti | ive Grade | | | | | | | | |
| Standard | | 7" Reel/Unmarked | AUTO | | | | | | | |
| | 6 | 13" Reel/Unmarked | AUT07210 | | | | | | | |

1 Orientation refers to the positioning of the KONNEKT capacitors in the Tape and Reel pockets. This allows pick and place machines to place capacitors on the PCB in the correct orientation.



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | Days Prior To | |
|-----------------------------|----------------------------------|----------------|------------------|
| C-Spec | Process/Product change | Implementation | |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum |
| AUTO | Yes (without approval) | Yes | 90 days minimum |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | PPAP (Product Part Approval Process) Level | | | | | | | | |
|-----------------------------|--|---|---|---|---|--|--|--|--|
| C-Spec | 1 | 2 | 3 | 4 | 5 | | | | |
| KEMET assigned ¹ | • | • | • | • | • | | | | |
| AUTO | | | 0 | | | | | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)



| EIA SIZE CODE | METRIC SIZE CODE | Number of Chips | Mounting | L LENGTH | W WIDTH | T THICKNESS | B Bandwidth | Mounting Technique | Typical Average Piece Weight (g) |
|---------------------|------------------------|--------------------|----------|-------------------------------|-------------------------------|----------------|----------------|-----------------------|---|
| 1812 | 4532 | 2 | Standard | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | See Table 1A | 0.60 (0.024) | Solder Reflow | See Table 1A |
| 2220 | 5750 | 2 | Standard | 5.70 (0.224) ±0.40 (0.016) | 5.00 (0.197) ±0.40 (0.016 | Thickness | ±0.35 (0.014) | Only | Weights |



Table 1A - 1812 Product Ordering Codes, Ratings, and Package Quantities

| | | | | Number | | Typical | Tape & Ree | el Quantity |
|-----------------------------------|-------------|-------------|---------|-------------|-----------------------------|------------------------|----------------------|-----------------------|
| KEMET Part Number ¹ | Capacitance | Cap Code | Voltage | of Chips | Thickness mm (inch) | Piece Weight (g) | 7" Tape & Reel | 13" Tape & Reel |
| C1812(a)444(b)5GLC(c) | 440 nF | 444 | 50 V | | 3.3 (0.130) ±0.4 (0.016) | 0.19 | 500 | 2,000 |
| C1812(a)304(b)1GLC(c) | 300 nF | 304 | 100 V | | 3.5 (0.138) ±0.4 (0.016) | 0.19 | 500 | 2,000 |
| C1812(a)204(b)2GLC(c) | 200 nF | 204 | 200 V | | 4.1 (0.161) ±0.4 (0.016) | 0.24 | 275 | 1,050 |
| C1812(a)204(b)AGLC(c) | 200 nF | 204 | 250 V | | 4.1 (0.161) ±0.4 (0.016) | 0.24 | 275 | 1,050 |
| C1812(a)943(b)CGLC(c) | 94 nF | 943 | 500 V | | 5.1 (0.200) ±0.4 (0.016) | 0.30 | 200 | 850 |
| C1812(a)943(b)BGLC(c) | 94 nF | 943 | 630 V | 2 | 5.1 (0.200) ±0.4 (0.016) | 0.30 | 200 | 850 |
| C1812(a)303(b)DGLC(c) | 30 nF | 303 | 1,000 V | | 5.1 (0.200) ±0.4 (0.016) | 0.30 | 200 | 850 |
| C1812(a)542(b)FGLC(c) | 5.4 nF | 542 | 1,500 V | | 5.1 (0.200) ±0.4 (0.016) | 0.30 | 200 | 850 |
| C1812(a)302(b)GGLC(c) | 3 nF | 302 | 2,000 V | | 5.1 (0.200) ±0.4 (0.016) | 0.30 | 200 | 850 |
| C1812(a)142(b)ZGLC(c) | 1.4 nF | 142 | 2,500 V | | 5.1 (0.200) ±0.4 (0.016) | 0.30 | 200 | 850 |
| C1812(a)781b)HGLC(c) | 0.78 nF | 781 | 3,000 V | | 5.1 (0.200) ±0.4 (0.016) | 0.30 | 200 | 850 |

1 Complete part number requires additional characters in the numbered positions provided in order to indicate capacitance tolerance and grade. For each numbered position, available options are as follows:

(a) End Termination "C".

(b) Capacitance tolerance character "K".

(c) C-Spec for Product Grade, Reeling and Mounting Orientation.



Table 1B - 2220 Product Ordering Codes, Ratings, and Package Quantities

| | | | | Number | | Typical | Tape & Reel Quantity | |
|-----------------------------------|-------------|-------------|---------|-------------|-----------------------------|------------------------|----------------------|-----------------------|
| KEMET Part Number ¹ | Capacitance | Cap Code | Voltage | of Chips | Thickness mm (inch) | Piece Weight (g) | 7" Tape & Reel | 13" Tape & Reel |
| C2220(a)944(b)5GLC(c) | 940 nF | 944 | 50 V | | 3.5 (0.138) ±0.4 (0.016) | 0.45 | 475 | 1825 |
| C2220(a)664(b)1GLC(c) | 660 nF | 664 | 100 V | | 3.5 (0.138) ±0.4 (0.016) | 0.45 | 475 | 1825 |
| C2220(a)444(b)2GLC(c) | 440 nF | 444 | 200 V | | 4.1 (0.161) ±0.4 (0.016) | 0.45 | 225 | 950 |
| C2220(a)204(b)CGLC(c) | 200 nF | 204 | 500 V | | 5.1 (0.200) ±0.4 (0.016) | 0.65 | 300 | 1,250 |
| C2220(a)204(b)BGLC(c) | 200 nF | 204 | 630 V | 2 | 5.1 (0.200) ±0.4 (0.016) | 0.65 | 300 | 1,250 |
| C2220(a)663(b)DGLC(c) | 66 nF | 663 | 1,000 V | | 5.1 (0.200) ±0.4 (0.016) | 0.65 | 300 | 1,250 |
| C2220(a)143(b)FGLC(c) | 14 nF | 143 | 1,500 V | | 5.1 (0.200) ±0.4 (0.016) | 0.65 | 300 | 1,250 |
| C2220(a)782(b)GGLC(c) | 7.8 nF | 782 | 2,000 V | | 5.1 (0.200) ±0.4 (0.016) | 0.65 | 300 | 1,250 |
| C2220(a)362(b)ZGLC(c) | 3.6 nF | 362 | 2,500 V | | 5.1 (0.200) ±0.4 (0.016) | 0.65 | 300 | 1,250 |
| C2220(a)202(b)HGLC(c) | 2 nF | 202 | 3,000 V | | 5.1 (0.200) ±0.4 (0.016) | 0.65 | 300 | 1,250 |

1 Complete part number requires additional characters in the numbered positions provided in order to indicate capacitance tolerance and grade. For each numbered position, available options are as follows:

(a) End Termination "C".

(b) Capacitance tolerance character "K".

(c) C-Spec for Product Grade, Reeling and Mounting Orientation.



Table 2 - Performance and Reliability: Test Methods and Conditions (Commercial Only)

| Test | Reference | | Test Co | ondition | | Limits |
|---|-------------------|--|--|--|---------------------|--|
| Visual and Mechanical | KEMET Internal | No defects t | hat may af | fect performance (1 | IOX) | Dimensions according KEMET Spec Sheet |
| Capacitance (Cap) | KEMET Internal | 1 kHz ±50 H Capacitance i are indexed | z and 1.0 ± neasureme d to a refere | :0.2 V _{rms} of capacita ents (including toler ee time of 1,000 hou | nce ance) ırs | Within Tolerance |
| Dissipation Factor (DF) | KEMET Internal | 1 kF | lz ±50 Hz a | and 1.0 \pm 0.2 V _{rms} | | Dissipation factor (DF) maximum limit at 25°C = 0.1% |
| Insulation Resistance (IR) | KEMET Internal | Rated voltage 500 V app | For < 5(applied fo For ≥ 5(lied for 12(| 00 VDC: r 120 ±5 seconds at 00 VDC: 0 ±5 seconds at 25° | 25°C C | Within Specification To obtain IR limit, divide MΩ-μF value by the capacitance and compare to GΩ limit. Select the lower of the two limits. 1,000 MΩ-μF or 100 GΩ |
| Temperature Coefficient of Capacitance (TCC) | KEMET Internal | F Capacitance * See part num 1 2 3 4 | Frequency: 1 kHz ±50 Hz nce change with reference to +25°C and 0 VDC applied number specification sheet for voltage tep Temperature (°C) 1 +25°C 2 -55°C 3 +25°C (Reference Temperature) | | 5°C oltage | ±30 PPM/°C |
| Dielectric Withstanding Voltage (DWV) | KEMET Internal | (5 ±1 seconds | ated /oltage 500 500 630 1,000 and charge 50 | DWV Voltage (% of Rated) 250% 150% 130% 120% e/discharge not exce mA) | eeding | Cap: Initial Limit DF: Initial Limit IR: Initial Limit Withstand test voltage without insulation breakdown or damage. |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | KEMET Internal | Maximum | % capacita | nce loss/decade ho | our | 0% Loss/Decade Hour |



Table 2 - Performance and Reliability: Test Methods and Conditions (Commercial Only) cont.

| Test | Reference | Test Condition | Limits |
|------------------------|---------------------------|---|---|
| Terminal Strength | KEMET Internal | Shear stress test per specific case size, Time: 60±1 seconds Case Force 1812 18N | No evidence of mechanical damage |
| Board Flex | AEC-Q200-005 | Standard Termination System 3.0 mm Test time: 60± 5 seconds Ramp time: 1 mm/second | No evidence of mechanical damage |
| Solderability | J-STD-002 | Magnification 10X. Conditions: Category 2 (Dry Bake 155°C/4 hours ±15 minutes) a) Method B, 245°C, SnPb b) Method B1 at 245°C, Pb-Free c) Method D, at 260°C, SnPb or Pb-Free | Visual Inspection. 95% coverage on termination. No leaching |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to +125°C) 2 – 3 cycles per hour Soak Time 1 or 5 minutes | Measurement at 24 hours ±4 hours after test conclusion. Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and 200 VDC. Add 100 KΩ resistor. Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 KΩ resistor. | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5% |
| Moisture Resistance | MIL-STD-202 Method 106 | Number of cycles required 10, 24 hours per cycle. Steps 7a and 7b not required. | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5% |



Table 2 - Performance and Reliability: Test Methods and Conditions (Commercial Only) cont.

| Test | Reference | Test Condition | Limits |
|--|--|---|---|
| Thermal Shock | Thermal Shock MIL-STD-202 Number of cycles required 5, (~55°C to 125°C) Method 107 Dwell time 15 minutes. | | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| High Temperature Life | MIL-STD-202 | 1,000 hours at 125°C with 1.0 X rated voltage applied | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits |
| Storage Life | Method 108 | 1,000 hours at 125°C, Unpowered | Cap: ±0.3% or ±0.25 pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5% |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Test from 10 – 2,000 Hz | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Mechanical MIL-STD-202 Shock Method 213 | | 1,500 g's 0.5 ms Half-sine, Velocity Change 15.4 feet/second (Condition F) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents. | Visual Inspection 10X Readable marking, no decoloration or stains. No physical damage. |

Environmental Compliance



Lead (Pb)-free, RoHS, and REACH compliant without exemptions.



Table 3 – KONNEKT Land Pattern Design Recommendations per IPC-7351 (mm)

| Chip Number | Mounting | EIA SIZE Code | METRIC SIZE CODE | | Median (Nominal) Land Protrusion | | | | |
|----------------|----------|------------------|---------------------|------|-------------------------------------|------|------|------|--|
| | | | | C Y | | X | V1 | V2 | |
| 2 | Standard | 1812 | 4532 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | |
| 2 | Standard | 2220 | 5750 | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | |



Storage & Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. In addition, temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years upon receipt.



Soldering Process

Recommended Reflow Soldering Profile

KEMET's KONNEKT family of high density surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with convection and IR reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Termination Finish | T_p |
|--|---------------------------|-----------------------------------|
| Tromereature | 100% matte Sn | Maximum Ramp-up Rate = 3 C/second |
| Preheat/Soak | 150°C | |
| Temperature Maximum (T_{smin}) Temperature Maximum (T_{smax}) Time (t_a) from T_{out} to T_{out} | 200°C 60 – 120 seconds | E 'smax DE Tsmin Tsmin |
| Ramp-Up Rate (T_L to T_p) | 3°C/second maximum | |
| Liquidous Temperature (T_L) | 217°C | $25 \sim 25^{\circ}$ C to Peak |
| Time Above Liquidous (t _L) | 60 – 150 seconds | Time |
| Peak Temperature (T_p) | 260°C | |
| Time Within 5°C of Maximum Peak Temperature $(t_{\rm p})$ | 30 seconds maximum | |
| Ramp-Down Rate $(T_p to T_L)$ | 6°C/second maximum | |
| Time 25°C to Peak Temperature | 8 minutes maximum | |

Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.

Hand Soldering and Removal of KONNEKT Capacitors

The preferred method of attachment for KEMET's KONNEKT Capacitors is IR or convection reflow where temperature, time and air flow are well controlled.

However, it is understood that the manual attachment of KONNEKT capacitors is necessary for prototype and lab testing. In these instances, care must be taken not to introduce excessive temperature gradients in the KONNEKT part type that may lead to cracking in the ceramic or separation of the TLPS material.



Construction – Standard Termination



MLCC



Tape & Reel Packaging Information

KEMET offers X7R with KONNEKT technology capacitors packaged in 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems.



Table 4 – Carrier Tape Configuration, Embossed Plastic (mm)

| | | | | Embossed Plastic | | |
|---------------|--------------------|--------------------------------|-------------------------------|------------------|----------------------------------|--|
| EIA Case Size | Number of Chins | Chip Thickness | Tape Size (W) ¹ | 7" Reel | 13" Reel | |
| | ompo | | (11) | Pitch | 1 (P ₁) ² | |
| | 2 | ≤ 3.5 mm | 16 | 8 | 8 | |
| KUNNEKT 1812 | 2 | > 3.5 mm | 10 | 12 | 12 | |
| | 2 | ≤ 3.5 mm >5.0 mm & ≤ 5.3 mm | 10 | 8 | 8 | |
| KUNNEKT 2220 | 2 | > 3.5 mm ≤ 5.0 | 10 | 12 | 12 | |

1. Refer to Figures 1 and 2 for W and P, carrier tape reference locations.

2. Refer to Tables 4 and 5 for tolerance specifications.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 5 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions — Millimeters (Inches) | | | | | | | | | | | |
|--------------|--|----------------------------------|----------------------------|---------------------------|---------------------------|-----------------------|----------------------------------|------------------|---------------------------|--|--|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum | | | |
| 16 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 (0.059) | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.05 (0.079±0.002) | 30 (1.181) | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | | |

| | Variable Dimensions – Millimeters (Inches) | | | | | | | | | | | | | |
|--------------|--|--------------|-------------------------------------|----------------------------------|---------------------------|---------------------------|---|---------------------------|-----------------|---|--|--|--|--|
| Case Size | Number of Chips | Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B ₀ & K ₀ | | | | |
| 1812 | 2 | 16 mm | Triple (12mm) Double (8mm) | 7.9 (0.311) 7.5 (0.295) | 14.25 (0.561) | 7.5±0.05 (0.138±0.002) | 12.0±0.10 (0.472±0.004) 8.0±0.10 (0.315±0.004) | 6.5 (0.256) | 16.3 (0.642) | Note 5 | | | | |
| 2220 | 2 | 16 mm | Triple (12mm) Double (8mm) | 8.5 (0.335) 9.2 (0.363) | 14.25 (0.561) | 7.5±0.05 (0.138±0.002) | 12.0±0.10 (0.472±0.004) 8.0±0.10 (0.315±0.004) | 6.5 (0.256) | 16.3 (0.642) | Note 5 | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6).

3. If S₁ < 1.0 mm, there may not be enough area for cover tape to be properly applied. See EIA Document 481, Paragraph 4.3 (b).

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{α} , B_{α} and K_{α} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed. (c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3).

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 mm and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4).

(e) For KPS product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see Addendum in EIA Document 481 for standards relating to more precise taping requirements.



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|------------|----------------------------------|
| 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

Table 6 – Reel Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|--|---|--|------------------------|--|--|--|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | | | | |
| 16 mm | 178±0.20 (7.008±0.008) or 330±0.20 (13.000±0.008) | 178±0.20 (7.008±0.008) or 1.5 (0.059) 330±0.20 (13.000±0.008) | | 20.2 (0.795) | | | | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | | | | | |
| Tape Size | N Minimum See Note 2, Tables 2-3 | W ₁ | W ₂ Maximum | W ₃ | | | | | | |
| 16 mm | 50 (1.969) | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | Shall accommodate tape width without interference | | | | | | |

Established Reliability Surface Mount Capacitors, MIL-PRF-123, 50 - 100 VDC (BP & BX Dielectric)



Overview

The KEMET MIL-PRF-123 BP and BX surface mount capacitors are designed, tested and screened to meet demanding high reliability defense and aerospace applications. Being renowned in the industry, the MIL-PRF-123 is legacy specification created by the Defense Logistics Agency's (DLA) with its proven flight hours. Qualified under performance specification MIL-PRF-123 and QPL listed, this series meets or exceeds the requirements outlined by DLA and is currently available in A and T product levels. Although, the A product level insinuated space grade through its existence, the T level provides an option for additional ultrasonic screening. This PME (precious metal electrode) product series complements the other popular DLA specifications such as the MIL-PRF-55681 (PME) and MIL-PRF-32535 (BME) offering a wider breadth of products making it easier for designers to choose the best solution.

Benefits

- PME (Precious Metal Electrode) technology
- Qualified per MIL-PRF-123 (QPL)
- Standard MIL-PRF-123 capacitors (A Level)
- Non-leaded capacitors with additional screening (T Level)
- EIA 0805, 1206, 1210, 1808, 1812, 1825, and 2225 case sizes
- DC voltage ratings of 50 V and 100 V
- BP Capacitance offerings ranging from 1.0 pF up to 10 nF
- BX Capacitance offerings ranging from 330 pF up to 1 μF
- Available capacitance tolerances of ± 0.25 pF, ± 0.5 pF, $\pm 1\%, \pm 5\%,$ and 10%
- Non-polar device, minimizing installation concerns

Applications

- Critical timing
- Tuning
- · Circuits requiring low loss
- · Circuits with pulse
- High current
- Decoupling
- Bypass
- Filtering
- Transient voltage suppression
- Blocking





MIL-PRF-123 Ordering Information

| M123 | Α | 10 | BX | В | 472 | K | Z |
|------------|--|---|-------------------------------|-----------------------|--|---|---|
| MIL Prefix | Product Level | Slash Sheet (MIL-PRF-123 Style) | Temperature Characteristic | Rated Voltage | Capacitance | Tolerance | Termination |
| M123 | A = Standard MIL- PRF-123 capacitors T = Non-leaded capacitors with additional screening | 10 = 0805 (CKS51) 21 = 1206 (CKS55) 11 = 1210 (CKS52) 12 = 1808 (CKS53) 22 = 1812 (CKS56) 23 = 1825 (CKS57) 13 = 2225 (CKS54) | BP BX | B = 50 V C = 100 V | Two significant digits and number of zeroes. Use R as decimal for 1.0 - 9.9 pF e.g., 2.2 pF = 2R2 | C = ±0.25 pF D = ±0.5 pF F = ±1% J = ±5% K = ±10% | S = Nickel guarded solder-coated (Sn60) Z = 70/30 SnPb Plated |

KEMET Part Number Equivalent (For Reference Only)

(Do not use this ordering code if a QPL MIL-SPEC part type is required. Please order using MIL-SPEC ordering code. Details regarding MIL-PRF-123 QPL ordering information is outlined above.)

| С | 0805 | Z | 101 | K | 5 | G | Α | L |
|---------|--|--------------------------|---|---|---------------------------|------------------|--|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Product Level | Termination Finish |
| | 0805 1206 1210 1808 1812 1825 2225 | Z = MIL-PRF-123 | Two significant digits and number of zeros. Use 9 for 1.0 - 9.9 pF e.g., 2.2 pF = 229 | C = ±0.25 pF D = ±0.5 pF F = ±1% J = ±5% K = ±10% | 5 = 50 V 1 = 100 V | G = BP X = BX | A = Standard MIL- PRF-123 capacitors T = Non-leaded capacitors with additional screening | H = Nickel guarded solder-coated (Sn60) L = 70/30 SnPb Plated |

Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) |
|----------------------------------|---|
| Standard Packaging (Waffle Tray) | Not required (blank) |
| 7" Tape & Reel | Contact Sales |

¹ Default packaging with no C-Spec is "Waffle Tray," and is recommended for order quantities of less than 250 pieces. See Waffle Tray packaging information section for additional details.

¹ See Tape & Reel Packaging information section of the datasheet for additional details.



Dimensions per MIL-PRF-32535 – Inches (Millimeters)



| Chip Size | Military Equivalent Styles | Length (L) | Width (W) | Thickness (T) Maximum | Bandwidth (B) |
|-----------|-------------------------------|---------------|---------------|--------------------------|---------------|
| 0805 | CKS51 | 0.080 ± 0.015 | 0.050 ± 0.015 | 0.055 | 0.020 ± 0.010 |
| 1206 | CKS55 | 0.120 ± 0.015 | 0.060 ± 0.015 | 0.065 | 0.020 ± 0.010 |
| 1210 | CKS52 | 0.120 ± 0.015 | 0.100 ± 0.015 | 0.065 | 0.020 ± 0.010 |
| 1808 | CKS53 | 0.180 ± 0.015 | 0.080 ± 0.015 | 0.065 | 0.020 ± 0.010 |
| 1812 | CKS56 | 0.180 ± 0.015 | 0.125 ± 0.015 | 0.080 | 0.020 ± 0.010 |
| 1825 | CKS57 | 0.180 ± 0.015 | 0.250 ± 0.015 | 0.080 | 0.020 ± 0.010 |
| 2225 | CKS54 | 0.220 ± 0.015 | 0.250 ± 0.015 | 0.070 | 0.020 ± 0.010 |

Environmental Compliance

These PME (precious metal electrode) devices are not RoHS compliant.



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|--|
| Operating temperature range | -55°C to +125°C |
| Capacitance change with reference to +25°C and 0 VDC applied (TCC) | BP: ±30 ppm/°C BX: ±15% |
| Aging rate (maximum % capacitance loss/decade hour) | BP: 0% BX: 1% |
| ¹ Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA) |
| ² Dissipation Factor (DF) maximum limit at 25°C | BP: Cap < 10 pF: 0.25% Cap ≥ 10 pF: 0.15% BX: 2.5% |
| ³ Insulation Resistance (IR) minimum limit at 25°C | At +25°C: 100,000 megaohms or 1,000 megaohm-microfarads, whichever is less. At +125°C: 10,000 megaohms or 100 megaohm-microfarads, whichever is less. |

¹ DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

² Capacitance and dissipation factor (DF) measured under the following conditions:

1 MHz ±100 kHz and 1.0 V_{rms} ±0.2 V if capacitance ≤ 1,000 pF

1 kHz \pm 50 Hz and 1.0 V_{rms} \pm 0.2 V if capacitance > 1,000 pF

³ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Capacitance and dissipation factor (DF) measured under the following conditions:

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as automatic level control (ALC). The ALC feature should be switched to "ON."



Table 1A - Product Ordering Codes & Ratings (BP Dielectric)

| | Cap Code | Can Codo | Case Size | 08 (CK | 05 S51) | 05 1206 1210 S51) (CKS55) (CKS5 | | .10 \$52) | 1808 (CKS53) | | 1812) (CKS56) | | 1825 (CKS57) | | 2225 (CKS54) | | |
|-------------|----------------|-------------|---|-----------|------------|------------------------------------|-------------|--------------|-----------------|--------------|-------------------|-----------|-----------------|-----------|-----------------|------------|------------|
| | (MIL- | Сар Соце | Voltage Code (MIL) | В | C | В | C | В | C | В | C | В | C | В | С | В | C |
| Capacitance | PRF-123 | Dort | Voltage Code (KEMET) | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 |
| | Part | Number) | Rated Voltage (VDC) | 50 | 100 | 50 | 100 | 50 | 10 | 50 | 100 | 50 | 100 | 50 | 100 | 50 | 10 |
| | Number) | | | | 1 | I | I | | Pre | ı oduct A | vailabi | l lity | | | | | L |
| 1.0 pF | 1R0 | 109 | | (1) | (1) | | (4) | | | | | | | | | | |
| 1.1 pF | 1R1 | 119 | | (1) | (1) | | (4) | | | | | | | | | | |
| 1.2 pF | 1R2 | 129 | | (1) | (1) | | (4) | | | | | | | | | | |
| 1.3 pF | 1R3 | 139 | | (1) | (1) | | (4) | | | | | | | | | | |
| 1.5 pF | 1R5 | 159 | | (1) | (1) | | (4) | | | | | | | | | | |
| 1.6 pF | 1R6 | 169 | | (1) | (1) | | (4) | | | | | | | | | | |
| 1.8 pF | 1R8 | 189 | | (1) | (1) | | (4) | | | | | | | | | | |
| 2.0 pF | 2R0 | 209 | | (1) | (1) | | (4) | | | | | | | | | | |
| 2.0 pt | 2R2 | 229 | | (1) | (1) | | (4) | | | | | | | | | | |
| 2.2 pr | 284 | 249 | | (1) | (1) | | (4) | | | | | | | | | | |
| 2.7 pF | 2R7 | 279 | | (1) | (1) | | (5) | | | | | | | | | | |
| 3.0 pF | 380 | 309 | | (1) | (1) | | (5) | | | | | | | | | | |
| 3.3 pF | 303 | 330 | | (1) | (1) | | (5) | | | | | | | | | | |
| 2.5 pF | 206 | 260 | | (1) | (1) | | (5) | | | | | | | | | | |
| 2.0 pF | 200 | 200 | Io complete the KEME I part | (1) | (1) | | (5) | | | | | | | | | | |
| 3.9 µF | 389 | 399 | numbers, insert the following | (1) | (1) | | (5) | | | | | | | | | | |
| 4.5 µr | 4R3 | 439 | (1) C = +0.25 pc D = +0.5 pc | (1) | (1) | | (5) | | | | | | | | | | |
| 4.7 µr | 4R7 | 4/9 | $(2) C = \pm 0.25 \text{ pF}, J = \pm 5\%, K = \pm 10\%$ | (1) | (1) | | (5) | | | | | | | | | | |
| 5.1 µr | | 519 | (3) F = ±1%, J = ±5%, K = ±10% | (1) | (1) | | (3) | | | | | | | | | | |
| 5.0 µF | 580 | 509 | (4) B = ±0.1 pF, C = ±0.25 pF | (1) | | | (5) | | | | | | | | | | |
| 6.2 pF | 6R2 | 629 | (5) B = ± 0.1 pF, C = ± 0.25 pF, D = ± 0.5 pF | (1) | (1) | | (5) | | | | | | | | | _ | |
| 6.8 pF | 688 | 689 | (6) K = $\pm 10\%$, M = $\pm 20\%$ | (1) | (1) | | (5) | | | | | | | | | | |
| 7.5 pF | /R5 | /59 | (7) K = ±10% | (1) | (1) | | (5) | | | | | | | | | | |
| 8.2 pF | 8R2 | 829 | | (1) | (1) | | (5) | | | | | | | | | | |
| 9.1 pF | 9R1 | 919 | | (1) | (1) | | (5) | | | | | | | | | | |
| 10 pF | 100 | 100 | | (2) | (2) | | (3) | | | | | | | | | | |
| 11 pF | 110 | 110 | | (2) | (2) | | (3) | | | | | | | | | | |
| 12 pF | 120 | 120 | | (2) | (2) | | (3) | | | | | | | | | | |
| 13 pF | 130 | 130 | | (2) | (2) | | (3) | | | | | | | | | | |
| 15 pF | 150 | 150 | | (2) | (2) | | (3) | | | | | | | | | | |
| 16 pF | 160 | 160 | | (2) | (2) | | (3) | | | | | | | | | | |
| 18 pF | 180 | 180 | | (2) | (2) | | (3) | | | | | | | | | | |
| 20 pF | 200 | 200 | | (2) | (2) | | (3) | | | | | | | | | | |
| 22 pF | 220 | 220 | | (2) | (2) | | | | | | | | | | | | |
| 24 pF | 240 | 240 | | (2) | (2) | | (3) | | | | | | | | | | |
| 27 pF | 270 | 270 | | (3) | (3) | | (3) | | | | | | | | | | |
| | Can Code | | Rated Voltage (VDC) | 50 | 100 | 50 | 100 | 50 | 100 | 50 | 100 | 50 | 100 | 50 | 100 | 50 | 100 |
| | (MIL- | Cap Code | Voltage Code (KEMET) | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 |
| Capacitance | PRF-123 Par | (KEMET Part | Voltage Code (MIL) | В | C | В | C | В | C | В | C | В | C | В | C | В | C |
| | Number) | Number) | Case Size | 08 (CK | 05 S51) | 12 (CK | 206 S55) | 12 (CK | 10 S52) | 18 (CK | 08 S53) | 18 (CK | 12 S56) | 18 (CK | 25 \$57) | 22 (CKS | 25 S54) |

To complete the KEMET part numbers, insert the following tolerance:

(1) C = ±0.25 pF, D = ±0.5 pF

(2) $C = \pm 0.25 \text{ pF}$, $J = \pm 5\%$, $K = \pm 10\%$ (3) $F = \pm 1\%$, $J = \pm 5\%$, $K = \pm 10\%$ (4) $B = \pm 0.1 \text{ pF}$, $C = \pm 0.25 \text{ pF}$ (5) $B = \pm 0.1 \text{ pF}$, $C = \pm 0.25 \text{ pF}$, $D = \pm 0.5 \text{ pF}$ (6) $K = \pm 10\%$, $M = \pm 20\%$

(7) K = ±10%



Table 1A - Product Ordering Codes & Ratings (BP Dielectric) cont.

| | Cap Code | Cap Code | Case Size | 08 (CK | 05 S51) | 12 (CK | 06 S55) | 12 (CK | 10 S52) | 18 (CK | 08 S53) | 18 (CK | 12 S56) | 18 (CK | 25 S57) | 22 (CK | 25 S54) |
|---|--|--|--|--|--|--------------------------|--|--|--|---------------------------|--|---------------------------|----------------------------|------------------------------------|---------------------------|--------------------------|--|
| o :: | (MIL- | (KEMET | Voltage Code (MIL) | В | C | В | C | В | C | В | C | В | С | В | C | В | C |
| Capacitance | PRF-123 | Part | Voltage Code (KEMET) | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 |
| | Part Number) | Number) | Rated Voltage (VDC) | 50 | 100 | 50 | 100 | 50 | 100 | 50 | 100 | 50 | 100 | 50 | 100 | 50 | 100 |
| | manisci) | | | | | | | | Pr | oduct A | vailabi | lity | | | | | |
| 30 pF 33 pF 36 pF 39 pF 43 pF 47 pF 51 pF 56 pF 62 pF 68 pF 75 pF 82 pF 91 pF 100 pF 100 pF 120 pF 130 pF 150 pF 160 pF 200 pF 220 pF 240 pF 270 pF 300 pF 300 pF 300 pF 300 pF 300 pF 510 pF 500 pF 30 | 300 330 360 390 430 470 510 560 620 680 750 820 910 101 111 121 131 151 161 181 201 221 241 271 241 271 301 331 361 391 431 471 511 561 621 621 | 300 330 360 390 430 470 510 560 620 680 750 820 910 101 111 121 131 151 161 181 201 221 241 221 241 221 241 271 301 331 361 391 431 471 511 561 621 621 | To complete the KEMET part numbers, insert the following tolerance: (1) C = ±0.25 pF, D = ±0.5 pF (2) C = ±0.25 pF, J = ±5%, K = ±10% (3) F = ±1%, J = ±5%, K = ±10% (4) B = ±0.1 pF, C = ±0.25 pF (5) B = ±0.1 pF, C = ±0.25 pF, D = ±0.5 pF (6) K = ±10%, M = ±20% (7) K = ±10% | (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) | (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) | | (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) | (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) | (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) | | (3) (3) (3) (3) (3) (3) (3) (3) (3) (3) | | | | | | |
| 750 pF | 751 | 751 | | (3) | | | (3) | (3) | (3) | (3) | (3) | | | | | | |
| Capacitance | Cap Code (MIL- PRF-123 Par Number) | Cap Code (KEMET Part Number) | Rated Voltage (VDC) Voltage Code (KEMET) Voltage Code (MIL) Case Size | 05 5 8 08 (CK | 02 1 05 \$51) | 5 5 8 12 (CK | 06 555) | 5 5 8 12 (CK) | 000 1 C 10 S52) | 5 5 8 18 (CK) | 08 553) | 5 5 8 18 (CK) | 00 1 C 12 S56) | 0 <u>5</u> 5 8 18 (CK) | 0 1 C 25 S57) | 5 5 8 22 (CK | 00000000000000000000000000000000000000 |

To complete the KEMET part numbers, insert the following tolerance:

(1) $C = \pm 0.25 \text{ pF}, D = \pm 0.5 \text{ pF}$ (2) $C = \pm 0.25 \text{ pF}, J = \pm 5\%, K = \pm 10\%$ (3) $F = \pm 1\%, J = \pm 5\%, K = \pm 10\%$ (4) $B = \pm 0.1 \text{ pF}, C = \pm 0.25 \text{ pF}$ (5) $B = \pm 0.1 \text{ pF}, C = \pm 0.25 \text{ pF}, D = \pm 0.5 \text{ pF}$ (6) $K = \pm 10\%, M = \pm 20\%$ (7) $K = \pm 10\%$



Table 1A - Product Ordering Codes & Ratings (BP Dielectric) cont.

| | Cap Code | Can Code | Case Size | 08 (CK | 05 S51) | 12 (CK | 06 S55) | 12 (CK | 10 S52) | 18 (CK | 08 S53) | 18 (CK | 12 \$56) | 1825 (CKS57) | | 2225 (CKS54) | |
|-------------|-----------------|-------------|--|-----------|------------------------------|-----------|------------|---|------------|-----------|------------|-----------|-------------|-----------------|----------|-----------------|------------|
| | (MIL- | (KEMET | Voltage Code (MIL) | В | C | В | c | В | C | В | C | В | C | В | C | В | C |
| Capacitance | PRF-123 | Part | Voltage Code (KEMET) | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 |
| | Part Number) | Number) | Rated Voltage (VDC) | 50 | 100 | 50 | 100 | 50 | 100 | 50 | 100 | 50 | 100 | 50 | 100 | 50 | 100 |
| | Number) | | | | | | | | Pro | oduct A | vailabi | lity | | | | | |
| 820 pF | 821 | 821 | | | | | (3) | (3) | (3) | (3) | (3) | | | | | | |
| 910 pF | 911 | 911 | | | | | (3) | (3) | (3) | (3) | (3) | | | | | | |
| 1,000 pF | 102 | 102 | | | | | (3) | (3) | (3) | (3) | (3) | | | | | | |
| 1,100 pF | 112 | 112 | | | | (3) | | (3) | (3) | | | | | | | (3) | |
| 1,200 pF | 122 | 122 | | | | (3) | | (3) | (3) | | | | (3) | | | (3) | |
| 1,300 pF | 132 | 132 | | | | (3) | | (3) | (3) | | | | | | | (3) | |
| 1,500 pF | 152 | 152 | | | | (3) | | (3) | (3) | | | | (3) | | | (3) | |
| 1.600 pF | 162 | 162 | | | | (3) | | (3) | (3) | | | | | | | (3) | |
| 1.800 pF | 182 | 182 | | | | (3) | | (3) | (3) | | | | (3) | | | (3) | |
| 2 000 pF | 202 | 202 | | | | (3) | | (3) | (3) | | | | (-) | | | (3) | |
| 2 200 pF | 222 | 222 | | | | (3) | | (3) | (3) | | | | (3) | | | (3) | |
| 2 400 pF | 242 | 242 | | | | (0) | | (3) | (0) | | | | (3) | | | (3) | |
| 2,100 pf | 272 | 272 | | | | | | (3) | | | | | (3) | | | (3) | |
| 2,700 pr | 302 | 302 | | | | | | (3) | | | | | (3) | | | (3) | |
| 2 200 pF | 222 | 222 | To complete the KEMET part | | | | | (3) | | | | | (3) | | | (3) | |
| 3,500 pl | 362 | 362 | numbers, insert the following | | | | | (3) | | | | | (3) | | | (3) | |
| 3,000 pF | 302 | 302 | tolerance: (1) $C = +0.25 \text{ pE}$ D = +0.5 pE | | | | | | | | | | (3) | | (2) | (3) | |
| 3,900 pF | 122 | 122 | (2) C = ± 0.25 pF, J = $\pm 5\%$, K = $\pm 10\%$ | | | | | | | | | | (3) | | (3) | (3) | |
| 4,300 pF | 432 | 432 | (3) F = ±1%, J = ±5%, K = ±10% | | | | | | | | | | (3) | | (2) | (3) | |
| 4,700 pF | 47Z 512 | 47Z 512 | (4) B = ± 0.1 pF, C = ± 0.25 pF (5) B = ± 0.1 pF, C = ± 0.25 pF | | | | | | | | | (2) | (3) | | (3) | (3) | |
| 5,100 pF | 562 | 512 | (5) $B = \pm 0.1 \text{ pr}, C = \pm 0.25 \text{ pr}, D = \pm 0.5 \text{ pr}$ (6) $K = \pm 10\% \text{ M} = \pm 20\%$ | | | | | | | | | (3) | | | (3) | (3) | |
| 5,000 pF | 502 | 502 | (7) K = ±10% | | | | | | | | | (3) | | | (3) | (3) | |
| 0,200 µF | 022 | 022 | | | | | | | | | | (3) | | | (3) | (3) | |
| 6,800 pF | 082 | 082 | | | | | | | | | | (3) | | | (3) | (3) | |
| 7,500 pF | /52 | 752 | | | | | | | | | | (3) | | | (3) | (3) | |
| 8,200 pF | 822 | 822 | | | | | | | | | | (3) | | | (3) | (3) | |
| 9,100 pF | 912 | 912 | | | | | | | | | | (3) | | | (3) | (3) | |
| 10,000 pF | 103 | 103 | | | | | | | | | | (3) | | | (3) | (3) | |
| 11,000 pF | 113 | 113 | | | | | | | | | | | | (3) | | | |
| 12,000 pF | 123 | 123 | | | | | | | | | | | | (3) | | | |
| 13,000 pF | 133 | 133 | | | | | | | | | | | | (3) | | | |
| 15,000 pF | 153 | 153 | | | | | | | | | | | | (3) | | | |
| 16,000 pF | 163 | 163 | | | | | | | | | | | | (3) | | | |
| 18,000 pF | 183 | 183 | | | | | | | | | | | | (3) | | | |
| 20,000 pF | 203 | 203 | | | | | | | | | | | | (3) | | | |
| 22,000 pF | 223 | 223 | | | 0 | | 0 | | 0 | | 0 | | 0 | (3) | 0 | | 0 |
| | Cap Code | Can Code | Rated Voltage (VDC) | 50 | 10 | 50 | 10 | 50 | 10 | - 50 | 10 | 50 | 10 | 50 | 10 | 50 | 10 |
| Canacitance | (MIL- | (KEMET Part | Voltage Code (KEMET) | 5 1 5 1 | | | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 | 5 | | |
| Jupacitance | PRF-123 Par | Number) | Voltage Code (MIL) | | | | | B C B C B | | | ^^ | В | U 10 | В | <u> </u> | В | <u> </u> |
| | Number) | | Case Size | 08 (CK | 0805 1206 (CKS51) (CKS55) | | | 1206 1210 1808 (CKS55) (CKS52) (CKS53) | | | 08 S53) | 18 (CK | 556) | 18 (CK | S57) | 22 (CK | 25 S54) |

To complete the KEMET part numbers, insert the following tolerance:

(1) $C = \pm 0.25 \text{ pF}, D = \pm 0.5 \text{ pF}$ (2) $C = \pm 0.25 \text{ pF}, J = \pm 5\%, K = \pm 10\%$ (3) $F = \pm 1\%, J = \pm 5\%, K = \pm 10\%$ (4) $B = \pm 0.1 \text{ pF}, C = \pm 0.25 \text{ pF}$ (5) $B = \pm 0.1 \text{ pF}, C = \pm 0.25 \text{ pF}, D = \pm 0.5 \text{ pF}$ (6) $K = \pm 10\%, M = \pm 20\%$ (7) $K = \pm 10\%$



Table 1B - Product Ordering Codes & Ratings (BX Dielectric)

| | Cap Code | Can Code | Case Size | 08 (CK | 05 S51) | 12 (CKS | 06 S55) | 12 (CKS | 10 S52) | 18 (CK | 08 S53) | 18 (CK | 12 S56) | 18 (CK | 25 S57) | 2225 (CKS54) | |
|------------------------|----------------|-------------|--|-----------|------------|--------------|------------|------------|------------|--------------|--------------|-----------|------------|-----------|-------------|-----------------|------------|
| | (MIL- | (KEMET | Voltage Code (MIL) | В | C | В | C | В | C | В | C | В | C | В | C | В | C |
| Capacitance | PRF-123 | Dart | Voltage Code (KEMET) | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 | 5 | 1 |
| | Part | Number) | Rated Voltage (VDC) | 50 | 00 | 50 | 00 | 50 | 8 | 50 | 0 | 50 | 00 | 50 | 001 | 50 | 00 |
| | Number) | · · · · | | | | | • | | Pro | l oduct A | , vailabi | l lity | | | • | | |
| 330 pF | 331 | 331 | | (7) | (7) | | | | | | | r. | | | | | |
| 390 pF | 391 | 391 | | (7) | (7) | | | | | | | | | | | | |
| 470 pF | 471 | 471 | | (7) | (7) | | | | | | | | | | | | |
| 560 pF | 561 | 561 | | (7) | (7) | | | | | | | | | | | | |
| 680 pF | 681 | 681 | | (7) | (7) | | | | | | | | | | | | |
| 820 pF | 821 | 821 | | (7) | (7) | | | | | | | | | | | | |
| 1,000 pF | 102 | 102 | | (7) | (7) | | | | | | | 1 | | | | | |
| 1,200 pF | 122 | 122 | | (7) | (7) | | | | | | | 1 | | | | | |
| 1,500 pF | 152 | 152 | | (7) | (7) | | | | | | | 1 | | | | | |
| 1,800 pF | 182 | 182 | | (7) | (7) | 1 | | | | | | i | | | | | |
| 2,200 pF | 222 | 222 | | (7) | (7) | | | | | | | | | | | | |
| 2,700 pF | 272 | 272 | | (7) | (7) | | | | | | | | | | | | |
| 3.300 pF | 332 | 332 | | (7) | (7) | | | | | | | | | | | | |
| 3.900 pF | 392 | 392 | | (7) | (7) | | | | | | | | | | | | |
| 4.700 pF | 472 | 472 | | (7) | (7) | | (6) | | | | | | | | | | |
| 5.600 pF | 562 | 562 | | (7) | (-) | | (6) | (6) | (6) | (7) | (7) | | | | | | |
| 6.800 pF | 682 | 682 | To complete the KEMET part | (7) | | | (6) | (6) | (6) | (7) | (7) | | | | | | |
| 8 200 pF | 822 | 822 | numbers, insert the following | (7) | | | (6) | (6) | (6) | (7) | (7) | | | | | | |
| 10 000 pF | 103 | 103 | tolerance: | (7) | | | (6) | (6) | (6) | (7) | (7) | | | | | | |
| 12 000 pF | 123 | 123 | (1) C = $\pm 0.25 \text{ pF}$, D = $\pm 0.5 \text{ pF}$ | (7) | | | (6) | (6) | (6) | (7) | (7) | | | | | | |
| 15 000 pF | 153 | 153 | $(2) C = \pm 0.25 \text{ pr}, J = \pm 5\%, K = \pm 10\%$ (3) F = $\pm 1\%$ J = $\pm 5\%$ K = $\pm 10\%$ | (7) | | | (6) | (6) | (6) | (7) | (7) | | | | | | |
| 18,000 pF | 183 | 183 | $(4) B = \pm 0.1 \text{ pF}$. C = $\pm 0.25 \text{ pF}$ | (7) | | (6) | (0) | (6) | (6) | (7) | (7) | | | | | | |
| 22 000 pF | 223 | 223 | (5) B = ±0.1 pF, C = ±0.25 pF, D = ±0.5 pF | (/) | | (6) | | (6) | (6) | (7) | (7) | | | | | | |
| 27,000 pF | 223 | 223 | (6) K = ±10%, M = ±20% | | | (6) | | (6) | (6) | (7) | (7) | | (6) | | | | |
| 27,000 pl 33.000 pE | 333 | 273 | (7) K = ±10% | | | (0) | | (0) | (0) | (7) | (7) | | (6) | | | | |
| 20,000 pF | 202 | 202 | | | | (0) | | (0) | | (7) | (7) | | (0) | | | | |
| 47.000 pF | 472 | 472 | | | | (0) | | (0) | | (7) | | | (0) | | | | |
| 47,000 pF | 473 | 473 | | | | | | (0) | | (7) | | | (0) | | (6) | | |
| 68 000 pF | 600 | 603 | | | | | | (0) | | (1) | | (6) | (0) | | (0) | | |
| 00,000 pF | 003 | 003 | | | | | | (0) | | (7) | | (0) | | | (0) | | |
| 82,000 pF | 823 | 823 | | | | | | (0) | | (7) | | (0) | | | (0) | | |
| 100,000 pF | 104 | 104 | | | | | | (0) | | (/) | | (0) | | | (0) | (7) | |
| 120,000 pF | 124 | 124 | | | | | | | | | | (0) | | | (0) | (7) | |
| 190,000 pF | 104 | 104 | | | | | | | | | | (0) | | (6) | (0) | (7) | |
| 220,000 pF | 184 | 184 | | | | | | | | | | | | (0) | | (7) | |
| 220,000 pF | 224 | 224 | | | | | | | | | | | | (0) | | (7) | |
| 270,000 pF | 2/4 | 2/4 | | | | | | | | | | | | (0) | | (7) | |
| 330,000 pF | 334 | 334 | | | | | | | | | | | | (0) | | (7) | |
| 390,000 pF | 394 | 394 | | | | | | | | | | | | (0) | | (7) | |
| 470,000 pr | 4/4 | 4/4 | | | | | | | | | | | | (0) | | (7) | |
| 1,000,000 pr | | 100 | Rated Voltage (VDC) | 6 | 8 | 100 | 8 | 8 | 00 | 8 | 8 | 100 | 8 | 20 | 8 | (/) ເ2 | 00 |
| | Cap Code | Cap Code | Voltage Code (KEMET) | | 1 | 5 | 1 | 5 | 1 | 5 | 1 | | 1 | 5 | - | | 1 |
| Capacitance | (MIL- | (KEMET Part | Voltage Code (NEMET) | J | | ³ | - I | | 1 C |))) | - I | D | |)] | 1 C | D | |
| | PRF-123 Par | Number) | | | | | 06 | 10 | 10 | 10 | ^0 | | 10 | 10 | 25 | ت مە | 15 15 |
| | Number) | , | Case Size | (CK | S51) | (CK | 555) | (CK | S52) | (CK | 553) | (CK | S56) | (CK | 525 S57) | (CKS | ∠5 S54) |

To complete the KEMET part numbers, insert the following tolerance: (1) $C = \pm 0.25 \text{ pF}$, $D = \pm 0.5 \text{ pF}$ (2) $C = \pm 0.25 \text{ pF}$, $J = \pm 5\%$, $K = \pm 10\%$ (3) $F = \pm 1\%$, $J = \pm 5\%$, $K = \pm 10\%$ (4) $B = \pm 0.1 \text{ pF}$, $C = \pm 0.25 \text{ pF}$ (5) $P = \pm 0.1 \text{ pF}$, $C = \pm 0.25 \text{ pF}$

(5) $B = \pm 0.1 \, pF$, $C = \pm 0.25 \, pF$, $D = \pm 0.5 \, pF$

(6) $K = \pm 10\%$, $M = \pm 20\%$

(7) K = ±10%



Legacy Ratings and Part Number Reference

| | 1 | | - | - | | - | | |
|-------|-------------------------|-------------------------|-----------|------------------------|-------------------------|-------------|-------------------------|------------------------|
| CAP. | KEMET | MIL-PRF-123 | CAP. | KEMET | MIL-PRF-123 | CAP. | KEMET | MIL-PRF-123 |
| pF | PART NUMBER | PART NUMBER | pF | PART NUMBER | PART NUMBER | pF | PART NUMBER | PART NUMBER |
| | | | | | | 50/4/ | | |
| 50/10 | J0 VOL 1- BP-C0805 SIZE | (MILITARY CKS51) | 50 | VOLT-BP-C0805 SIZE (| MILITARY CKS51) | 50/10 | 10 VOLT-BP-C1808 SIZE (| MILITARY CK553) |
| 1.0 | C0805Z109(1)(8)GA(9) | M123A10BP(7)1R0(1)(10) | 510.0 | C0805Z511(3)5GA(9) | M123A10BPB511(3)(10) | 300.0 | C1808Z301(3)(8)GA(9) | M123A12BP(7)301(3)(10) |
| 1.1 | C0805Z119(1)(8)GA(9) | M123A10BP(7)1R1(1)(10) | 560.0 | C0805Z561(3)5GA(9) | M123A10BPB561(3)(10) | 330.0 | C1808Z331(3)(8)GA(9) | M123A12BP(7)331(3)(10) |
| 1.2 | C0805Z129(1)(8)GA(9) | M123A10BP(7)1R2(1)(10) | 620.0 | C0805Z621(3)5GA(9) | M123A10BPB621(3)(10) | 360.0 | C1808Z361(3)(8)GA(9) | M123A12BP(7)361(3)(10) |
| 1.3 | C0805Z139(1)(8)GA(9) | M123A10BP(7)1R3(1)(10) | 680.0 | C0805Z681(3)5GA(9) | M123A10BPB681(3)(10) | 390.0 | C1808Z391(3)(8)GA(9) | M123A12BP(7)391(3)(10) |
| 1.5 | C0805Z159(1)(8)GA(9) | M123A10BP(7)1R5(1)(10) | 50/1 | 00 VOI T-BX-C0805 SIZE | (MILITARY CKS51) | 430.0 | C1808Z431(3)(8)GA(9) | M123A12BP(7)431(3)(10) |
| 1.6 | C08057169(1)(8)GA(9) | M123A10BP(7)1R6(1)(10) | 50/1 | 00 VOLT-BX-C0000 SIZE | | 470.0 | C1808Z471(3)(8)GA(9) | M123A12BP(7)471(3)(10) |
| 1.0 | C08057189(1)(8)GA(9) | M123A10BP(7)1R8(1)(10) | 330.0 | C0805Z331K(8)XA(9) | M123A10BX(7)331K(10) | 510.0 | C1808Z511(3)(8)GA(9) | M123A12BP(7)511(3)(10) |
| 2.0 | C08057209(1)(8)GA(9) | M123A10BP(7)2P0(1)(10) | 390.0 | C0805Z391K(8)XA(9) | M123A10BX(7)391K(10) | 560.0 | C1808Z561(3)(8)GA(9) | M123A12BP(7)561(3)(10) |
| 2.0 | C0805Z200(1)(0)C/(0) | M122A10PP(7)2P2(1)(10) | 470.0 | C0805Z471K(8)XA(9) | M123A10BX(7)471K(10) | 620.0 | C1808Z621(3)(8)GA(9) | M123A12BP(7)621(3)(10) |
| 2.2 | C0805Z229(1)(8)GA(9) | M123A10BF(7)2R2(1)(10) | 560.0 | C0805Z561K(8)XA(9) | M123A10BX(7)561K(10) | 680.0 | C1808Z681(3)(8)GA(9) | M123A12BP(7)681(3)(10) |
| 2.4 | C0805Z249(1)(8)GA(9) | M123A10BP(7)2R4(1)(10) | 680.0 | C0805Z681K(8)XA(9) | M123A10BX(7)681K(10) | 750.0 | C18087751(3)(8)GA(9) | M123A12BP(7)751(3)(10) |
| 2.7 | C0805Z279(1)(8)GA(9) | M123A10BP(7)2R7(1)(10) | 820.0 | C0805Z821K(8)XA(9) | M123A10BX(7)821K(10) | 820.0 | C18087821(2)(8)CA(0) | M122A12BD(7)921(2)(10) |
| 3.0 | C0805Z309(1)(8)GA(9) | M123A10BP(7)3R0(1)(10) | 1.000.0 | C0805Z102K(8)XA(9) | M123A10BX(7)102K(10) | 020.0 | C1808Z821(3)(8)GA(9) | M123A12BF(7)021(3)(10) |
| 3.3 | C0805Z339(1)(8)GA(9) | M123A10BP(7)3R3(1)(10) | 1.200.0 | C0805Z122K(8)XA(9) | M123A10BX(7)122K(10) | 910.0 | C1808Z9T1(3)(8)GA(9) | M123A12BP(7)911(3)(10) |
| 3.6 | C0805Z369(1)(8)GA(9) | M123A10BP(7)3R6(1)(10) | 1 500 0 | C08057152K(8)XA(9) | M123A10BX(7)152K(10) | 1,000.0 | C18082102(3)(8)GA(9) | M123A12BP(7)102(3)(10) |
| 3.9 | C0805Z399(1)(8)GA(9) | M123A10BP(7)3R9(1)(10) | 1,800.0 | C0805Z182K(8)XA(9) | M123A10BX(7)182K(10) | 50/10 | 10 VULT-BX-C1808 SIZE (| MILITARY CK553) |
| 4.3 | C0805Z439(1)(8)GA(9) | M123A10BP(7)4R3(1)(10) | 2 200 0 | C08057222K(8)XA(9) | M123A10BX(7)222K(10) | 5,600.0 | C1808Z562K(8)XA(9) | M123A12BX(7)562K(10) |
| 4.7 | C0805Z479(1)(8)GA(9) | M123A10BP(7)4R7(1)(10) | 2,200.0 | C00052222R(0)XA(0) | M122A10BX(7)2Z2K(10) | 6,800.0 | C1808Z682K(8)XA(9) | M123A12BX(7)682K(10) |
| 5.1 | C0805Z519(1)(8)GA(9) | M123A10BP(7)5R1(1)(10) | 2,700.0 | C0805Z27ZK(8)XA(9) | M123A10BA(7)272K(10) | 8,200.0 | C1808Z822K(8)XA(9) | M123A12BX(7)822K(10) |
| 5.6 | C0805Z569(1)(8)GA(9) | M123A10BP(7)5R6(1)(10) | 3,300.0 | C0805Z332K(8)XA(9) | M123A10BX(7)332K(10) | 10,000.0 | C1808Z103K(8)XA(9) | M123A12BX(7)103K(10) |
| 6.2 | C08057629(1)(8)GA(9) | M123A10BP(7)6R2(1)(10) | 3,900.0 | C0805Z392K(8)XA(9) | M123A10BX(7)392K(10) | 12,000.0 | C1808Z123K(8)XA(9) | M123A12BX(7)123K(10) |
| 6.8 | C0805Z689(1)(8)GA(9) | M123A10BP(7)6R8(1)(10) | 4,700.0 | C0805Z472K(8)XA(9) | M123A10BX(7)472K(10) | 15,000.0 | C1808Z153K(8)XA(9) | M123A12BX(7)153K(10) |
| 7.5 | C08057759(1)(8)GA(9) | M123A10BP(7)7P5(1)(10) | 50 | VOLT-BX-C0805 SIZE (| MILITARY CKS51) | 18,000.0 | C1808Z183K(8)XA(9) | M123A12BX(7)183K(10) |
| 0.0 | C0805Z733(1)(0)GA(3) | M123A10BP(7)9P2(1)(10) | 5.600.0 | C0805Z562K5XA(9) | M123A10BXB562K(10) | 22,000.0 | C1808Z223K(8)XA(9) | M123A12BX(7)223K(10) |
| 0.2 | C08052829(1)(8)GA(9) | M123A10BF(7)8K2(1)(10) | 6 800 0 | C08057682K5XA(9) | M123A10BXB682K(10) | 27 000 0 | C1808Z273K(8)XA(9) | M123A12BX(7)273K(10) |
| 9.1 | C08052919(1)(8)GA(9) | M123A10BP(7)9R1(1)(10) | 8 200 0 | C08057822K5XA(9) | M123A10BXB822K(10) | 33,000,0 | C18087333K(8)XA(9) | M123A12BX(7)333K(10) |
| 10.0 | C0805Z100(2)(8)GA(9) | M123A10BP(7)100(2)(10) | 10,000,0 | C08057103K5XA(9) | M123A10BXB103K(10) | 50 | VOI T-BX-C1808 SIZE (M | ILITARY CKS53) |
| 11.0 | C0805Z110(2)(8)GA(9) | M123A10BP(7)110(2)(10) | 12,000.0 | C0805Z105K5XA(9) | M123A10BXB103K(10) | 20,000,0 | C18087202KEXA(0) | M122A12BXB202K(10) |
| 12.0 | C0805Z120(2)(8)GA(9) | M123A10BP(7)120(2)(10) | 12,000.0 | C08052123K5XA(9) | M122A10BXB123K(10) | 39,000.0 | C1808Z472K5XA(9) | M123A12BAB393K(10) |
| 13.0 | C0805Z130(2)(8)GA(9) | M123A10BP(7)130(2)(10) | 10,000.0 | C08052153K5XA(9) | M123A10BAB133K(10) | 47,000.0 | C1606Z473K5XA(9) | W123A12BAB473K(10) |
| 15.0 | C0805Z150(2)(8)GA(9) | M123A10BP(7)150(2)(10) | 18,000.0 | C0805Z183K5XA(9) | M123A10BXB183K(10) | 56,000.0 | C1808Z563K5XA(9) | M123A12BXB563K(10) |
| 16.0 | C0805Z160(2)(8)GA(9) | M123A10BP(7)160(2)(10) | 50/1 | 00 VOLT-BP-C1210 SIZE | (MILITARY CKS52) | 68,000.0 | C1808Z683K5XA(9) | M123A12BXB683K(10) |
| 18.0 | C0805Z180(2)(8)GA(9) | M123A10BP(7)180(2)(10) | 300.0 | C1210Z301(3)(8)GA(9) | M123A11BP(7)301(3)(10) | 82,000.0 | C1808Z823K5XA(9) | M123A12BXB823K(10) |
| 20.0 | C0805Z200(2)(8)GA(9) | M123A10BP(7)200(2)(10) | 330.0 | C1210Z331(3)(8)GA(9) | M123A11BP(7)331(3)(10) | 100,000.0 | C1808Z104K5XA(9) | M123A12BXB104K(10) |
| 22.0 | C0805Z220(2)(8)GA(9) | M123A10BP(7)220(2)(10) | 360.0 | C1210Z361(3)(8)GA(9) | M123A11BP(7)361(3)(10) | 50 | VOLT-BP-C2225 SIZE (M | ILITARY CKS54) |
| 24.0 | C0805Z240(2)(8)GA(9) | M123A10BP(7)240(2)(10) | 390.0 | C1210Z391(3)(8)GA(9) | M123A11BP(7)391(3)(10) | 1 100 0 | C22257112(3)5GA(9) | M123A13BPB112(3)(10) |
| 27.0 | C08057270(3)(8)GA(9) | M123A10BP(7)270(3)(10) | 430.0 | C1210Z431(3)(8)GA(9) | M123A11BP(7)431(3)(10) | 1,100.0 | C2225Z122(3)5GA(9) | M123A13BPB122(3)(10) |
| 30.0 | C0805Z300(3)(8)GA(9) | M123A10BP(7)300(3)(10) | 470.0 | C1210Z471(3)(8)CA(9) | M123A11BD(7)/71(3)(10) | 1,200.0 | C2225Z122(2)5CA(0) | M122A12BDB122(0)(10) |
| 33.0 | C08057330(3)(8)GA(9) | M123A10BP(7)330(3)(10) | 510.0 | C1210Z511(3)(8)CA(9) | M123A11BD(7)511(3)(10) | 1,500.0 | C22252152(3)5CA(3) | M122A13DF D132(3)(10) |
| 26.0 | C0805Z350(3)(8)CA(8) | M122A10BP(7)260(2)(10) | 510.0 | C1210Z511(3)(0)CA(9) | M123A11DD (7)511(3)(10) | 1,500.0 | C22252152(3)5GA(9) | M123A13BFB132(3)(10) |
| 30.0 | C0805Z300(3)(8)CA(9) | M123A10DF(7)300(3)(10) | 500.0 | C1210Z501(5)(6)GA(9) | M123A11BF(7)501(3)(10) | 1,000.0 | C2225Z162(3)5GA(9) | M123A13BPB102(3)(10) |
| 39.0 | C0805Z390(3)(8)GA(9) | M123A10BP(7)390((3)(10) | 620.0 | C12102621(3)(8)GA(9) | W123A11BP(7)621(3)(10) | 1,800.0 | C2225Z182(3)5GA(9) | M123A13BPB182(3)(10) |
| 43.0 | C0805Z430(3)(8)GA(9) | M123A10BP(7)430(3)(10) | 680.0 | C1210Z681(3)(8)GA(9) | M123A11BP(7)681(3)(10) | 2,000.0 | C2225Z202(3)5GA(9) | M123A13BPB202(3)(10) |
| 47.0 | C0805Z470(3)(8)GA(9) | M123A10BP(7)470(3)(10) | 750.0 | C1210Z751(3)(8)GA(9) | M123A11BP(7)751(3)(10) | 2,200.0 | C2225Z222(3)5GA(9) | M123A13BPB222(3)(10) |
| 51.0 | C0805Z510(3)(8)GA(9) | M123A10BP(7)510(3)(10) | 820.0 | C1210Z821(3)(8)GA(9) | M123A11BP(7)821(3)(10) | 2,400.0 | C2225Z242(3)5GA(9) | M123A13BPB242(3)(10) |
| 56.0 | C0805Z560(3)(8)GA(9) | M123A10BP(7)560(3)(10) | 910.0 | C1210Z911(3)(8)GA(9) | M123A11BP(7)911(3)(10) | 2,700.0 | C2225Z272(3)5GA(9) | M123A13BPB272(3)(10) |
| 62.0 | C0805Z620(3)(8)GA(9) | M123A10BP(7)620(3)(10) | 1,000.0 | C1210Z102(3)(8)GA(9) | M123A11BP(7)102(3)(10) | 3,000.0 | C2225Z302(3)5GA(9) | M123A13BPB302(3)(10) |
| 68.0 | C0805Z680(3)(8)GA(9) | M123A10BP(7)680(3)(10) | 1,100.0 | C1210Z112(3)(8)GA(9) | M123A11BP(7)112(3)(10) | 3,300.0 | C2225Z332(3)5GA(9) | M123A13BPB332(3)(10) |
| 75.0 | C0805Z750(3)(8)GA(9) | M123A10BP(7)750(3)(10) | 1,200.0 | C1210Z122(3)(8)GA(9) | M123A11BP(7)122(3)(10) | 3,600.0 | C2225Z362(3)5GA(9) | M123A13BPB362(3)(10) |
| 82.0 | C0805Z820(3)(8)GA(9) | M123A10BP(7)820(3)(10) | 1,300.0 | C1210Z132(3)(8)GA(9) | M123A11BP(7)132(3)(10) | 3,900.0 | C2225Z392(3)5GA(9) | M123A13BPB392(3)(10) |
| 91.0 | C0805Z910(3)(8)GA(9) | M123A10BP(7)910(3)(10) | 1,500.0 | C1210Z152(3)(8)GA(9) | M123A11BP(7)152(3)(10) | 4,300.0 | C2225Z432(3)5GA(9) | M123A13BPB432(3)(10) |
| 100.0 | C0805Z101(3)(8)GA(9) | M123A10BP(7)101(3)(10) | 1.600.0 | C1210Z162(3)(8)GA(9) | M123A11BP(7)162(3)(10) | 4,700.0 | C2225Z472(3)5GA(9) | M123A13BPB472(3)(10) |
| 110.0 | C0805Z111(3)(8)GA(9) | M123A10BP(7)111(3)(10) | 1.800.0 | C1210Z182(3)(8)GA(9) | M123A11BP(7)182(3)(10) | 5,100.0 | C2225Z512(3)5GA(9) | M123A13BPB512(3)(10) |
| 120.0 | C0805Z121(3)(8)GA(9) | M123A10BP(7)121(3)(10) | 2 000 0 | C12107202(3)(8)GA(9) | M123A11BP(7)202(3)(10) | 5 600 0 | C22257562(3)5GA(9) | M123A13BPB562(3)(10) |
| 130.0 | C0805Z131(3)(8)GA(9) | M123A10BP(7)131(3)(10) | 2,200.0 | C1210Z222(3)(8)GA(9) | M123A11BP(7)222(3)(10) | 6 200 0 | C22257622(3)5GA(9) | M123A13BPB622(3)(10) |
| 150.0 | C0805Z151(3)(8)GA(9) | M123A10BP(7)151(3)(10) | | VOI T-BD-C1210 SIZE / | | 6 800 0 | C22257682(3)5GA(9) | M123A13BPB682(3)(10) |
| 160.0 | C0805Z161(3)(8)GA(9) | M123A10BP(7)161(3)(10) | 50 | | | 7 500 0 | C22257752/3\5CA/0\ | M123A13BPB752(3)(10) |
| 180.0 | C08057181/3)/8)CA/0) | M123A10BP(7)181(3)(10) | 2,400.0 | C1210Z242(3)5GA(9) | M123A11BPB242(3)(10) | 0.000.0 | C22257822/2/5CA(8) | M123A13BDP022(3)(10) |
| 200.0 | C0805Z101(3)(8)CA(9) | M122A10BP(7)201(2)(10) | 2,700.0 | C1210Z272(3)5GA(9) | M123A11BPB272(3)(10) | 0,200.0 | C22252822(3)5GA(9) | W123A13BFB022(3)(10) |
| 200.0 | C00052201(3)(0)GA(9) | M123A10DF(7)201(3)(10) | 3,000.0 | C1210Z302(3)5GA(9) | M123A11BPB302(3)(10) | 9,100.0 | C22252912(3)5GA(9) | M123A13BPB912(3)(10) |
| 220.0 | C0805Z221(3)(8)GA(9) | M123A10BP(7)221(3)(10) | 3,300.0 | C1210Z332(3)5GA(9) | M123A11BPB332(3)(10) | 10,000.0 | C2225Z103(3)5GA(9) | M123A13BPB103(3)(10) |
| 240.0 | C0805Z241(3)(8)GA(9) | M123A10BP(7)241(3)(10) | 50/1 | 00 VOLT-BX-C1210 SIZE | (MILITARY CKS52) | 50 | VOLT-BX-C2225 SIZE (M | ILITARY CKS54) |
| 270.0 | C0805Z271(3)(8)GA(9) | M123A10BP(7)271(3)(10) | 5 600 0 | C12107562(6)(8)XA(9) | M123A11BX/7)562(6)(10) | 120,000.0 | C2225Z124K5XA(9) | M123A13BXB124K(10) |
| 300.0 | C0805Z301(3)(8)GA(9) | M123A10BP(7)301(3)(10) | 6 800 0 | C12107682(6)(8)XA(9) | M123A11BX(7)682(6)(10) | 150,000.0 | C2225Z154K5XA(9) | M123A13BXB154K(10) |
| 330.0 | C0805Z331(3)(8)GA(9) | M123A10BP(7)331(3)(10) | 0,000.0 | C1210Z082(0)(8)XA(9) | M123A11BX(7)002(0)(10) | 180,000,0 | C2225Z184K5XA(9) | M123A13BXB184K(10) |
| 360.0 | C0805Z361(3)(8)GA(9) | M123A10BP(7)361(3)(10) | 0,200.0 | C1210Z0ZZ(0)(0)XA(9) | M122A11BA(7)022(0)(10) | 220.000.0 | C2225Z224K5XA(9) | M123A13BXB224K(10) |
| 390.0 | C0805Z391(3)(8)GA(9) | M123A10BP(7)391(3)(10) | 10,000.0 | C12102103(b)(8)XA(9) | W123A11BX(7)103(6)(10) | 270 000 0 | C22257274K5XA(9) | M123A13BXB274K(10) |
| 430.0 | C0805Z431(3)(8)GA(9) | M123A10BP(7)431(3)(10) | 12,000.0 | C1210Z123(6)(8)XA(9) | M123A11BX(7)123(6)(10) | 330,000.0 | C22257334K5YA(0) | M123A13BXB334K(10) |
| 470.0 | C0805Z471(3)(8)GA(9) | M123A10BP(7)471(3)(10) | 15,000.0 | C1210Z153(6)(8)XA(9) | M123A11BX(7)153(6)(10) | 300,000.0 | C22257304//EVA(0) | M123A13BYP204K(10) |
| | | // / . | 18,000.0 | C1210Z183(6)(8)XA(9) | M123A11BX(7)183(6)(10) | 390,000.0 | C22232394N3AA(9) | M122A12DXD394K(10) |
| | | | 22,000.0 | C1210Z223(6)(8)XA(9) | M123A11BX(7)223(6)(10) | 470,000.0 | 0222024/4K5XA(9) | W123A13DAB4/4K(1U) |
| | | | 27,000.0 | C1210Z273(6)(8)XA(9) | M123A11BX(7)273(6)(10) | 560,000.0 | C22252564K5XA(9) | M123A13BXB564K(10) |
| | | | 50 | VOLT-BX-C1210 SIZE (| MILITARY CKS52) | 680,000.0 | C22252684K5XA(9) | M123A13BXB684K(10) |
| | | | 33,000.0 | C1210Z333(6)5XA(9) | M123A11BXB333(6)(10) | 820,000.0 | C22252824K5XA(9) | M123A13BXB824K(10) |
| | | | 39,000.0 | C12107393(6)5XA(9) | M123A11BXB393(6)(10) | 1,000,000.0 | C2225Z105K5XA(9) | M123A13BXB105K(10) |
| | | | 47 000 0 | C12107473(6)5XA(0) | M123A11BXB473(6)(10) | | | |
| | | | F6 000 0 | C1210Z413(0)37A(8) | M122A11DXD473(0)(10) | | | |
| | | | 60,000.0 | C1210Z003(0)3AA(9) | M122A11DAD303(0)(10) | | | |
| | | | 00,000.0 | C12102003(0)5XA(9) | | | | |
| | | | 82,000.0 | C12102823(6)5XA(9) | W123A11BAB823(6)(10) | | | |
| | | | 100,000.0 | C12102104(6)5XA(9) | W123A11BAB104(6)(10) | | | |

To complete the KEMET part numbers, insert the following tolerance:

(4) B = ±0.1pF; C = ±0.25pF
(5) B = ±0.1pF; C = 0.25pF; D = 0.50pF
(6) K = ±10%; M =±20%
To complete the KEMET part numbers, insert the following voltage:
(7) B = 50 volts; C = 100 volts
(8) 5 = 50 volts; 1 = 100 volts
To complete the KEMET part numbers, insert termination designation:
(9) H = Nickel Guarded, Solder Coated (Sn60); L = 70/30 Tin/Lead Plated
(10) S = Nickel Guarded, Solder Coated (Sn60); Z = 70/30 Tin/Lead Plated



Legacy Ratings and Part Number Reference cont.

| CAP. pF | KEMET PART NUMBER | MIL-PRF-123 PART NUMBER | CAP. pF | KEMET PART NUMBER | MIL-PRF-123 PART NUMBER | CAP. | | MIL-PRF-123 |
|------------|-----------------------|--|--------------------------|-------------------------|--|-------------|----------------------|--|
| 100 V | OLT - BP - C1206 SIZE | (MILITARY CKS55) | 50 V | OI T-BP-C1206 SIZE (N | III ITARY CKS55) | pi | | |
| 1.0 | C1206Z109(4)1GA(9) | M123A21BPC1R0(4)(10) | 1,100.0 | C1206Z112(3)5GA(9) | M123A21BPB112(3)(10) | 100 V | 0L1-BP-01825 SIZE (| M122A22PDC202/2//40 |
| 1.1 | C1206Z119(4)1GA(9) | M123A21BPC1R1(4)(10) | 1,200.0 | C1206Z122(3)5GA(9) | M123A21BPB122(3)(10) | 3,900.0 | C1825Z392(3)1GA(9) | M123A23BPC392(3)(10) M123A23BPC472(3)(10) |
| 1.2 | C1206Z129(4)1GA(9) | M123A21BPC1R2(4)(10) | 1,300.0 | C1206Z132(3)5GA(9) | M123A21BPB132(3)(10) | 5 100 0 | C1825Z512(3)1GA(9) | M123A23BPC512(3)(10) |
| 1.3 | C1206Z139(4)1GA(9) | M123A21BPC1R3(4)(10) | 1,500.0 | C1206Z152(3)5GA(9) | M123A21BPB152(3)(10) | 5,600.0 | C1825Z562(3)1GA(9) | M123A23BPC562(3)(10) |
| 1.5 | C1206Z159(4)1GA(9) | M123A21BPC1R5(4)(10) | 1,600.0 | C1206Z162(3)5GA(9) | M123A21BPB162(3)(10) | 6,200.0 | C1825Z622(3)1GA(9) | M123A23BPC622(3)(10) |
| 1.6 | C1206Z169(4)1GA(9) | M123A21BPC1R6(4)(10) | 1,800.0 | C1206Z182(3)5GA(9) | M123A21BPB182(3)(10) | 6,800.0 | C1825Z682(3)1GA(9) | M123A23BPC682(3)(10) |
| 1.0 | C1206Z169(4)1GA(9) | M123A21BPC1R6(4)(10) | 2,000.0 | C1206Z202(3)5GA(9) | M123A21BPB202(3)(10) | 7,500.0 | C1825Z752(3)1GA(9) | M123A23BPC752(3)(10) |
| 2.0 | C1206Z209(4)1GA(9) | M123A21BPC2R0(4)(10) M123A21BPC2R2(4)(10) | 2,200.0 | OI T-BX-C1206 SIZE (| M123A21BPB222(3)(10) | 8,200.0 | C1825Z822(3)1GA(9) | M123A23BPC822(3)(10) |
| 2.4 | C1206Z249(4)1GA(9) | M123A21BPC2R4(4)(10) | 4 700 0 | C12067472(6)1XA(9) | M123A21BXC472(6)(10) | 9,100.0 | C1825Z912(3)1GA(9) | M123A23BPC912(3)(10) |
| 2.7 | C1206Z279(5)1GA(9) | M123A21BPC2R7(5)(10) | 5,600.0 | C1206Z562(6)1XA(9) | M123A21BXC562(6)(10) | 10,000.0 | C1825Z103(3)1GA(9) | M123A23BPC103(3)(10) |
| 3.0 | C1206Z309(5)1GA(9) | M123A21BPC3R0(5)(10) | 6,800.0 | C1206Z682(6)1XA(9) | M123A21BXC682(6)(10) | 50 VC | DLT-BP-C1812 SIZE (N | |
| 3.3 | C1206Z339(5)1GA(9) | M123A21BPC3R3(5)(10) | 8,200.0 | C1206Z822(6)1XA(9) | M123A21BXC822(6)(10) | 11,000.0 | C1825Z113(3)5GA(9) | M123A23BPB113(3)(10) |
| 3.6 | C1206Z369(5)1GA(9) | M123A21BPC3R6(5)(10) | 10,000.0 | C1206Z103(6)1XA(9) | M123A21BXC103(6)(10) | 12,000.0 | C1825Z123(3)5GA(9) | M123A23BPB123(3)(10) |
| 3.9 | C1206Z399(5)1GA(9) | M123A21BPC3R9(5)(10) | 12,000.0 | C1206Z123(6)1XA(9) | M123A21BXC123(6)(10) | 15,000.0 | C1825Z153(3)5GA(9) | M123A23BPB153(3)(10) |
| 4.3 | C1206Z439(5)1GA(9)+ | M123A21BPC4R3(5)(10) | 15,000.0 | C1206Z153(6)1XA(9) | M123A21BXC153(6)(10) | 16,000.0 | C1825Z153(3)5GA(9) | M123A23BPB163(3)(10) |
| 4.7 | C1206Z479(5)1GA(9) | M123A21BPC5R1(5)(10) | 50 V | ULI-BA-C1206 SIZE (N | ILTIART CK555) | 18,000.0 | C1825Z183(3)5GA(9) | M123A23BPB183(3)(10) |
| 5.6 | C1206Z569(5)1GA(9) | M123A21BPC5R6(5)(10) | 22,000,0 | C1206Z163(6)5XA(9) | M123A21BAB163(6)(10) | 20.000.0 | C1825Z203(3)5GA(9) | M123A23BPB203(3)(10) |
| 6.2 | C1206Z629(5)1GA(9) | M123A21BPC6R2(5)(10) | 22,000.0 | C1206Z2Z3(0)5XA(9) | M123A21BXB223(0)(10) M123A21BXB273(6)(10) | 22.000.0 | C1825Z223(3)5GA(9) | M123A23BPB223(3)(10) |
| 6.8 | C1206Z689(5)1GA(9) | M123A21BPC6R8(5)(10) | 33.000.0 | C1206Z333(6)5XA(9) | M123A21BXB333(6)(10) | 100 V | OLT-BX-C1825 SIZE (M | MILITARY CKS57) |
| 7.5 | C1206Z759(5)1GA(9) | M123A21BPC7R5(5)(10) | 39,000.0 | C1206Z393(6)5XA(9) | M123A21BXB393(6)(10) | 56,000.0 | C1825Z563(6)1XA(9) | M123A23BXC563(6)(10) |
| 8.2 | C1206Z829(5)1GA(9) | M123A21BPC8R2(5)(10) | 100 \ | /OLT-BP-C1812 SIZE (I | MILITARY CKS56) | 68,000.0 | C1825Z683(6)1XA(9) | M123A23BXC683(6)(10) |
| 9.1 | C1206Z919(5)1GA(9) | M123A21BPC9R1(5)(10) | 1,200.0 | C1812Z122(3)1GA(9) | M123A22BPC122(3)(10) | 82,000.0 | C1825Z823(6)1XA(9) | M123A23BXC823(6)(10) |
| 10.0 | C1206Z100(3)1GA(9) | M123A21BPC100(3)(10) | 2,200.0 | C1812Z222(3)1GA(9) | M123A22BPC222(3)(10) | 100,000.0 | C1825Z104(6)1XA(9) | M123A23BXC104(6)(10) |
| 11.0 | C1206Z110(3)1GA(9) | M123A21BPC110(3)(10) | 2,400.0 | C1812Z242(3)1GA(9) | M123A22BPC242(3)(10) | 120,000.0 | C1825Z124(6)1XA(9) | M123A23BXC124(6)(10) |
| 12.0 | C1206Z120(3)1GA(9) | M123A21BPC120(3)(10) | 2,700.0 | C1812Z272(3)1GA(9) | M123A22BPC272(3)(10) | 150,000.0 | C1825Z154(6)1XA(9) | M123A23BXC154(6)(10) |
| 15.0 | C1206Z150(3)1GA(9) | M123A21BPC150(3)(10) M123A21BPC150(3)(10) | 3,000.0 | C1812Z302(3)1GA(9) | M123A22BPC302(3)(10) | 50 VC | JLI-BX-C1825 SIZE (N | ILITARY CKS57) |
| 16.0 | C1206Z160(3)1GA(9) | M123A21BPC160(3)(10) | 3,300.0 | C1812Z332(3)1GA(9) | M123A22BPC332(3)(10) | 180,000.0 | C1825Z184(6)5XA(9) | M123A23BXB184(6)(10) |
| 18.0 | C1206Z180(3)1GA(9) | M123A21BPC180(3)(10) | 3,600.0 | C1812Z362(3)1GA(9) | M123A22BPC362(3)(10) | 220,000.0 | C1825Z224(0)5XA(9) | M123A23BXB224(0)(10) |
| 20.0 | C1206Z200(3)1GA(9) | M123A21BPC200(3)(10) | 3,900.0 | C1012Z392(3)1GA(9) | M123A22BPC392(3)(10) | 330,000,0 | C1825Z274(0)5XA(9) | M123A23BXB334(6)(10) |
| 24.0 | C1206Z240(3)1GA(9) | M123A21BPC240(3)(10) | 4,300.0 | C1812Z432(3)1GA(9) | M123A22BFC432(3)(10) | 390.000.0 | C1825Z394(6)5XA(9) | M123A23BXB394(6)(10) |
| 27.0 | C1206Z270(3)1GA(9) | M123A21BPC270(3)(10) | 50 V | OI T-BP-C1812 SIZE (N | III ITARY CKS56) | 470,000.0 | C1825Z474(6)5XA(9) | M123A23BXB474(6)(10) |
| 33.0 | C1206Z330(3)1GA(9) | M123A21BPC330(3)(10) | 5 100 0 | C18127512/3)5GA/0) | M123A22BDB512(3)(10) | | | |
| 30.0 | C1206Z360(3)1GA(9) | M123A21BPC360(3)(10) M122A21BPC200(2)(10) | 5,600.0 | C1812Z562(3)5GA(9) | M123A22BPB562(3)(10) | | | |
| 43.0 | C1206Z430(3)1GA(9) | M123A21BPC430(3)(10) | 6.200.0 | C1812Z622(3)5GA(9) | M123A22BPB622(3)(10) | | | |
| 47.0 | C1206Z470(3)1GA(9) | M123A21BPC470(3)(10) | 6,800.0 | C1812Z682(3)5GA(9) | M123A22BPB682(3)(10) | | | |
| 51.0 | C1206Z510(3)1GA(9) | M123A21BPC510(3)(10) | 7,500.0 | C1812Z752(3)5GA(9) | M123A22BPB752(3)(10) | | | |
| 56.0 | C1206Z560(3)1GA(9) | M123A21BPC560(3)(10) | 8,200.0 | C1812Z822(3)5GA(9) | M123A22BPB822(3)(10) | | | |
| 62.0 | C1206Z620(3)1GA(9) | M123A21BPC620(3)(10) | 9,100.0 | C1812Z912(3)5GA(9) | M123A22BPB912(3)(10) | | | |
| 68.0 | C1206Z680(3)1GA(9) | M123A21BPC680(3)(10) | 10,000.0 | C1812Z103(3)5GA(9) | M123A22BPB103(3)(10) | | | |
| 75.0 | C1206Z750(3)1GA(9) | M123A21BPC750(3)(10) | 100 \ | ULI-BX-C1812 SIZE (I | VILLITARY CK556) | | | |
| 02.0 | C1206Z620(3)1GA(9) | M123A21BPC020(3)(10) | 27,000.0 | C1812Z273(6)1XA(9) | M123A22BXC273(6)(10) | | | |
| 100.0 | C1206Z910(3)1GA(9) | M123A21BPC101(3)(10) | 33,000.0 | C1812Z333(6)1XA(9) | M123A22BXC333(6)(10) | | | |
| 110.0 | C1206Z111(3)1GA(9) | M123A21BPC111(3)(10) | 47 000.0 | C18127473(6)1XA(9) | M123A22BXC473(6)(10) | | | |
| 120.0 | C1206Z121(3)1GA(9) | M123A21BPC121(3)(10) | 56.000.0 | C1812Z563(6)1XA(9) | M123A22BXC563(6)(10) | | | |
| 130.0 | C1206Z131(3)1GA(9) | M123A21BPC131(3)(10) | 50 V | OLT-BX-C1812 SIZE (N | ILITARY CKS56) | | | |
| 150.0 | C1206Z151(3)1GA(9) | M123A21BPC151(3)(10) | 100.000.0 | C1812Z104(6)5XA(9) | M123A22BXB104(6)(10) | | | |
| 160.0 | C1206Z161(3)1GA(9) | M123A21BPC161(3)(10) | 120,000.0 | C1812Z124(6)5XA(9) | M123A22BXB124(6)(10) | | | |
| 180.0 | C1206Z181(3)1GA(9) | M123A21BPC181(3)(10) | 150,000.0 | C1812Z154(6)5XA(9) | M123A22BXB154(6)(10) | | | |
| 200.0 | C1206Z201(3)1GA(9) | M123A21BPC201(3)(10) M123A21BPC221/3)(10) | 180,000.0 | C1812Z184(6)5XA(9) | M123A22BXB184(6)(10) | | | |
| 220.0 | C1206Z241(3)1GA(9) | M123A21BPC241(3)(10) | To complete t | he KEMET part number | s, insert the following tolers | ince: | | |
| 270.0 | C1206Z271(3)1GA(9) | M123A21BPC271(3)(10) | (1) C = ±0 | .25pF; D = ±0.5pF | ., | | | |
| 300.0 | C1206Z301(3)1GA(9) | M123A21BPC301(3)(10) | (2) C = ±0 | 25pF; J = ±5%; K = ±1 | 0% | | | |
| 330.0 | C1206Z331(3)1GA(9) | M123A21BPC331(3)(10) | (3) F = ±1 | %; J = ±5%; K = ±10% | | | | |
| 360.0 | C1206Z361(3)1GA(9) | M123A21BPC361(3)(10) | (4) B = ±0. | 1pF; C = ±0.25pF | | | | |
| 390.0 | C1206Z391(3)1GA(9) | M123A21BPC391(3)(10) | (5) B = ±0. | .1p⊢; C = 0.25pF; D = 0 | 0.50pF | | | |
| 430.0 | C1206Z431(3)1GA(9) | M123A21BPC431(3)(10) | (6) K = ±1 | U%; M =±20% | in incost the following the | ~~ | | |
| 470.0 | C1206Z471(3)1GA(9) | M123A21BPC471(3)(10) | (7) P = 50 | volte: C = 100 volte | ers, insert the following volta | ye: | | |
| 510.0 | C1206Z511(3)1GA(9) | M123A21BPC561(3)(10) | (7) D = 50 (8) 5 = 50 | volts: 1 = 100 volts | | | | |
| 620.0 | C1206Z621(3)1GA(9) | M123A21BPC621(3)(10) | To complete t | he KEMET part number | s, insert termination design | ation: | | |
| 680.0 | C1206Z681(3)1GA(9) | M123A21BPC681(3)(10) | (9) H = Nic | kel Guarded, Solder Co | pated (Sn60); L = 70/30 Tin | Lead Plated | | |
| 750.0 | C1206Z751(3)1GA(9) | M123A21BPC751(3)(10) | (10) S = Nic | kel Guarded, Solder Co | pated (Sn60); Z = 70/30 Tin | Lead Plated | | |
| 820.0 | C1206Z821(3)1GA(9) | M123A21BPC821(3)(10) | | | | | | |
| 910.0 | C1206Z911(3)1GA(9) | M123A21BPC911(3)(10) | | | | | | |
| 1000.0 | C1206Z102(3)1GA(9) | M123A21BPC102(3)(10) | | | | | | |



Table 2 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size Code | Metric Size Code | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | Metric Size CodeDensity Level A: Maximum (Most)Density Level B: Median (Nominal) Land Protrusion (mm)CodeVVV1 | | | | | |) | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | |
|---------------------|------------------------|--|------|------|------|--|------|------|------|------|------|------|---|------|------|------|--|--|--|
| oouc | oouc | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | | | |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 | | | |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 | | | |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 | | | |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 | | | |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 | | | |
| 1825 | 4564 | 2.15 | 1.60 | 6.90 | 6.90 | 7.90 | 2.05 | 1.40 | 6.80 | 6.00 | 7.30 | 1.95 | 1.20 | 6.70 | 5.30 | 7.00 | | | |
| 2225 | 5664 | 2.70 | 1.70 | 6.90 | 8.10 | 7.90 | 2.60 | 1.50 | 6.80 | 7.20 | 7.30 | 2.50 | 1.30 | 6.70 | 6.50 | 7.00 | | | |

Density Level A: For low-density product applications. It is recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. It provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations, the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of Surface Mount Multilayer Ceramic Capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR, or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/ J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Terminat | ion Finish |
|--|-----------------------|-----------------------|
| Tomeredure | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate (T_L to T_p) | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T _L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T_p \text{ to } T_L)$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 3 – Performance & Reliability: Test Methods and Conditions

| Inspection | Test Method | MIL-PRF-123 M-Level | MIL-PRF-123 T-Level | | |
|---|------------------------------------|------------------------|------------------------|--|--|
| | In-Process In | ispection | | | |
| Ultrasonic inspection (pre-termination) | MIL-PRF-123 Method 4.6.1 | Yes (100 %) | Yes (100 %) | | |
| Pre-termination destructive physical analysis | MIL-PRF-123 Method 4.6.2 | Yes (Sample) | Yes (Sample) | | |
| Visual examination (post termination for non- leaded capacitors or post lead attachment for leaded capacitors) | MIL-PRF-123 Method 4.6.3.1 | Yes (100 %) | Yes (100 %) | | |
| Pre-encapsulation terminal strength (leaded capacitors only) | MIL-PRF-123 Method 4.6.4 | Yes (Sample) | Yes (Sample) | | |
| | Group A Ins | pection | | | |
| Thermal shock | MIL-PRF-123 Method 4.6.6.1 | Yes (100 %) | Yes (100 %) | | |
| Ultrasonic inspection (T level ≥ 0805 only) | MIL-PRF-123 Method 4.6.1 | Not Required | Yes (100 %) | | |
| Voltage conditioning | MIL-PRF-123 Method 4.6.6.2 | Yes (100 %) | Yes (100 %) | | |
| Radiographic inspection (encapsulated capacitors only) | MIL-PRF-123 Method 4.6.5 | Yes (100 %) | Yes (100 %) | | |
| Visual and mechanical inspection; material, physical dimensions, design, construction, marking, and workmanship | MIL-PRF-123 Method 4.6.3.2 | Yes (Sample) | Yes (Sample) | | |
| Destructive physical analysis (DPA) | MIL-PRF-123 Method 4.6.11 | Yes (5 Pieces) | Yes (5 Pieces) | | |
| | Group B Ins | pection | | | |
| Thermal shock | MIL-PRF-123 Method 4.6.6.1 | Yes (Sample) | Yes (Sample) | | |
| Life | MIL-PRF-123 Method 4.6.19 | Yes (Sample) | Yes (Sample) | | |
| Humidity, steady-state, low voltage | MIL-PRF-123 Method 4.6.16.1 | Yes (Sample) | Yes (Sample) | | |
| Voltage - temperature limits | MIL-PRF-123 Method 4.6.15 | Yes (Sample) | Yes (Sample) | | |
| Moisture resistance | MIL-PRF-123 Method 4.6.16.2 | Yes (Sample) | Yes (Sample) | | |
| | Group C Inspection (Subg | roup 2: Chip Devices) | | | |
| Terminal Strength | MIL-PRF-123 Method 4.6.12.2.1 | | | | |
| Board flex | MIL-PRF-123 Method 4.6.12.2.1 | | | | |
| Shear stress | MIL-PRF-32535 Method 4.6.12.2.2 | | | | |
| Solderability (terminations S and Z only) | MIL-PRF-123 Method 4.6.13.1.2 | Yes (Military Monitori | ng Program, periodic) | | |
| Bond strength (wire) (termination G only) | MIL-PRF-123 Method 4.6.13.2 | 3 3.2 3.5 1.2 | | | |
| Resistance to soldering heat (terminations S and Z only) | MIL-PRF-32535 Method 4.6.14.2 | | | | |
| Resistance to solvents (chips with markings other than laser marking) | MIL-PRF-32535 Method 4.6.18 | | | | |



Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. In addition, temperature fluctuations should be minimized to avoid condensation on the parts. The atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years upon receipt.

S Ζ **MIL Finish** Н **KEMET Finish** 70/30 SnPb (Plated) Sn60 Termination Finish (Coated) Barrier Ni Ni Layer **Detailed Cross Section** End Aq Aq Termination * End Termination is solderable. **Dielectric Material** ВΧ BaTiO₂ BP Ba-Nd-Ti-O Barrier Layer Termination End Termination/ Finish External Electrode **Inner Electrodes** (AqPd) End Termination/ **External Electrode** Barrier Layer Termination Finish Inner Electrodes (AqPd)

Construction



Capacitor Marking

KEMET MIL-PRF-123 ceramic capacitors will be marked in accordance with the military specification on case sizes \geq 0805. Case sizes below 0805 will not be marked. Two sides of the ceramic body will be laser marked with a " \bar{K} " to identify KEMET, followed by two characters to identify the capacitance value.

The marking appears in legible contrast. Illustrated below is an example of an MLCC with laser the marking of " $\bar{K}A5$ ", which designates a KEMET device with the rated capacitance of 100 nF.



| Capacitance (pF) For Various Alpha/Numeral Identifiers | | | | | | | | | |
|--|------|-----|----|----------|----------|--------|---------|-----------|--|
| | | | | Num | neral | | | | |
| Alpha | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | |
| Character | | | | Capacita | nce (pF) | | I | | |
| A | 0.1 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | |
| Н | 0.2 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | |
| М | 0.3 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | |
| d | 0.4 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | |
| f | 0.5 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | |
| m | 0.6 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | |
| n | 0.7 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | |
| t | 0.8 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | |
| у | 0.9 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8 and 12 mm tape on 7" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems.



Table 4 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tono sino | Embossed Plastic |
|---------------|-----------|---------------------|
| EIA Case Size | (W)* | 7" Reel |
| | | Pitch (P1)* |
| 0805 - 1210 | 8 | 4 |
| ≥ 1808 | 12 | 8 |

*Refer to Figures 1 and 2 for W and P₁ carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 5 - Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|--|---------------------------------------|----------------------------------|----------------------------|---------------------------|---------------------------|---------------------------|----------------------------------|----------------------|---------------------------|
| Tape Size | D _o | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum |
| 8 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.0 (0.039) | 1.75±0.10 (0.069±0.004) | 4.0±0.10 (0.157±0.004) | 2.0±0.05 (0.079±0.002) | 25.0 (0.984) | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 12 mm | | 1.5 (0.059) | | | | 30 (1.181) | | | |
| Variable Dimensions – Millimeters (Inches) | | | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A_0, B_0 and K_0 | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5±0.05 (0.138±0.002) | 4.0±0.10 (0.157±0.004) | 2.5 (0.098) | 8.3 (0.327) | Note 5 | |
| 12 mm | Single (4 mm) and Double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5±0.05 (0.217±0.002) | 8.0±0.10 (0.315±0.004) | 4.6 (0.181) | 12.3 (0.484) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independent of each other.

2. The tape with or without components, shall pass around R without damage (see Figure 6).

3. If S1 < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Document 481 paragraph 4.3 (b)).

4. B1 dimension is a reference dimension for a tape feeder clearance only.

5. The cavity defined by A, B, and K, shall surround the component with sufficient clearance that:

(a) The component does not protrude above the top surface of the carrier tape.

(b) The component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed. (c) Rotation of the component is limited to 20° maximum for 8 and 12 mm tapes; 10° maximum for 16 mm tapes (see Figure 3).

(d) Lateral movement of the component is restricted to 0.5 mm maximum for 8 mm and 12 mm wide tape; to 1.0 mm maximum for 16 mm tape (see Figure 4).

(e) See addendum in EIA Document 481 for standards relating to more precise taping requirements.


Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 Newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 Newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 2 – Maximum Component Rotation



Figure 3 – Maximum Lateral Movement



Figure 4 – Bending Radius





Figure 5 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 6 – Reel Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | | | |
|-----------|--|---|------------------------|-----------------------------|--|--|--|--|--|--|--|--|--|
| Tape Size | A | B Minimum | С | D Minimum | | | | | | | | | |
| 8 mm | 178±0.20 (7.008±0.008) | 1.5 | 13.0 + 0.5/-0.2 | 20.2 | | | | | | | | | |
| 12 mm | 330±0.20 (13.000±0.008) | (0.059) | (0.521 + 0.02/-0.008) | (0.795) | | | | | | | | | |
| | Variable | Dimensions – Millimeter | rs (Inches) | | | | | | | | | | |
| Tape Size | N Minimum See Note 2, Tables 2–3 | W ₁ | W ₂ Maximum | W ₃ | | | | | | | | | |
| 8 mm | 50 | 8.4 + 1.5/-0.0 (0.331 + 0.059/-0.0) | 14.4 (0.567) | Shall accomadate tape width | | | | | | | | | |
| 12 mm | (1.969) | 12.4 + 2.0/-0.0 (0.488 + 0.078/-0.0) | 18.4 (0.724) | without interference | | | | | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Waffle Tray Packaging Information – 2" x 2" w/ Static Protection

Figure 9 – Waffle Tray Dimensions – Inches (Millimeters)





Table 7A – Waffle Tray Dimensions – Inches

| Cas | e Size | | | 2" x 2' | ' Waffle T | ray Dime | nsions – | Inches | | | Packaging Quantity |
|----------|-------------|--------|--------|---------|------------|----------|----------|--------|-------|---------|-----------------------|
| | | М | M1 | M2 | M3 | Х | Y | Z | A° | MATRIX | (pcs/unit |
| EIA (in) | Metric (mm) | ±0.003 | ±0.003 | ±0.002 | ±0.002 | ±0.002 | ±0.002 | ±0.003 | ±1/2° | (X x Y) | packaging) |
| 0402 | 1005 | 0.175 | 0.153 | 0.077 | 0.110 | 0.073 | 0.042 | 0.041 | 7 | 16 X 23 | 368 |
| 0603 | 1608 | 0.175 | 0.153 | 0.077 | 0.110 | 0.073 | 0.042 | 0.041 | 7 | 16 X 23 | 368 |
| 0805 | 2012 | 0.232 | 0.186 | 0.181 | 0.171 | 0.062 | 0.092 | 0.036 | 10 | 10 X 10 | 100 |
| 1206 | 3216 | 0.194 | 0.228 | 0.193 | 0.124 | 0.067 | 0.130 | 0.065 | 5 | 14 X 9 | 126 |
| 1210 | 3225 | 0.217 | 0.244 | 0.215 | 0.174 | 0.110 | 0.145 | 0.080 | 5 | 10 X 8 | 80 |
| 1812 | 4532 | 0.271 | 0.285 | 0.286 | 0.243 | 0.150 | 0.200 | 0.075 | 5 | 7 X 6 | 42 |
| 2220 | 5650 | 0.318 | 0.362 | 0.424 | 0.34 | 0.24 | 0.32 | 0.032 | 5 | 5 X 4 | 20 |

Table 7B – Waffle Tray Dimensions – Millimeters

| Cas | e Size | | 2" x 2" Waffle Tray Dimensions – Millimeters | | | | | | | | | | | |
|----------|--|-------|--|-------|-------|-------|-------|-------|-------|---------|------------|--|--|--|
| | M M1 M2 M3 X Y Z A° MATRIX | | | | | | | | | | | | | |
| EIA (in) | Metric (mm) | ±0.08 | ±0.08 | ±0.05 | ±0.05 | ±0.05 | ±0.05 | ±0.08 | ±1/2° | (X x Y) | packaging) | | | |
| 0402 | 1005 | 4.45 | 3.89 | 1.96 | 2.79 | 1.85 | 1.07 | 1.04 | 7 | 16 X 23 | 368 | | | |
| 0603 | 1608 | 4.45 | 3.89 | 1.96 | 2.79 | 1.85 | 1.07 | 1.04 | 7 | 16 X 23 | 368 | | | |
| 0805 | 2012 | 5.89 | 4.72 | 4.60 | 4.34 | 1.57 | 2.34 | 0.91 | 10 | 10 X 10 | 100 | | | |
| 1206 | 3216 | 4.93 | 5.79 | 4.90 | 3.15 | 1.70 | 3.30 | 1.65 | 5 | 14 X 9 | 126 | | | |
| 1210 | 3225 | 5.51 | 6.20 | 5.46 | 4.42 | 2.79 | 3.68 | 2.03 | 5 | 10 X 8 | 80 | | | |
| 1812 | 4532 | 6.88 | 7.24 | 7.26 | 6.17 | 3.81 | 5.08 | 1.91 | 5 | 7 X 6 | 42 | | | |
| 2220 | 5650 | 8.08 | 9.19 | 10.77 | 8.64 | 6.10 | 8.13 | 0.81 | 5 | 5 X 4 | 20 | | | |

CHT High Temperature 260°C, COG Dielectric, 10 –100 VDC (Industrial Grade)



Overview

KEMET's CHT High Temperature 260°C surface mount Multilayer Ceramic Capacitors (MLCCs) are constructed of a robust and proprietary COG/NP0 base metal electrode (BME) dielectric system that offers industry-leading performance at extreme temperatures.

These devices are specifically designed for applications in harsh environmental conditions such as down hole oil exploration, industrial high temperature electronics, geothermal, and aerospace which need capacitors that are robust and reliable at extreme temperatures such as 260°C. KEMET's COG dielectric exhibits no change in capacitance with respect to time and voltage and boast a negligible change in capacitance with reference to ambient temperature.

KEMET's CHT High Temperature 260°C also incorporates a gold (Au) termination finish providing a clean solderable surface that can withstand the most extreme environments. These devices are Lead (Pb)-Free, RoHS and REACH compliant without the need of any exemptions.

Benefits

- -55°C to +260°C operating temperature range
- Lead (Pb)-Free, RoHS and REACH compliant
- EIA 0603, 0805, 1206 & 1210 case sizes
- DC voltage ratings of 10V, 16V, 25V, 50V & 100V
- Capacitance offerings ranging from 0.5pF up to 15nF
- Gold (Au) termination finish
- Available capacitance tolerances of ±0.10 pF, ±0.25 pF, ±0.5 pF, ±1%, ±2%, ±5%, ±10% or ±20%
- · Extremely low ESR and ESL
- High thermal stability
- · High ripple current capability
- No capacitance change with respect to applied rated DC voltage
- Negligible capacitance change with respect to temperature from -55°C to +260°C
- No capacitance decay with time



Applications

- Downhole Oil Exploration
- Industrial High Temperature Electronics/Sensors
- Geothermal
- Aerospace
- Decoupling
- Bypass
- Filtering
- Transient voltage suppression



Built Into Tomorrow



Ordering Information

| CHT | 13 | С | 124 | J | 5 | G | Α | F | TU |
|--------|--|--------------------------|---|--|---|------------|-------------------------|---------------------------|--|
| Series | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance ¹ | Rated Voltage (VDC) | Dielectric | Failure Rate /Design | Termination Finish | Packaging/ Grade (C-Spec) |
| СНТ | 06 = 0603 08 = 0805 12 = 1206 13 = 1210 | C = Standard | Two significant digits and number of zeros. Use 9 for 1.0 - 9.9 pF Use 8 for 0.5 - 0.99 pF ex. 2.2pF = 229 ex. 0.5pF = 508 | $B = \pm 0.10 \text{ pF}$ $C = \pm 0.25 \text{ pF}$ $D = \pm 0.5 \text{ pF}$ $F = \pm 1\%$ $G = \pm 2\%$ $J = \pm 5\%$ $K = \pm 10\%$ $M = \pm 20\%$ | 8 = 10 V 4 = 16 V 3 = 25 V 5 = 50 V 1 = 100 V | G =COG | A = N/A | F = Gold (Au) 30 – 70 μin | See "Packaging C-Spec Ordering Options Table" |

¹ Additional capacitance tolerance offerings may be available. Contact KEMET for details.

Qualification/Certification

High temperature (260°C) Industrial grade products meet or exceed the requirements outlined in Table 4 , Performance and Reliability.

Packaging C-Spec Ordering Options Table

| Packaging Type/Options ¹ | Packaging Ordering Code (C-Spec) ² | | | | | |
|-------------------------------------|--|--|--|--|--|--|
| 7" Reel | TU | | | | | |
| 12" Dool | 7411 (EIA 0603 and smaller case sizes) | | | | | |
| | 7210 (EIA 0805 and larger case sizes) | | | | | |
| 7" Reel - 50 pcs | Т050 | | | | | |
| 7" Reel - 100 pcs | T100 | | | | | |
| 7" Reel - 250 pcs | T250 | | | | | |
| 7" Reel - 500 pcs | Т500 | | | | | |
| 7" Reel - 1,000 pcs | Т1К0 | | | | | |

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of components. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is **not available** on these devices.

² Reeling quantities are dependent upon chip size and thickness dimension. When ordering using the "Txxx" packaging ordering codes (C-Specs) outlined above, product may be shipped on multiple 7" reels or a single 13" reel. Additional reeling or packaging options may be available. Contact KEMET for details.



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum |
|---------------|---------------------|-------------------------------|-------------------------------|----------------|-------------------------------|----------------------------|
| 0603 | 1608 | 1.60 (0.063) ±0.15 (0.006) | 0.80 (0.032) ±0.15 (0.006) | | 0.35 (0.014) ±0.15 (0.006) | 0.70 (0.028) |
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | See Table 2 | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | for Thickness | 0.50 (0.02) ±0.25 (0.010) | N / A |
| 1210 | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | N/A |

Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions.



Table 1 – Capacitance Range/Selection Waterfall (0603 – 1210 Case Sizes)

| | | Γ | C | a | se | Si | ize | 2/ | | | C | HT | 06 | | | C | HTO | 8 | | | C | HT1 | 2 | | | C | HT1 | 3 | |
|---------------|-------------|---|------|------|--------|------|------|-----|-----------|----|----|------|------|-----|----------|-------|-------|---------|---------|--------|-----------|-------|-------|-------|----|----|-------|-----|----------|
| | Con | | | S | er | rie | S | | | | | 060 | 3 | | | | 080 | 5 | | | | 1206 | 5 | | | | 1210 | | |
| Capacitance | Cap | | | Vol | tag | e C | ode | e | | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 |
| | Code | F | Rate | ed \ | Volt | tage | e (V | /DC | ;) | 10 | 16 | 25 | 50 | 100 | 10 | 16 | 25 | 50 | 100 | 10 | 16 | 25 | 50 | 100 | 15 | 16 | 25 | 50 | 100 |
| | | F | (| Cap | pac | ita | nc | e | - | | | | | | P | roduc | t Ava | ilabili | ity an | d Chip |) Thic | kness | s Cod | es | | | | | <u> </u> |
| | | Ļ | | To | ler | ran | ce | _ | | | | | | | See | Packa | ging | Spece | s for (| Chip Ť | hickn | ess D | imen | sions | | | | | |
| 0.5 & 0.75 pF | 508 & 758 | B | C | D | | | | | | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | ГР | ГР | ГР | ГР | ГР | ГР | ГР | ГР | ED. | ГР |
| 0.1 nF | 010 | B | | | | | | | | | | | | | | | | | | ED | ED | ED | ED | ED | FR | FB | FB | FB | FB |
| 10 - 91 nF* | 100-910* | ľ | | | F | G | | к | м | CE | CE | CE | CE | CE | | | | | | FR | FR | FR | FR | FR | FR | FR | FR | FR | FR |
| 100 - 180 pF* | 101 - 181* | | | | F | G | J | K | M | CF | CE | CE | CE | CE | | | | | | FR | FR | FR | FR | FR | FR | FR | FR | FR | FR |
| 200 - 430 nF* | 201 - 431* | Т | | | E | G | J | ĸ | M | CF | CF | CF | CF | | DN | DN | DN | | DN | FB | FB | FR | FB | FB | FB | FB | FB | FB | FB |
| 470 nF | 471 | | | | F | G | J | ĸ | м | CF | CF | CF | | | DP | DP | DP | DP | DP | FB | FB | FB | FB | FB | FB | FB | FB | FB | FB |
| 510 pF | 511 | | | | F | G | J | K | м | CF | CF | CF | | | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB |
| 560 pF | 561 | | | | F | G | Ĵ | ĸ | м | CF | CF | CF | | | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB |
| 620 pF | 621 | | | | F | G | J | K | м | ĊF | CF | CF | | | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB |
| 680 pF | 681 | | | | F | G | J | К | м | CF | CF | CF | | | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB |
| 750 pF | 751 | | | | F | G | J | К | м | CF | CF | CF | | | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB |
| 820 pF | 821 | | | | F | G | J | К | М | CF | CF | CF | | | DN | DN | DN | DN | DN | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB |
| 910 pF | 911 | | | | F | G | J | Κ | М | CF | CF | CF | | | DP | DP | DP | DP | DP | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB |
| 1,000 pF | 102 | | | | F | G | J | K | М | CF | CF | CF | | | DP | DP | DP | DP | DP | EE | EE | EE | EE | EE | FB | FB | FB | FB | FB |
| 1,100 pF | 112 | | | | F | G | J | Κ | М | CF | CF | CF | | | DN | DN | DN | DN | | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB |
| 1,200 pF | 122 | | | | F | G | J | K | М | CF | CF | CF | | | DN | DN | DN | DN | | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB |
| 1,300 pF | 132 | | | | F | G | J | K | м | CF | CF | CF | | | DP | DP | DP | DP | | EC | EC | EC | EC | EC | FC | FC | FC | FC | FC |
| 1,500 pF | 152 | | | | F | G | J | K | М | CF | CF | CF | | | DP | DP | DP | DP | | EC | EC | EC | EC | EC | FE | FE | FE | FE | FE |
| 1,600 pF | 162 | | | | F | G | J | K | М | | | | | | DP | DP | DP | DP | | ED | ED | ED | ED | ED | FE | FE | FE | FE | FE |
| 1,800 pF | 182 | | | | F | G | J | K | М | | | | | | DP | DP | DP | DP | | ED | ED | ED | ED | ED | FE | FE | FE | FE | FE |
| 2,000 pF | 202 | | | | F | G | J | K | М | | | | | | DN | DN | DN | | | ED | ED | ED | ED | ED | FE | FE | FE | FE | FE |
| 2,200 pF | 222 | | | | F | G | J | K | М | | | | | | DN | DN | DN | | | EE | EE | EE | EE | EE | FG | FG | FG | FG | FG |
| 2,400 pF | 242 | | | | F | G | J | K | М | | | | | | DN | DN | DN | | | EC | EC | EC | EC | EC | FC | FC | FC | FC | FC |
| 2,700 pF | 2/2 | | | | F | G | J | K | M | | | | | | DN | DN | DN | | | EC | EC | EC | EC | EC | FC | FC | FC | FC | FC |
| 3,000 pF | 302 | | | | | G | J | K | M | | | | | | UP DP | DP DP | DP | | | EC | EU | EU | EU | | | | | | |
| 3,300 pF | 332 | | | | | G | J | K | M | | | | | | UP DP | DP DP | DP | | | EE | EE | EE | EE | | | | | | |
| 3,600 pF | 362 | | | | F | G | J | K | M | | | | | | UP DF | DP | DP | | | | EE | EE | EE | | | FF | FF | | |
| 3,900 pF | 392 | | | | F | 6 | 1 | K | M | | | | | | | DE | DE | | | EF | EF | EF | EF | | FF | FF | FF | | FF CC |
| 4,300 pr | 432 | | | | F | 6 | J | ĸ | IVI NA | | | | | | DE | DE | DE | | | EC | EC | EC | EC | | 50 | FC | FF | FC | FF |
| 4,700 pr | 512 | | | | r c | 6 | 1 | ĸ | M | | | | | | DE | DE | DE | | | ED | ED | | ED | | FG | FG | FG | FG | FG |
| 5,100 pr | 562 | | | | r c | G | 5 | ĸ | M | | | | | | DE | DE | DE | | | ED | | | | | FG | FG | FG | FG | FG |
| 6 200 pF | 622 | | | | F | G | 1 I | ĸ | M | | | | | | | | | | | FR | FR | FR | EU | | FG | FG | FG | FG | FU |
| 6,200 pr | 682 | | | | F | G | 1 I | K | M | | | | | | | | | | | EB | FR | FR | | | FG | FG | FG | FG | |
| 7 500 pF | 752 | T | | | F | G | ů, | ĸ | M | | | | | | | | | | | FB | FR | FR | | | FC | FC | FC | FC | |
| 8 200 pF | 822 | | | | F | G | J. | K | м | | | | | | | | | | | FC | FC | FC | | | FC | FC | FC | FC | |
| 9 100 nF | 912 | | | | F | G | J. | ĸ | м | | | | | | | | | | | FC | FC | FC | | | FF | FF | FF | FF | |
| 10 000 pF | 103 | | | | F. | G | J | ĸ | м | | | | | | | | | | | FD | FD | FD | | | FF | FF | FF | FF | |
| 12 000 pF | 123 | | | | F | G | J | ĸ | м | | | | | | | | | | | | | | | | FG | FG | FG | | |
| 15.000 pF | 153 | | | | F | G | J | K | М | | | | | | | | | | | | | | | | FG | FG | FG | | |
| | | Г | Rate | ed ۱ | Volt | tage | e (V | /DC | ;) | 10 | 16 | 25 | 50 | 00 | 9 | 16 | 25 | 50 | 100 | 5 | 16 | 25 | 50 | 001 | 5 | 16 | 25 | 50 | 100 |
| Capacitance | Cap Code | ┢ | | Vol | tag | e C | ode | 9 | | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 | 8 | 4 | 3 | 5 | 1 |
| | | | Ca | se | Siz | e/s | Ser | ies | \$ | | СН | T06/ | 0603 | | | CH. | T08/0 | 805 | | | CH | T12/1 | 206 | | | CH | T13/1 | 210 | |

*Capacitance range includes E24 decade values only (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91). These products are protected under US Patent 7,172,985 & 7,670,981, other patents pending, and any foreign counterparts.

4



| Thickness | Case | Thickness ± | Paper C |)uantity | Plastic (| Quantity |
|-----------|------|-------------|----------------|----------|--------------------------|----------|
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| CF | 0603 | 0.80 ± 0.07 | 4,000 | 15,000 | 0 | 0 |
| DN | 0805 | 0.78 ± 0.10 | 4,000 | 15,000 | 0 | 0 |
| DP | 0805 | 0.90 ± 0.10 | 4,000 | 15,000 | 0 | 0 |
| DE | 0805 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| EB | 1206 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| EC | 1206 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| ED | 1206 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| EE | 1206 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| FB | 1210 | 0.78 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| FC | 1210 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| FE | 1210 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FF | 1210 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FG | 1210 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size | Range (mm) | Paper Quantity | | uantity Plastic Quantity | |

Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

Package quantity based on finished chip thickness specifications.

Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size Code | Metric Size Code | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | | | Dens Media Land Pi | sity Lev an (Noi rotrusio | vel B: minal) on (mm |) | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | |
|---------------------|------------------------|--|------|------|------|------|------|--------------------------|---------------------------------|----------------------------|------|---|------|------|------|------|--|
| oouc | oouc | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 | |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 | |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 | |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 | |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





COG HT 260°C Performance and Reliability: SMD Test Methods and Conditions

| Stress | Reference | Test Condition | Limits |
|---|-------------------|--|--|
| Visual and Mechanical | KEMET Internal | No defects that may affect performance (10X) | Dimensions according KEMET Spec Sheet |
| Capacitance (Cap) | KEMET Internal | $C \le 1,000 \text{ pF}$ Frequency: 1 MHz ±100 kHz Voltage*:1.0 V _{rms} ±0.2 V C > 1,000 pF Frequency: 1 kHz ±50 Hz Voltage: 1.0 V _{rms} ±0.2 V * See part number specification sheet for voltage | Within Tolerance |
| Dissipation Factor (DF) | KEMET Internal | C ≤ 1,000 pF Frequency: 1 MHz ±100 kHz Voltage*:1.0 V _{rms} ±0.2 V C > 1,000 pF Frequency: 1 kHz ±50 Hz Voltage: 1.0 V _{rms} ±0.2 V * See part number specification sheet for voltage | Within Specification Dissipation factor (DF) maximum limit at 25°C = 0.1% |
| Insulation Resistance (IR) | KEMET Internal | Rated voltage applied for 120 ±5 seconds at 25°C | Within Specification To obtain IR limit, divide MΩ-μF value by the capacitance and compare to GΩ limit. Select the lower of the two limits: 1,000 megohm microfarads or 100 GΩ. |
| Temperature Coefficient of Capacitance (TCC) | KEMET Internal | Capacitance change with reference to +25°C and 0 VDC applied.* See part number specification sheet for voltageStepTemperature (°C)1+25°C2-55°C3+25°C (Reference)4+125°C | Within Specification: ±30 ppm / °C |
| Dielectric Withstanding Voltage (DWV) | KEMET Internal | 250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit Withstand test voltage without insulation breakdown or damage. |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | KEMET Internal | Maximum % capacitance loss/decade hour | 0% Loss/Decade Hour |

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COG HT 260°C Performance and Reliability: SMD Test Methods and Conditions cont.

| Test | Reference | Test Condition | Limits |
|------------------------|---------------------------|---|--|
| Terminal Strength | KEMET Internal | Shear stress test per specific case size, Time: 60±1 secondsCase SizeForce06035N08059N≥120618N | No evidence of mechanical damage |
| Board Flex | AEC-Q200-005 | 3.0 mm minimum Test time: 60 ±5 seconds Ramp time: 1 mm / second | No evidence of mechanical damage |
| Temperature Cycling | JESD22 Method JA-104 | 50 cycles (~55°C to +260°C) 2 – 3 cycles per hour Soak Time: 1 or 5 minutes | Measurement at 24 hours ±4 hours after test conclusion. Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| | | Load Humidity: | Measurement at 24 hours ±4 hours after test conclusion. |
| Biased | MIL-STD-202 Method 103 | 1,000 hours 85°C/85% RH and rated voltage. | Within Post Environmental Limits |
| Tumuty | Method 103 | Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. | Cap: ±0.3% or ±0.25 pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5% |
| High | | | Within Post Environmental Limits |
| Temperature Life | MIL-STD-202 Method 108 | 1,000 hours at 260°C with rated voltage applied | Cap: ±0.3% or ±0.25 pF shift IR: 10% of Initial Limit DF: 0.5% |

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COG HT 260°C Performance and Reliability: SMD Test Methods and Conditions cont.

| Test | Reference | Test Condition | Limits |
|---------------------------------|--|---|---|
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Test from 10 – 2,000 Hz | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Mechanical Shock | MIL-STD-202 Method 213 | 1,500 g's 0.5 ms Half-sine, Velocity Change 15.4 feet/second (Condition F) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents. | Visual Inspection 10X Readable marking, no decoloration or stains. No physical damage. |
| Resistance to Soldering Heat | MIL-STD-202 Method 210 | 260 ± 5°C, Immersion time: 10 ±1 seconds (Condition B) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit No physical damage. |
| Solderability | derability ANSI/J-STD-002 Magnification 50X. Conditions: a) Method B, 4 hours at 155°C, dry heat at 235°C b) Method B at 215°C category 3 c) Method D at 260°C category 3 | | Visual Inspection. 95% coverage on termination. No leaching |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. In addition, temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction (Typical)



Capacitor Marking (Optional):

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- · EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | | Embosse | ed Plastic | Punched Paper | | |
|----------------------|------|---------|--------------------|---------------|--------------------|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | (W)* | Pitch | (P ₁)* | Pitch | (P ₁)* | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 | |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | |
| Array 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P₁ carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size. 2 mm pitch reel for 0805 EIA case size under development.

2 mm pitch reel for U805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|--|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 16 mm | | (0.059) | | | | (1.181) | | | |
| | Variable Dimensions — Millimeters (Inches) | | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | Note 5 | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_{a} and B_{a} are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | |
|--|---------------------------------------|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | |
| Variable Dimensions – Millimeters (Inches) | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | |
| 8 mm Single (4 m | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | Note I | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength | | | |
|--------------|----------------------------------|--|--|--|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) | | | |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) | | | |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | | |
|--|--|---------------------------------------|--|--|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | | |
| 8 mm | 178 ±0.20 | | | | | | | |
| 12 mm | 0r | 1.5 (0.059) | 13.0 +0.5/-0.2 (0 521 +0 02/-0 008) | 20.2 (0.795) | | | | |
| 16 mm | (13.000 ±0.008) | | · · · / | | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | | |
| 16 mm | · · · | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber



HiQ-CBR Automotive Series, COG Dielectric, Low ESR, 50 VDC, 1 MHz – 50 GHz (RF & Microwave)

Overview

KEMET's HiQ CBR Automotive RF Capacitor Series features a copper electrode BME (Base Metal Electrode) system that offers ultra-low ESR and High Q in the VHF, UHF, and microwave frequency bands. Low ESR allows for higher RF currents which are ideal for applications such as V2X, safety systems, power train and automotive communication systems.

CBR Series capacitors exhibit no change in capacitance with respect to time and voltage, and boast a negligible change in capacitance with reference to ambient temperature.

(())) HIQ-CBR RF & MICROWAVE

KEMET's HiQ CBR RF capacitors are characterized using Modelithics[™] substrate scalable models and is available in most EDA software. Contact KEMET Sales for details on accessing models.



Benefits

- AEC-Q200 Qualified
- Ultra-low ESR and High Q
- High SRF
- High thermal stability
- 1 MHz to 50 GHz frequency range
- Operating temperature range of -55° C to $+125^{\circ}$ C
- Base metal electrode (BME) dielectric system
- Pb-free and RoHS compliant
- 0402 and 0603 case sizes (inches)
- DC voltage rating of 50 V
- Capacitance offerings ranging from 0.1 pF up to 100 pF
- Available capacitance tolerances of ± 0.05 pF, ± 0.1 pF, ± 0.25 pF, ± 0.5 pF, $\pm 1\%,$ $\pm 2\%,$ and $\pm 5\%$
- Negligible capacitance change with respect to temperature
- 100% pure matte tin-plated termination finish allowing for excellent solderability

Applications

- V2X
- Safety Systems
- Power Train
- Automotive Communication Systems
- Bypass, coupling, filtering, impedance matching, DC blocking







Ordering Information

| CBR | 04 | C | 330 | F | 5 | G | Α | C | AUTO |
|--------|------------------------|--------------------------|--|---|----------|------------|----------------------|-----------------------|--|
| Series | Case Size (L"x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Voltage | Dielectric | Termination Style | Termination Finish | Packaging/ Grade (C-Spec) |
| CBR | 04 = 0402 06 = 0603 | C = Standard | Two significant digits and number of zeros Use 9 for 1.0 – 9.9 pF Use 8 for 0.1 – 0.99 pF ex. 2.2 pF = 229 ex. 0.5 pF = 508 | $A = \pm 0.05 \text{ pF} \\ B = \pm 0.1 \text{ pF} \\ C = \pm 0.25 \text{ pF} \\ D = \pm 0.5 \text{ pF} \\ F = \pm 1\% \\ G = \pm 2\% \\ J = \pm 5\%$ | 5 = 50 V | G = COG | A = N/A | C = 100% Matte Sn | See "Packaging C-Spec Ordering Options Table" |

Tape & Reel Packaging Information

| Packaging Type | Packaging Ordering Code (C-SPEC) | | |
|----------------|-------------------------------------|--|--|
| 7" Reel | AUTO | | |
| 13" Reel | AUT07411 | | |

Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions





Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | Days Prior To | | |
|-----------------------------|--------------------------------------|---------------|------------------|--|
| C-Spec | Process/Product change Obsolescence* | | Implementation | |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum | |
| AUTO | Yes (without approval) | Yes | 90 days minimum | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | PPAP (Product Part Approval Process) Level | | | | | | |
|-----------------------------|---|---|---|---|---|--|--|
| C-Spec | 1 | 2 | 3 | 4 | 5 | | |
| KEMET assigned ¹ | • | • | • | • | • | | |
| AUTO | | | 0 | | | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)



| Case Size (in.) | Case Size (mm) | L Length | W Width | T Thickness | B Bandwidth | Mounting Technique | |
|--------------------|-------------------|------------------------------|------------------------------|------------------------------|------------------------------|-----------------------|--|
| 0402 | 1005 | 1.00 ±0.05 (0.040 ±0.002) | 0.50 ±0.05 (0.020 ±0.002) | 0.50 ±0.05 (0.020 ±0.002) | 0.25 ±0.10 (0.010 ±0.004) | Solder Wave | |
| 0603 | 1608 | 1.60 ±0.10 (0.063 ±0.004) | 0.80 ±0.10 (0.031 ±0.004) | 0.80 ±0.10 (0.031 ±0.004) | 0.40 ±0.20 (0.016 ±0.008) | or Solder Reflow | |

Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|--|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±30 ppm/°C |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 0% |
| ¹ Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA) |
| ² Quality Factor (Q): | ≥ 1,000 for capacitance values ≥ 30 pF ≥ 400 + 20C for capacitance values < 30 pF (C = Capacitance in pF) |
| Insulation Resistance (IR) Limit at 25°C | 10 G Ω minimum (rated voltage applied for 120 ±5 seconds) |

¹ DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

 2 Capacitance and Quality Factor (Q) measured $\,$ at 1 MHz ±100 kHz and 1.0 ±0.2 V $_{\rm rms}$



Table 1 – CBR AUTO Series, Capacitance Range Waterfall

| Case Size - | Inches (mm) | 0402 (1005) | 0603 (1608) | | |
|-------------|--------------|------------------|-------------|--|--|
| Rated Volt | age (VDC) | 50 | 50 | | |
| Voltag | e Code | 5 | 5 | | |
| | Capacitance | Capacitance Code | | | |
| Capacitance | Tolerance | (Available C | apacitance) | | |
| 0.1 pF | B = ±0.1pF | 108 | | | |
| 0.2 pF | | 208 | 208 | | |
| 0.3 pF | | 308 | 308 | | |
| 0.4 pF | | 408 | 408 | | |
| 0.5 pF | | 508 | 508 | | |
| 0.6 pF | | 608 | 608 | | |
| 0.7 pF | | 708 | 708 | | |
| 0.8 pF | | 808 | 808 | | |
| 0.9 pF | | 908 | 908 | | |
| 1.0 pF | A = ±0.05 pF | 109 | 109 | | |
| 1.1 pF | B = ±0.1 pF | 119 | 119 | | |
| 1.2 pF | C = ±0.25 pF | 129 | 129 | | |
| 1.3 pF | | 139 | 139 | | |
| 1.4 pF | | 149 | 149 | | |
| 1.5 pF | | 159 | 159 | | |
| 1.6 pF | | 169 | 169 | | |
| 1.7 pF | | 179 | 179 | | |
| 1.8 pF | | 189 | 189 | | |
| 1.9 pF | | 199 | 199 | | |
| 2.0 pF | | 209 | 209 | | |
| 2.1 pF | | 219 | 219 | | |
| 2.2 pF | | 229 | 229 | | |
| 2.3 pF | | 239 | 239 | | |
| 2.4 pF | | 249 | 249 | | |
| 2.5 pF | | 259 | 259 | | |
| 2.6 pF | | 269 | 269 | | |
| 2.7 pF | | 279 | 279 | | |
| 2.8 pF | | 289 | 289 | | |
| 2.9 pF | | 299 | 299 | | |
| 3.0 pF | | 309 | 309 | | |
| 3.1 pF | | 319 | 319 | | |
| 3.2 pF | | 329 | 329 | | |
| 3.3 pF | | 339 | 339 | | |
| 3.4 pF | A = ±0.05 pF | 349 | 349 | | |
| 3.5 pF | B = ±0.1 pF | 359 | 359 | | |
| 3.6 pF | C = ±0.25 pF | 369 | 369 | | |
| 3.7 pF | D = ±0.5 pF | 379 | 379 | | |
| 3.8 pF | | 389 | 389 | | |
| 3.9 pF | | 399 | 399 | | |
| 4.0 pF | | 409 | 409 | | |
| 4.1 pF | | 419 | 419 | | |
| 4.2 pF | | 429 | 429 | | |
| 4.3 pF | | 439 | 439 | | |
| 4.4 pF | | 449 | 449 | | |
| 4.5 pF | | 459 | 459 | | |
| 4.6 pF | | 469 | 469 | | |
| 4.7 pF | | 479 | 479 | | |
| 4.8 pF | | 489 | 489 | | |
| 4.9 pF | | 499 | 499 | | |
| 5.0 pF | | 509 | 509 | | |
| Rated Volt | age (VDC) | 50 | 50 | | |
| Voltag | e Code | 5 | 5 | | |



Table 1 – CBR AUTO Series, Capacitance Range Waterfall cont.

| Case Size - | Inches (mm) | 0402 (1005) | 0603 (1608) | | |
|------------------|--------------|------------------|--------------------|--|--|
| Rated Volt | age (VDC) | 50 | 50 | | |
| Voltag | e Code | 5 | 5 | | |
| 0 11 | Capacitance | Capacitance Code | | | |
| Capacitance | Tolerance | (Available C | apacitance) | | |
| 5.1 pF | | 519 | 519 | | |
| 5.2 pF | | 529 | 529 | | |
| 5.3 pF | | 539 | 539 | | |
| 5.4 pF | | 549 | 549 | | |
| 5.5 pF | | 559 | 559 | | |
| 5.6 pF | | 569 | 569 | | |
| 5.7 pF | | 579 | 579 | | |
| 5.8 pF | | 589 | 589 | | |
| 5.9 pF | | 599 | 599 | | |
| 6.0 pF | | 609 | 609 | | |
| 6.1 pF | | 619 | 619 | | |
| 6.2 pF | | 629 | 629 | | |
| 6.3 pF | | 639 | 639 | | |
| 6.4 pF | | 649 | 649 | | |
| 6.5 pF | | 659 | 659 | | |
| 6.6 pF | | 669 | 669 | | |
| 6.7 pF | | 679 | 679 | | |
| 6.8 pF | | 689 | 689 | | |
| 6.9 pF | | 699 | 699 | | |
| 7.0 pF | | 709 | 709 | | |
| 7.1 pF | | 719 | 719 | | |
| 7.2 pF | | 729 | 729 | | |
| 7.3 pF | | 739 | 739 | | |
| 7.4 pF | B = ±0.1 pF | 749 | 749 | | |
| 7.5 pF | C = ±0.25 pF | 759 | 759 | | |
| 7.6 pF | D = ±0.5 pF | 769 | 769 | | |
| 7.7 pF | | 779 | 779 | | |
| 7.8 pF | | 789 | 789 | | |
| 7.9 pF | | 799 | 799 | | |
| 8.0 pF | | 809 | 809 | | |
| 8.1 pF | | 819 | 819 | | |
| 8.2 pF | | 829 | 829 | | |
| 8.3 pF | | 839 | 839 | | |
| 8.4 pF | | 849 | 849 | | |
| 8.5 pF | | 859 | 859 | | |
| 8.6 pF | | 869 | 869 | | |
| 8.7 pF | | 8/9 | 8/9 | | |
| 8.8 pF | | 889 | 889 | | |
| 0.9 pr | | 000 | 000 | | |
| 9.0 pr | | 909 | 909 | | |
| 9.1 µr | | 020 | 020 | | |
| 9.2 µr | | 929 | 929 | | |
| 9.5 µr | | 939 | 939 | | |
| 9.4 pr | | 949 | 949 | | |
| 9.5 pr | | 969 | 969 | | |
| 9.0 pr | | 979 | 979 | | |
| 9.8 nF | | 980 | 980 | | |
| 9.0 pr 9.0 nF | | 909 | 909 | | |
| 5.7 pi | | 533 FA | ,,,, F ^ | | |
| Kated Volt | age (VDC) | อบ | οU | | |
| Voltag | e Code | 5 | 5 | | |



Table 1 – CBR AUTO Series, Capacitance Range Waterfall cont.

| Case Size - | Inches (mm) | 0402 (1005) | 0603 (1608) | | |
|-------------|-------------|------------------|-------------|--|--|
| Rated Volt | age (VDC) | 50 | 50 | | |
| Voltag | e Code | 5 | 5 | | |
| Canacitance | Capacitance | Capacitance Code | | | |
| Capacitance | Tolerance | (Available C | apacitance) | | |
| 10 pF | | 100 | 100 | | |
| 11 pF | | 110 | 110 | | |
| 12 pF | | 120 | 120 | | |
| 13 pF | | 130 | 130 | | |
| 15 pF | | 150 | 150 | | |
| 16 pF | | 160 | 160 | | |
| 18 pF | | 180 | 180 | | |
| 20 pF | | 200 | 200 | | |
| 22 pF | | 220 | 220 | | |
| 24 pF | | 240 | 240 | | |
| 27 pF | | 270 | 270 | | |
| 30 pF | F = ±1% | 300 | 300 | | |
| 33 pF | G = ±2% | 330 | 330 | | |
| 36 pF | J = ±5% | 360 | 360 | | |
| 39 pF | | 390 | 390 | | |
| 43 pF | | 430 | 430 | | |
| 47 pF | | 470 | 470 | | |
| 51 pF | | 510 | 510 | | |
| 56 pF | | 560 | 560 | | |
| 62 pF | | 620 | 620 | | |
| 68 pF | | 680 | 680 | | |
| 75 pF | | 750 | 750 | | |
| 82 pF | | 820 | 820 | | |
| 91 pF | | 910 | 910 | | |
| 100 pF | | 101 | 101 | | |
| Rated Volt | age (VDC) | 50 | 50 | | |
| Voltag | e Code | 5 | 5 | | |

Table 2 – Chip Thickness/Reeling Quantities

| Chip Size | Chip Thickness | Reel Quantity | | | |
|------------------------|----------------|---------------|-----------|--|--|
| Inches (mm) | (mm) | 7" Paper | 13" Paper | | |
| 0402 (1005) | 0.50 ±0.05 | 10,000 | 50,000 | | |
| 0603 (1608) 0.80 ±0.10 | | 4,000 | 15,000 | | |



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351 (mm)

| Case Case Size Size (Inches) (mm) | | Density Level A: Maximum (Most) Land Protrusion | | | Density Level B: Median (Nominal) Land Protrusion | | | | Density Level C: Minimum (Least) Land Protrusion | | | | | | | |
|---|---|---|------|------|---|------|------|------|--|------|------|------|------|------|------|------|
| (menes) (mm) | (,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of 0603(1608) and 0805 (2012) case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1608 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Drofile Feature | Termination Finish | | | | |
|--|-----------------------|-----------------------|--|--|--|
| Fromereature | SnPb | 100% Matte Sn | | | |
| Preheat/Soak | | | | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C | | | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | | | |
| Time (t _s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds | | | |
| Ramp-Up Rate (T_L to T_P) | 3°C/second maximum | 3°C/second maximum | | | |
| Liquidous Temperature (T _L) | 183°C | 217°C | | | |
| Time Above Liquidous (t _L) | 60 – 150 seconds | 60 – 150 seconds | | | |
| Peak Temperature (T _P) | 235°C | 260°C | | | |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum | 30 seconds maximum | | | |
| Ramp-Down Rate $(T_P to T_L)$ | 6°C/second maximum | 6°C/second maximum | | | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | | | |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degradedby high temperature – reels may soften or warp, and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C, and maximum storage humidity not exceed 70% relative humidity. In addition, temperature fluctuations should be minimized to avoid condensation on the parts, and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability, chip stock should be used promptly, preferably within 1.5 years of receipt.

Construction





Tape & Reel Packaging Information

KEMET offers RF and Microwave Multilayer Ceramic Chip Capacitors packaged in 8 mm tape on 7" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems.



Table 4 – Carrier Tape Configuration (mm)

| EIA Case Size | Tape Size (W)* | Lead Space (P ₁)* |
|---------------|----------------|-------------------------------|
| 0402 | 8 | 2 |
| 0603 | 8 | 4 |

*Refer to Figure 1 for W and P₁ carrier tape reference locations. *Refer to Table 6 for tolerance specifications.



Figure 1 – Punched (Paper) Carrier Tape Dimensions



Table 5 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | | | |
|--|----------------------------|----------------------------|---------------------------|---------------------------|---------------------------|----------------------------|---------------------------|----------------|--|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | R Reference Note 2 | | K ₀ | | | |
| 8 mm | 1.55+0.05 (0.061+0.002) | 1.55±0.05 (0.061±0.002) | 4.0±0.10 (0.157±0.004) | 2.0±0.05 (0.079±0.002) | 25.0 (0.984) | - | | | | |
| Variable Dimensions – Millimeters (Inches) | | | | | | | | | | |
| Tape Size | Pitch | A ₀ | B ₀ | F | P ₁ | Т | W | D ₁ | | |
| 0 mm | Half (2 mm) | 0.37±0.03 (0.015±0.001) | 0.67±0.03 (0.03±0.001) | 3 5+0 05 | 2.0±0.05 (0.079±0.002) | 0.42±0.03 (0.017±0.001) | | | | |
| 0 11111 | | 0.62±0.05 (0.025±0.002) | 1.12±0.05 (0.04±0.002) | | | 0.60±0.05 (0.024±0.002) | 8.0±0.10 (0.315±0.004) | | | |
| 8 mm | Single (4 mm) | 1.00±0.10 (0.040±0.004) | 1.80±0.10 (0.07±0.004) | (0.138±0.002) | 4.0±0.10 | 0.95±0.05 (0.037±0.002) | | - | | |
| | | 1.50±0.10 (0.06±0.004) | 2.30±0.10 (0.09±0.004) | | (0.157±0.004) | 0.95±0.05 (0.037±0.002) | | | | |

2. The tape with or without components shall pass around R without damage (see Figure 3).



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 Kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 2 – Bending Radius



Figure 3 – Tape Leader & Trailer Dimensions





Figure 4 – Maximum Camber



Figure 5 – Reel Dimensions



Table 6 – Reel Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | | | |
|--|--|-----------------------------|------------------------------|--|--|--|--|--|--|
| Tape Size | Reel Size | А | С | | | | | | |
| 8 mm | 7 | 178 ±0.10 (7.008 ±0.004) | 13.0 ±0.20 (0.512 ±0.008) | | | | | | |
| | Variable Dimensions — Millimeters (Inches) | | | | | | | | |
| Tape Size | Reel Size | W1 | | | | | | | |
| 8 mm | 8 mm 60 ±0.10 (2.4 ±0.04) | | | | | | | | |

High Voltage, U2J Dielectric, 2,000 VDC (Commercial & Automotive Grade)



Overview

KEMET's Class I U2J High Voltage series is designed to meet the growing demand for high AC current resonant applications such as LLC resonant converters and wireless power transfer circuits in electric vehicles. By utilizing KEMET's proprietary U2J dielectric, this series provides designers with a surface mount solution with extremely low ESR and ESL with very high AC current capability. This leads to minimal i²R heating losses which equates to higher efficiency power conversion. U2J is not sensitive to capacitance loss with DC Bias as compared to Class II dielectric materials and retains over 99% of nominal capacitance at full rated voltage. KEMET automotive grade capacitors meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements. Capacitance change is limited to -750 ±120 ppm/°C from -55°C to +125°C. These devices are lead (Pb)-free, RoHS and REACH compliant without exception and are capable of withstanding multiple passes through a lead (Pb)-free solder reflow profile.



Benefits

- AEC-Q200 automotive qualified
- Very High ripple current capability
- Extremely low effective series resistance (ESR)
- Extremely low effective series inductance (ESL)
- Retains over 99% of nominal capacitance at full rated voltage
- Small predictable and linear capacitance change with respect to temperature < -750 ±120 ppm/°C
- Operating temperature range of -55°C to +125°C
- · Lead (Pb)-free, RoHS, and REACH Compliant

Applications

- Wide bandgap (WBG), silicon carbide (SiC) and gallium nitride (GaN) systems
- EV/HEV (drive systems, charging)
- Wireless charging
- Power converters
- Inverters
- · LLC resonant converters



Ordering Information

| С | 3640 | C | 153 | J | G | J | Α | C | TU |
|---------|------------------------|--------------------------|--|---|------------------------|------------|-------------------------|--------------------|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance ¹ | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish | Packaging/ Grade (C-Spec) |
| С | 3640 | C = Standard | Two significant digits and number of zeros. | F = ±1% G = ±2% J = ±5% K = ±10% M = ±20% | G = 2,000 V | J = U2J | A = N/A | C = 100% Matte Sn | See "Packaging C-Spec Ordering Options Table" |

¹ Additional capacitance tolerance offerings may be available. Contact KEMET for details.

Packaging C-Spec Ordering Options Table

| Packaging Type ¹ | Packaging/Grade Ordering Code (C-Spec) |
|-------------------------------|---|
| Commercial Grade | |
| 7" Reel/Unmarked | TU |
| 13" Reel/Unmarked | 7210 |
| Automotive Grade ¹ | |
| 7" Reel | AUTO |
| 13" Reel/Unmarked | AUT07210 |

¹ For additional information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information."

All Automotive packaging C-Specs listed exclude the option to laser mark components. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking".


Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|---------------------|------------------------|-------------------------------|--------------------------------|------------------------------|-------------------------------|----------------------------|-----------------------|
| 3640 | 9210 | 9.10 (0.358) ±0.40 (0.016) | 10.20 (0.402) ±0.40 (0.016) | See Table 2 for thickness | 1.27 (0.050) ±0.40 (0.016) | N/A | Solder Reflow Only |



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | tion Due To: | Days Prior To |
|-----------------------------|----------------------------------|---------------|------------------|
| C-Spec | Process/Product change | Obsolescence* | Implementation |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum |
| AUTO | Yes (without approval) | Yes | 90 days minimum |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | | PPAP (Product | Part Approval | Process) Leve | I |
|-----------------------------|---|---------------|---------------|---------------|---|
| C-Spec | 1 | 2 | 3 | 4 | 5 |
| KEMET assigned ¹ | • | • | • | • | • |
| AUTO | | | 0 | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

- Part number specific PPAP available
- Product family PPAP only



Table 1 – Capacitance Range/Selection Waterfall

| | | Case Size/ Series | C3640 | | | |
|-------------|-------------|--------------------------|--|--|--|--|
| Capacitance | Сар | Voltage Code | G | | | |
| oupuonunoe | Code | Rated Voltage (VDC) | 2,000 | | | |
| | | Capacitance Tolerance | Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions | | | |
| 15,000 pF | 153 | FGJKM | MC | | | |
| | | Rated Voltage (VDC) | 2,000 | | | |
| Capacitance | Cap Code | Voltage Code | G | | | |
| | | Case Size/ Series | C3640 | | | |

These products are protected under US Patent 7,172,985 & 7,670,981, other patents pending, and any foreign counterparts.

Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case Thickness ± | | Paper C | Quantity | Plastic Quantity | | |
|-----------|-------------------|-------------|------------------|----------|------------------|----------|--|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| MC | 3640 | 2.50 ± 0.20 | 0 | 0 | 250 | 1,000 | |
| Thickness | Case | Thickness ± | 7" Reel 13" Reel | | 7" Reel 13" Reel | | |
| Code | Size ¹ | Range (mm) | Paper (| Quantity | Plastic Quantity | | |



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Metric Size Size Code Code | Density Level A: Maximum (Most) Land Protrusion (mm) | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | | | | |
|--------------------------------------|--|------|------|--|-------|-------|---|------|-------|-------|-------|------|------|-------|-------|-------|
| ooue | ooue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 3640 | 9210 | 4.45 | 1.70 | 10.70 | 11.60 | 11.70 | 4.35 | 1.50 | 10.60 | 10.70 | 11.10 | 4.25 | 1.30 | 10.50 | 10.00 | 10.80 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805, and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations, the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

Solder reflow only

Recommended Reflow Soldering Profile:

The KEMET families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Drofile Feature | Terminat | ion Finish |
|--|-----------------------|-----------------------|
| Fromereature | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from ${\rm T}_{\rm Smin}$ to ${\rm T}_{\rm Smax}$ | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate (T_L to T_P) | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T_L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T_P to T_L)$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |

Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test Condition | Limits |
|---|-------------------|--|---|
| Visual & Mechanical | KEMET Internal | No defects that may affect performance (10X) | Dimensions according KEMET Spec Sheet |
| Capacitance (Cap) | KEMET Internal | C ≤ 1,000 pF Frequency: 1 MHz ±100 kHz Voltage*:1.0 V _{rms} ±0.2 V C > 1,000 pF Frequency: 1 kHz ±50 Hz Voltage: 1.0 V _{rms} ±0.2 V * See part number specification sheet for voltage | Within Tolerance |
| Dissipation Factor (DF) | KEMET Internal | C ≤ 1,000 pF Frequency: 1 MHz ±100 kHz Voltage*:1.0 V _{rms} ±0.2 V C > 1,000 pF Frequency: 1 kHz ±50 Hz Voltage: 1.0 V _{rms} ±0.2 V * See part number specification sheet for voltage | Within Specification Dissipation factor (DF) maximum limit at 25°C = 0.1% |
| Insulation Resistance (IR) | KEMET Internal | Rated voltage applied for 120 ±5 seconds at 25°C | Within Specification To obtain IR limit, divide MΩ-μF value by the capacitance and compare to GΩ limit. Select the lower of the two limits: 1,000 megohm microfarads or 100 GΩ. |
| Temperature Coefficient of Capacitance (TCC) | KEMET Internal | Capacitance change with reference to +25°C and 0 VDC applied.* See part number specification sheet for voltageStepTemperature (°C)1+25°C2-55°C3+25°C (Reference)4+125°C | Within Specification: -750 ±120 ppm/°C |
| Dielectric Withstanding Voltage (DWV) | KEMET Internal | 120% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit Withstand test voltage without insulation breakdown or damage. |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | KEMET Internal | Maximum % capacitance loss/decade hour | 0.1% Loss/Decade Hour |
| Terminal Strength | KEMET Internal | Shear stress test per specific case size, Time: 60±1 secondsCase SizeForce364018N | No evidence of mechanical damage |



Table 4 – Performance & Reliability: Test Methods and Conditions cont.

| Stress | Reference | Test Condition | Limits |
|------------------------|---------------------------|---|---|
| Board Flex | AEC-Q200-005 | 3.0 mm minimum Test Time: 60 ±5 seconds Ramp Time: 1 mm/second 50 F F R220 t t t 45 t t t t t t t t t t t t t t t t t t t | No evidence of mechanical damage |
| Solderability | J-STD-002 | Condition: 4 hours ±15 minutes at 155°C dry bake apply all methods Test 245 ±5°C (SnPb & Pb-Free) | Visual Inspection. 95% coverage on termination. No leaching |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to +125°C) 2 - 3 cycles per hour Soak Time: 1 or 5 minutes | Measurement at 24 hours ±4 hours after test conclusion. Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and rated voltage. Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5% |
| High Temperature Life | MIL-STD-202 | 1,000 hours at 125°C with 2 X rated voltage applied | Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift |
| Storage Life | Method 108 | 1,000 hours at 125°C, Unpowered | IR: 10% of Initial Limit DF: 0.5% |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Test from 10 – 2,000 Hz | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Mechanical Shock | MIL-STD-202 Method 213 | 1,500 g's 0.5 ms Half-sine, Velocity Change 15.4 ft/second (Condition F) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents | Readable marking, no discoloration or stains. No physical damage. |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction



Capacitor Marking (Optional)

Laser marking option is not available on:

- COG, U2J, Ultra Stable X8R, and Y5V dielectric devices
- · EIA 0402 case size devices
- EIA 0603 case size devices with flexible termination option
- · KPS commercial and automotive grade stacked devices

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punched Paper | | |
|----------------------|------|---------|--------------------|--------------------------|----------|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | (W)* | Pitch | (P ₁)* | Pitch (P ₁)* | | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 | |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | |
| Array 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size. 2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|--|--|--|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum | | | | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | | | |
| 16 mm | | (0.059) | | | | (1.181) | | | | | | | |
| | | , | Variable Dime | ensions – Mil | limeters (Incl | nes) | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ | | | | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | | | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | te 5 | | | | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A, and B, are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | | | | | |
|--|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|--|--|--|--|--|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | | | | | | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | | | | | | | |
| Variable Dimensions – Millimeters (Inches) | | | | | | | | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | | | | | | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | | | | | | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | | | | | | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 Newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 Newton (10 to 130 gf) |
| 24 mm | 0.1 to 1.6 Newton (10 to 160 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | | | | | |
|--|--|---------------------------------------|--|--|--|--|--|--|--|--|--|--|--|--|--|
| Tape Size | A | B Minimum | С | D Minimum | | | | | | | | | | | |
| 8 mm | 178 ±0.20 | | | | | | | | | | | | | | |
| 12 mm | (7.008 ±0.008) Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | | | | | | | | | |
| 16 mm | (13.000 ±0.008) | | , , , , , , , , , , , , , , , , , , , | | | | | | | | | | | | |
| Variable Dimensions – Millimeters (Inches) | | | | | | | | | | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | | | | | | | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | | | | | | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | | | | | | | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | | | | | | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber



Floating Electrode (FF-CAP), High Voltage with Flexible Termination X7R Dielectric, 500 – 3,000 VDC (Commercial & Automotive Grade)



Overview

KEMET's Floating Electrode High Voltage with Flexible Termination capacitor (FF-CAP) combines two existing KEMET technologies - Floating Electrode and Flexible Termination. The floating electrode component utilizes a a cascading / serial electrode design configured to form multiple capacitors in series within a single monolithic structure. This unique configuration results in enhanced voltage and ESD performance over standard capacitor designs while allowing for a fail-open condition if mechanically damaged (cracked). The flexible termination component utilizes a conductive silver epoxy between the base metal and nickel barrier layers of KEMET's standard termination system in order to establish pliability while maintaining terminal strength, solderability and electrical performance. Both technologies address the primary failure mode of MLCCs-flex cracks, which are typically the result of excessive tensile and shear stresses produced during board flexure and thermal cycling.

Combined with the stability of an X7R dielectric and designed to accommodate all capacitance requirements, these flex-robust devices are RoHS-compliant, offer up to 5 mm of flex-bend capability and exhibits a predictable change in capacitance with respect to time and voltage. Capacitance change with reference to ambient temperature is limited to $\pm 15\%$ from -55°C to +125°C.

Whether under-hood or in-cabin, these capacitors are designed to provide reliable performance in mission and safety critical automotive circuits. Stricter testing protocol and inspection criteria have been established for automotive grade products in recognition of potentially harsh environmental conditions. KEMET automotive grade series capacitors meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.



Ordering Information

| С | 1210 | Y | 154 | K | С | R | Α | С | TU |
|---------|--|--|---|---------------------------------|---|------------|-------------------------|--|--|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ¹ | Packaging/ Grade (C-Spec) |
| | 0805 1206 1210 1808 1812 1825 2220 2225 | Y = Floating Electrode with Flexible Termination | Two significant digits and number of zeros | J = ±5% K = ±10% M = ±20% | C = 500 B = 630 D = 1,000 F = 1,500 G = 2,000 Z = 2,500 H = 3,000 | R = X7R | A = N/A | C = 100% Matte Sn L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ Additional termination finish options may be available. Contact KEMET for details. ¹ SnPb termination finish option is not available on automotive grade product.

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1



Packaging C-Spec Ordering Options Table

| Packaging Type | Packaging/Grade Ordering Code (C-Spec) |
|---------------------|---|
| Commerc | ial Grade ¹ |
| Bulk Bag | Not required (Blank) |
| 7" Reel / Unmarked | TU |
| 13" Reel / Unmarked | 7210 |
| 7" Reel / Marked | ТМ |
| 13" Reel / Marked | 7215 |
| Automoti | ve Grade ³ |
| 7" Reel | AUTO |
| 13" Reel / Unmarked | AUT07210 |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked.

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

³ Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information".

³ For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information".

³ All Automotive packaging C-Specs listed exclude the option to laser mark components. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking".

Benefits

- · Floating Electrode/fail open design
- AEC-Q200 automotive qualified
- -55°C to +125°C operating temperature range
- Industry leading CV values
- · Superior flex performance (up to 5 mm)
- · Exceptional performance at high frequencies
- Lead (Pb)-Free, RoHS and REACH compliant
- EIA 0805, 1206, 1210, 1808, 1812, 1825, 2220 and 2225 case sizes

- DC voltage ratings of 500 V, 630 V ,1 KV, 1.5 KV, 2 KV, 2.5 KV and 3 KV
- Capacitance offerings ranging from 10 pF to 220 nF
- Available capacitance tolerances of ±5%, ±10% or ±20%
- Low ESR and ESL
- · Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish allowing for excellent solderability
- SnPb plated termination finish option available upon request (5% Pb minimum)

Applications

- EV/HEV (drive systems, charging)
- LCD fluorescent backlight ballasts
- Power converters
- LAN/WAN interface
- Voltage multiplier circuits

- · High voltage decoupling
- Filters
- DC blocking
- ESD Protection

Application Note

X7R dielectric is not recommended for AC line filtering or pulse applications. These capacitors and/or the assembled circuit board containing these capacitors may require a protective surface coating to prevent external surface arcing.



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- · Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | tion Due To: | Days Prior To |
|-----------------------------|----------------------------------|-----------------|------------------|
| C-Spec | Process/Product change | Implementation | |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum |
| AUTO | Yes (without approval) | 90 days minimum | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | | PPAP (Product | Part Approval | Process) Leve | I |
|-----------------------------|---|---------------|---------------|---------------|---|
| C-Spec | 1 | 2 | 3 | 4 | 5 |
| KEMET assigned ¹ | • | • | • | • | • |
| AUTO | | | 0 | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|--------------------------------|-----------------|-------------------------------|----------------------------|-----------------------|
| 0805 | 2012 | 2.00 (0.079) ±0.30 (0.012) | 1.25 (0.049) ± 0.30 (0.012) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave or |
| 1206 | 3216 | 3.30 (0.130) ±0.40 (0.016) | 1.60 (0.063) ± 0.35(0.013) | | 0.60 (0.024) ±0.25 (0.010) | | Solder Reflow |
| 1210 | 3225 | 3.30 (0.130) ±0.40 (0.016) | 2.60(0.102) ± 0.30(0.012) | | 0.60 (0.024) ±0.25 (0.010) | | |
| 1808 | 4520 | 4.70 (0.185) ±0.50 (0.020) | 2.00 (0.079) ± 0.20 (0.008) | See Table 2 for | 0.70 (0.028) ±0.35 (0.014) | | |
| 1812 | 4532 | 4.50 (0.178) ±0.40 (0.016) | 3.20 (0.126) ± 0.30 (0.012) | Thickness | 0.70 (0.028) ±0.35 (0.014) | N/A | Solder Reflow |
| 1825 | 4564 | 4.60 (0.181) ±0.40 (0.016) | 6.40 (0.252) ± 0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | Only |
| 2220 | 5650 | 5.90 (0.232) ±0.75 (0.030) | 5.00 (0.197) ± 0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | |
| 2225 | 5664 | 5.90 (0.232) ±0.75 (0.030) | 6.40 (0.248) ± 0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | |



Table 1A - Capacitance Range/Selection Waterfall (0805 - 1812 Case Sizes)

| | | Cas S | se Si erie | ze/ s | C |)80 | 5Y | | C 1 | 120 | 6Y | | | C | 121 | OY | | | | C 1 | 80 | 8Y | | | | | C 1 | 81 | 2 Y | | |
|-------------|-------------|-----------|-----------------|-----------|-----|-----|--------|------|------------|--------|---------------|--------|------------|-------------|---------------|--------------|----------------|---------------|-----|-------------|------------|--------------|------------|--------|-----|-----|------------|------|------------|---------|------|
| . | Capacitance | Volt | age C | ode | C | В | D | С | В | D | F | G | С | В | D | F | G | С | В | D | F | G | z | н | C | В | D | F | G | Z | Н |
| Capacitance | Code | Rate | d Voli (VDC) | tage | 500 | 630 | 1,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| | | Cap To | acita Ieran | nce ce | | | | | | | | F | Prod Se | uct e Ta | Avai ble 2 | labil for | lity a Chir | nd C 5 Thi | ckn | Thio ess | kne Dim | ss C ensi | ode ons | S | | | | | | | |
| 10 pF | 100 | J | K | M | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 11 pF | 110 | J | к | м | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 12 pF | 120 | J | к | м | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 13 pF | 130 | J | К | м | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 15 pF | 150 | J | К | м | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 16 pF | 160 | J | К | М | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 18 pF | 180 | J | к | м | DG | DG | DG | ES | ES | ES | ES | ES | FМ | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 20 pF | 200 | J | К | М | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 22 pF | 220 | J | К | м | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 24 pF | 240 | J | к | м | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 27 pF | 270 | J | K | М | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 30 pF | 300 | J | к | м | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 33 pF | 330 | J | к | м | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 36 pF | 360 | J | К | м | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 39 pF | 390 | Ĵ | к | м | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 43 pF | 430 | J | К | М | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 47 pF | 470 | Ĵ | к | м | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 51 pF | 510 | Ĵ | к | м | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 56 pF | 560 | J | к | м | DG | DG | DG | ES | ES | ES | ES | ES | FМ | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 62 pF | 620 | J | к | м | DG | DG | DG | ES | ES | ES | ES | ES | FМ | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 68 pF | 680 | J | K | М | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 75 pF | 750 | J | к | м | DG | DG | DG | ES | ES | ES | ES | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 82 pF | 820 | J | к | м | DG | DG | DG | ES | ES | ES | ES | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 91 pF | 910 | J | к | м | DG | DG | DG | ES | ES | ES | ES | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GD | GD | GD | GD | GD | GD | GD |
| 100 pF | 101 | J | к | м | DG | DG | DG | ES | ES | ES | ES | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LC | LB | GD | GD | GD | GD | GD | GD | GD |
| 110 pF | 111 | J | К | М | DG | DG | DG | ES | ES | ES | ES | EU | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LC | LB | GD | GD | GD | GD | GD | GD | GD |
| 120 pF | 121 | J | к | м | DG | DG | DG | ES | ES | ES | ES | EU | FZ | FZ | FZ | FM | FM | LA | LA | LA | LA | LB | LC | LB | GD | GD | GD | GD | GD | GD | GD |
| 130 pF | 131 | J | К | М | DG | DG | DG | ES | ES | ES | ES | EU | FZ | FZ | FZ | FM | FM | LA | LA | LA | LA | LB | LC | LC | GD | GD | GD | GD | GD | GD | GD |
| 150 pF | 151 | J | К | М | DG | DG | DG | ES | ES | ES | EF | EU | FZ | FZ | FZ | FM | FM | LA | LA | LA | LA | LB | LC | LC | GK | GK | GK | GK | GK | GK | GK |
| 180 pF | 181 | J | К | м | DG | DG | DG | ES | ES | ES | EF | EU | FZ | FZ | FZ | FM | FM | LA | LA | LA | LA | LC | LC | LC | GK | GK | GK | GK | GK | GK | GK |
| | | Rate | d Vol | tage | 8 | 8 | 8 | 8 | 30 | 00 | 500 | 000 | 8 | 30 | 8 | 500 | 00 | 8 | 30 | 00 | 500 | 000 | 200 | 8 | 8 | 30 | 00 | 500 | 000 | 200 | 8 |
| Capacitance | Capacitance | Volt | (VDC) | ode | 10 | 9 | - - | 2 | 9 | - - | -` - | 6 6 | 2 | 9 | 1 2 | ř | 5 | <u>د</u> | 9 | 7 | ~~ c | 5 | 5 7 | м ц | | 9 | ≓ ⊓ | ř | 5 | ій 7 | 3 |
| Capacitance | Code | | aye U | oue | ۲ | D | ע | 1 | D | ע | Г | U | ۲ | D | ע | Г | U | <u>۲</u> | D | ע | г | G | 4 | п | ۲ | D | U | F | U | 2 | - |
| | | | C | 080 | 5Y | | C | 1206 | ōΥ | | C1210Y C1808Y | | | | | C1812Y | | | | | | | | | | | | | | | |



Table 1A - Capacitance Range/Selection Waterfall (0805 - 1812 Case Sizes) cont.

| | | Cas S | e Si erie | ze/ s | C | 080 | 5Y | | C | 120 | 6Y | | | C | 121 | OY | | | | C1 | 80 | 8Y | | | | | C 1 | 181: | 2Y | | |
|-------------|-------------|---|----------------|----------|-----|-----|-------|--------|-----|-------|-------|-------|-------------|--------------|---------------|--------------|---------------|----------------|--------------|---------------|-------------|--------------|------------|------|-----|-----|------------|------|------|------|------|
| | Capacitance | Volt | age C | ode | c | В | D | С | В | D | F | G | С | В | D | F | G | С | В | D | F | G | z | н | С | В | D | F | G | z | н |
| Capacitance | Code | Rate | d Vol (VDC) | tage | 500 | 630 | 1,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| | | Cap | acita Ieran | nce | | | | | | | | F | rod? Sei | uct / Tal | Avai hle 2 | labil for | ity a Chir | ind (n Thi | Chip ickn | Thio ess l | kne: Dim | ss C ensi | ode ons | S | | | | | | | |
| 220 nF | 221 | | К | м | DG | DG | DG | FS | FS | FS | FU | FU | F7 | F7 | F7 | FM | FM | | IA | IA | IA | | | IB | GB | GB | GB | GB | GB | GD | GE |
| 270 pF | 271 | Ĵ | ĸ | M | DG | DG | DG | ES | ES | ES | EU | EU | FZ | FZ | FZ | FK | FK | LA | LA | LA | LB | LC | LC | LC | GB | GB | GB | GB | GB | GH | GH |
| 330 pF | 331 | J | ĸ | M | DG | DG | DG | ES | ES | EF | EU | EU | FZ | FZ | FZ | FK | FK | LA | LA | LA | LB | LC | LC | LC | GB | GB | GB | GB | GB | GH | GH |
| 390 pF | 391 | J | K | M | DG | DG | DG | ES | ES | EF | EU | EU | FZ | FZ | FZ | FK | FS | LA | LA | LA | LB | LA | LC | LC | GB | GB | GB | GB | GD | GK | GH |
| 470 pF | 471 | J | K | M | DG | DG | DG | ES | ES | EU | EU | EU | FM | FM | FM | FS | FS | LB | LB | LB | LC | LA | LB | LC | GB | GB | GB | GB | GD | GK | GK |
| 560 pF | 561 | J | К | М | DG | DG | DG | ES | ES | EU | EU | EU | FM | FM | FM | FS | FS | LB | LB | LB | LC | LB | LB | LC | GB | GB | GB | GD | GH | GH | GK |
| 680 pF | 681 | Ĵ | к | м | DG | DG | DG | EU | EU | EU | EU | EU | FM | FM | FM | FS | FS | LB | LB | LB | LA | LC | LC | LC | GB | GB | GB | GD | GH | GH | GΚ |
| 820 pF | 821 | J | к | м | DG | DG | DG | ΕU | EU | EU | EU | EU | FM | FM | FM | FS | FL | LB | LB | LB | LB | LB | LC | LC | GB | GB | GB | GD | GH | GH | GK |
| 1,000 pF | 102 | J | к | м | DG | DG | DG | EU | EU | EU | EU | EU | FM | FM | FM | FS | FL | LB | LB | LB | LB | LB | LC | LC | GB | GB | GB | GH | GK | GK | GK |
| 1,200 pF | 122 | J | к | м | DG | DG | DG | ES | ES | ES | EU | EU | FK | FK | FK | FS | FM | LC | LC | LC | LC | LC | LA | | GB | GB | GB | GH | GK | GK | GK |
| 1,500 pF | 152 | J | K | М | DG | DG | DG | ES | ES | ES | EU | EU | FS | FS | FS | FL | FM | LC | LC | LC | LC | LC | LC | | GB | GB | GB | GH | GK | GK | |
| 1,800 pF | 182 | J | K | М | DG | DG | DG | EF | EF | EF | EU | EU | FS | FS | FS | FL | FM | LC | LC | LC | LB | LC | LC | | GD | GD | GD | GH | GK | GK | |
| 2,200 pF | 222 | J | K | М | DG | DG | DG | EF | EF | EF | EU | EU | FS | FS | FS | FL | FM | LB | LB | LB | LB | LC | LC | | GH | GH | GH | GH | GK | GK | |
| 2,700 pF | 272 | J | К | М | DG | DG | DG | EF | EF | EF | EU | | FS | FS | FS | FL | FM | LC | LC | LC | LB | LC | | | GB | GB | GB | GH | GM | GM | |
| 3,300 pF | 332 | J | К | М | DG | DG | DG | EF | EF | EF | EU | | FL | FL | FL | FL | FS | LA | LB | LB | LB | LA | | | GB | GB | GB | GH | GM | GM | |
| 3,900 pF | 392 | J | K | М | DG | | | EF | EF | EF | EU | | FL | FL | FL | FL | FS | LA | LB | LB | LB | LB | | | GB | GB | GB | GH | GM | GO | |
| 4,700 pF | 472 | J | К | м | DG | | | EF | EF | EF | EU | | FL | FL | FL | FL | FS | LA | LB | LB | LB | LC | | | GH | GH | GH | GH | GH | GO | |
| 5,600 pF | 562 | J | K | М | DG | | | EF | EF | EF | EU | | FO | FL | FL | FM | FS | LA | LB | LB | LC | | | | GH | GH | GH | GK | GK | | |
| 6,800 pF | 682 | J | K | М | DG | | | EF | EF | EF | EU | | FO | FL | FL | FM | FS | LA | LB | LB | LC | | | | GH | GH | GH | GK | GM | | |
| 8,200 pF | 822 | J | K | М | DG | | | EU | EU | EU | EU | | FO | FL | FL | FK | | LA | LC | LC | LC | | | | GH | GH | GH | GK | GM | | |
| 10,000 pF | 103 | J | K | M | | | | EU | EU | EU | EU | | FO | FL | FL | FK | | LA | LC | LC | LC | | | | GH | GH | GH | GK | GO | | |
| 12,000 pF | 123 | J | K | M | | | | EU | | | | | FO | FL | FL | FS | | LA | LC | LC | LC | | | | GB | GK | GK | GK | | | |
| 15,000 pF | 153 | J | K | M | | | | EU | | | | | FO | FU | FU | FL | | LA | LC | LC | LC | | | | GB | GK | GK | GK | | | |
| 18,000 pF | 183 | J | K | M | | | | | | | | | FO | FL | FL | FM | | LA | | | | | | | GB | GM | GM | GM | | | |
| 22,000 pF | 223 | J | K | M | | | | | | | | | FU | FK | FK | FM | | LA | | | | | | | GB | GL | GL | GM | | | |
| 27,000 pF | 273 | J | K | M | | | | | | | | | FM | FK | FK | FK | | LB | | | | | | | GH | GO | GO | GO | | | |
| 33,000 pF | 333 | J | K | M | | | | | | | | | FK | FS | FS | FS | | LC | | | | | | | GH | GO | GO | GO | | | |
| 39,000 pF | 393 | J | K | M | 1 | | | | | | | | FK | FS | FS | FS | | LC | | | | | | | GH | | | | | | |
| 47,000 pF | 473 | J | K | M | | | | | | | | | FS | | | | | LC | | | | | | | GH | | | | | | |
| 56,000 pF | 563 | J | K | M | | | | | | | | | | | | | | LC | | | | | | | GK | | | | | | |
| | | Rate | d Vol (VDC) | tage | 500 | 630 | 1,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| Capacitance | Capacitance | Volt | age C | ode | c | В | D | C | В | D | F | G | c | В | D | F | G | c | В | D | F | G | Z | H | c | В | D | F | G | Z | H |
| | Coue | Code Case Size/ Series C0805Y C1206Y C1210Y C1808Y | | | | | | C1812Y | | | | | | | | | | | | | | | | | | | | | | | |



Table 1B - Capacitance Range/Selection Waterfall (1825 - 2225 Case Sizes)

| | | Cas | se S Serie | ize/ es | | | C | 1825 | 5Y | | | | | C | 2220 | Y | | | | | C | 222 | 5Y | | |
|-------------|----------|-----|-----------------|------------|-----|-----|-------|-------|-------|-------|----------------|---------------|--------|--------|-------|--------------|--------|--------|-----------------|-----|-----------------|-------|-------|-------|----------|
| Canacitance | Сар | Vol | tage C | ode | C | В | D | F | G | Z | н | C | В | D | F | G | z | н | С | В | D | F | G | Z | н |
| oupaonanoe | Code | Rat | ed Vol | tage | 20 | 630 | 000 | ,500 | 000' | ,500 | 000' | 200 | 630 | 000 | ,500 | 000' | ,500 | 000' | 200 | 630 | 00 ⁽ | ,500 | 000' | ,500 | ,000 |
| | | Cap | pacita | ince | | | - | - | 7 | 7 | Pro | duct / | Availa | bility | and C | _∾ hip Tł | nickne | ess Co | odes | | - | - | 7 | 7 | <u>м</u> |
| 100 pF | 101 | | bieran | м | нс | НС | HC | НС | НС | НС | <u>в</u> 10 | | | | | CKNES | | ensio | ns Ike | KE | KE | KE | KE | KE | KE |
| 110 pF | 111 | J | ĸ | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 120 nF | 121 | Ĵ | ĸ | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 130 pF | 131 | Ĵ | ĸ | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 150 pF | 151 | Ĵ | K | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 180 pF | 181 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 220 pF | 221 | J | K | M | HE | HE | HE | HE | HE | HE | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 270 pF | 271 | J | K | M | HE | HE | HE | HE | HE | HE | HG | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 330 pF | 331 | J | K | M | HE | HE | HE | HE | HE | HE | HG | JE | JE | JE | JE | JE | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 390 pF | 391 | J | K | M | HE | HE | HE | HE | HE | HE | HG | JE | JE | JE | JE | JE | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 470 pF | 471 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JE | JE | JE | JE | JE | JK | JK | KF | KF | KF | KF | KE | KE | KF |
| 560 pF | 561 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KE | KE | KF |
| 680 pF | 681 | J | к | м | HG | HG | HG | HG | HG | HG | HG | JE | JE | JE | JK | JK | JK | JK | KF | KF | KF | KF | KE | KF | KF |
| 820 pF | 821 | J | к | м | HG | HG | HG | HG | HG | HG | HG | JE | JE | JE | JK | JK | JK | JK | KE | KE | KE | KF | KE | KF | KF |
| 1,000 pF | 102 | J | к | м | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KF | KE | KF | KF |
| 1.200 pF | 122 | J | К | М | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KF | KF | KF | KF |
| 1.500 pF | 152 | Ĵ | к | м | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KF | KF | KF | KF |
| 1.800 pF | 182 | Ĵ | к | м | HE | HE | HE | HE | HE | HG | HG | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KF | KF | KF | KF |
| 2.200 pF | 222 | Ĵ | к | м | HE | HE | HE | HE | HE | HG | HJ | JK | JK | JK | JE | JK | JL | JL | KE | KE | KE | KF | KF | KF | KF |
| 2,700 pF | 272 | J | К | М | HE | HE | HE | HE | HE | HG | | JK | JK | JK | JE | JK | JL | JL | KE | KE | KE | KE | KE | KF | KF |
| 3,300 pF | 332 | J | K | М | HE | HE | HE | HE | HE | HG | | JK | JK | JK | JE | JK | JE | JE | KE | KE | KE | KE | KE | KF | KF |
| 3,900 pF | 392 | J | K | M | HE | HE | HE | HE | HE | HG | | JK | JK | JK | JE | JK | JE | JE | KF | KF | KF | KE | KE | KF | KF |
| 4,700 pF | 472 | J | K | M | HE | HE | HE | HE | HG | HG | | JK | JK | JK | JE | JK | JK | JK | KF | KF | KF | KE | KE | KF | KF |
| 5,600 pF | 562 | J | К | M | HE | HE | HE | HE | HJ | HJ | | JK | JK | JK | JE | JK | JK | JK | KF | KF | KF | KE | KE | KE | KE |
| 6,800 pF | 682 | J | K | M | HE | HE | HE | HE | HJ | HJ | | JE | JE | JE | JE | JK | JK | JK | KF | KF | KF | KE | KF | KE | KE |
| 8,200 pF | 822 | J | K | М | HE | HE | HE | HE | HG | HJ | | JE | JE | JE | JE | JK | JK | JK | KE | KE | KE | KE | KF | KF | KF |
| 10,000 pF | 103 | J | K | М | HE | HE | HE | HE | HJ | HK | | JE | JE | JE | JE | JL | JL | JL | KE | KE | KE | KE | KH | KH | KH |
| 12,000 pF | 123 | J | K | М | HE | HE | HE | HG | HJ | | | JE | JK | JK | JK | JL | JL | JL | KE | KE | KE | KE | KH | KJ | KJ |
| 15,000 pF | 153 | J | K | М | HE | HE | HE | HG | НК | | | JE | JK | JK | JK | JL | JN | JN | KE | KE | KE | KE | KH | KJ | KJ |
| 18,000 pF | 183 | J | K | М | HE | HE | HE | HG | | | | JE | JK | JK | JK | JN | | | KE | KE | KE | KE | KJ | | |
| 22,000 pF | 223 | J | K | M | HE | HG | HG | HG | | | | JE | JK | JK | JK | JN | | | KE | KF | KF | KF | KJ | | |
| 27,000 pF | 273 | J | K | M | HE | HG | HG | HG | | | | JE | JK | JK | JK | | | | KE | KF | KF | KF | KJ | | |
| 33,000 pF | 333 | J | K | M | HE | HG | HG | HE | | | | JE | JK | JK | JK | | | | KE | KF | KF | KF | | | |
| 39,000 pF | 393 | J | K | M | HE | HG | HG | HG | | | | JE | JK | JK | JK | | | | KE | KF | KF | KF | | | |
| 47,000 pF | 473 | J | K | M | HE | HJ | HJ | HJ | | | | JE | JG | JG | JG | | | | KE | KF | KF | KH | | | |
| 56,000 pF | 563 | J | K | M | HE | HG | HG | HJ | | | | JE | JE | JE | JL | | | | KE | KH | KH | КН | | | |
| 68,000 pF | 683 | J | K | M | HG | HJ | HJ | HK | | | | JE | JK | JK | JN | | | | KE | KH | KH | KJ | | | |
| 82,000 pF | 823 | J | K | M | HG | HJ | HJ | | | | | JE | JL | JL | JN | | | | KE | KF | KF | KJ | | | |
| 0.10 µF | 104 | J | K | M | HG | нк | НК | | | | | JE | JN | JN | | | | | KE | KH | KH | KJ | | | |
| 0.12 µF | 124 | J | K | М | HG | | | | | | | JE | JN | JN | | | | | KE | KJ | KJ | | | | |
| 0.15 µF | 154 | J | K | M | HG | | | | | | | JK | | | | | | | KF | KJ | KJ | | | | |
| 0.18 µF | 184 | J | K | M | HG | | | | | | | JK | | | | | | | KF | | | | | | |
| 0.22 µF | 224 | J | K | M | HG | | - | - | - | - | - | | | - | - | - | - | - | | | | | | | |
| | | Кат | ea vol (VDC) | tage | 500 | 630 | 1,00(| 1,50(| 2,00(| 2,50(| 3,00(| 500 | 630 | 1,00(| 1,50(| 2,00(| 2,50(| 3,00(| 500 | 630 | 1,00(| 1,50(| 2,00(| 2,50(| 3,00(|
| Capacitance | Cap Code | Vol | tage C | ode | С | В | D | F | G | Z | Н | С | В | D | F | G | Z | Н | H C B D F G Z H | | | | | | |
| | | Ca | ise Si Serie | ze/ s | | | C | C1825 | Y | | | C2220Y C2225Y | | | | | | | | | | | | | |



Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic | Quantity | | | | |
|-----------|-------------------|------------------------------------|---------|----------------------|------------------|----------|--|--|--|--|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | | | |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | | | | |
| ES | 1206 | 1.00 ± 0.20 | 0 | 0 | 2,500 | 10,000 | | | | |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 | | | | |
| EU | 1206 | 1.60 ± 0.25 | 0 | 0 | 2,000 | 8,000 | | | | |
| FZ | 1210 | 1.25 ± 0.20 | 0 | 0 | 2,500 | 10,000 | | | | |
| FL | 1210 | 1.40 ± 0.15 | 0 | 0 | 2,000 | 8,000 | | | | |
| FO | 1210 | 1.50 ± 0.20 | 0 | 0 | 2,000 | 8,000 | | | | |
| FU | 1210 | 1.55 ± 0.20 | 0 | 0 | 2,000 | 8,000 | | | | |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 | | | | |
| FK | 1210 | 2.10 ± 0.20 | 0 | 0 | 2,000 | 8,000 | | | | |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1,000 | 4,000 | | | | |
| LA | 1808 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | | | | |
| LB | 1808 | 1.60 ± 0.15 | 0 | 0 | 1,000 4,0 | | | | | |
| LC | 1808 | 2.00 ± 0.15 | 0 | 0 | 1,000 | 4,000 | | | | |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 | | | | |
| GD | 1812 | 1.25 ± 0.15 | 0 | 0 | 1,000 | 4,000 | | | | |
| GE | 1812 | 1.30 ± 0.10 | 0 | 0 | 1,000 | 4,000 | | | | |
| GH | 1812 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | | | | |
| GK | 1812 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 | | | | |
| GL | 1812 | 1.90 ± 0.20 | 0 | 0 | 500 | 2,000 | | | | |
| GM | 1812 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 | | | | |
| GO | 1812 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 | | | | |
| HE | 1825 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 | | | | |
| HG | 1825 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 | | | | |
| HJ | 1825 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 | | | | |
| HK | 1825 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 | | | | |
| | 2220 | 1.40 ± 0.15 | | | 1,000 | 4,000 | | | | |
| | 2220 | 1.00 ± 0.20 | | | 1,000 | 4,000 | | | | |
| | 2220 | 1./UIU.13 | | | 1,000 | 4,000 | | | | |
| JL | 2220 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 | | | | |
| | 2220 | 2.30 ± 0.20 1 40 \pm 0.15 | 0 | 0 | 1 000 | 2,000 | | | | |
| | 2223 | 1.40 ± 0.13 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 | | | | |
| KH | 2225 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 | | | | |
| KJ | 2225 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 | | | | |
| Thickness | C 250 | Thickness + | 7" Reel | 13" Reel | 7" Reel | 13" Reel | | | | |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic Quantity | | | | | |

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".



Table 2B – Bulk Packaging Quantities

| Deelver | ing Turne | Loose Packaging | | | | |
|----------|---|------------------------|------------------------|--|--|--|
| Раска | jing type | Bulk Bag | Bulk Bag (default) | | | |
| Packagi | ng C-Spec ¹ | N, | /A² | | | |
| Cas | e Size | Packaging Quantities (| pieces/unit packaging) | | | |
| EIA (in) | Metric (mm) | Minimum | Maximum | | | |
| 0402 | 1005 | | | | | |
| 0603 | 1608 | | 50,000 | | | |
| 0805 | 2012 | | | | | |
| 1206 | 3216 | | | | | |
| 1210 | 3225 | 1 | | | | |
| 1808 | 4520 | | | | | |
| 1812 | 4532 | | | | | |
| 1825 | 1825 4564 2220 5650 | | 20,000 | | | |
| 2220 | | | | | | |
| 2225 | 5664 | | | | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial Grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive Grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size | Metric Size | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | |
|-------------|----------------|--|------|------|------|--|------|------|------|---|------|------|------|------|------|------|
| ooue | ooue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0805 | 2012 | 0.99 | 1.44 | 1.66 | 4.47 | 2.71 | 0.89 | 1.24 | 1.56 | 3.57 | 2.11 | 0.79 | 1.04 | 1.46 | 2.42 | 1.81 |
| 1206 | 3216 | 1.59 | 1.62 | 2.06 | 5.85 | 3.06 | 1.49 | 1.42 | 1.96 | 4.95 | 2.46 | 1.39 | 1.22 | 1.86 | 4.25 | 2.16 |
| 1210 | 3225 | 1.59 | 1.62 | 3.01 | 5.90 | 4.01 | 1.49 | 1.42 | 2.91 | 4.95 | 3.41 | 1.39 | 1.22 | 2.81 | 4.25 | 3.11 |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 |
| 1812 | 4532 | 2.10 | 1.80 | 3.60 | 7.00 | 4.60 | 2.00 | 1.60 | 3.50 | 6.10 | 4.00 | 1.90 | 1.40 | 3.40 | 5.40 | 3.70 |
| 1825 | 4564 | 2.15 | 1.80 | 6.90 | 7.10 | 7.90 | 2.05 | 1.60 | 6.80 | 6.20 | 7.30 | 1.95 | 1.40 | 6.70 | 5.50 | 7.00 |
| 2220 | 5650 | 2.85 | 2.10 | 5.50 | 8.80 | 6.50 | 2.75 | 1.90 | 5.40 | 7.90 | 5.90 | 2.65 | 1.70 | 5.30 | 7.20 | 5.60 |
| 2225 | 5664 | 2.85 | 2.10 | 6.90 | 8.80 | 7.90 | 2.75 | 1.90 | 6.80 | 7.90 | 7.30 | 2.65 | 1.70 | 6.70 | 7.20 | 7.00 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Terminat | ion Finish |
|--|-----------------------|-----------------------|
| Tomeredure | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate $(T_L to T_P)$ | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T_L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T_{p} to T_{l})$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test Condition | Limits | | |
|--|----------------|--|---|--|--|
| Visual and Mechanical | KEMET Internal | No defects that may affect performance (10X) | Dimensions according KEMET Spec Sheet | | |
| Capacitance (Cap) | KEMET Internal | C ≤ 10 µF 1 kHz ±50 Hz and 1.0 ±0.2 V or 0.5 ±0.2 V ms* C > 10 µF120 Hz ±10 Hz and 0.5 ±0.1 V ms* * See part number specification sheet for voltage Capacitance measurements (including tolerance) are indexed to a referee time of 48 or 1,000 hours Please refer to a part number specification sheet for referee time details | Within Tolerance | | |
| Dissipation Factor (DF) | KEMET Internal | $C \leq 10 \ \mu\text{F}$ Frequency: 1 kHz ±50 Hz Voltage*:1.0 ±0.2 V _{rms} , 0.5 ±0.2 V _{rms} , C > 10 \ \mu\text{F} Frequency: 120 Hz ±10 Hz Voltage: 0.5 ±0.1 V _{rms} * See part number specification sheet for voltage | Within Specification Dissipation factor (DF) maximum limit at 25°C = 2.5% | | |
| Insulation Resistance (IR) | KEMET Internal | 500 VDC applied for 120 ±5 seconds at 25°C | $eq:spectral_$ | | |
| Temperature Coefficient of Capacitance (TCC) | KEMET Internal | $C \leq 10 \ \mu\text{F}$ Frequency: 1 kHz ±50 Hz Voltage*: 1.0 ±0.2 V _{rms} , 0.5 ±0.2 V _{rms} , 0.2 ±0.1 V C > 10 \ \mu\text{F} Frequency: 120 Hz ±10 Hz Voltage: 0.5 ±0.1 V _{rms} * See part number specification sheet for voltage $\frac{\text{Step} \qquad \text{Temperature (°C)}}{1 \qquad +25^{\circ}\text{C}}$ $\frac{3 \qquad +25^{\circ}\text{C} (\text{Reference Temperature})}{4 \qquad +125^{\circ}\text{C}}$ | Capacitance ±15% over -55°C to +125°C | | |



Table 4 – Performance & Reliability: Test Methods and Conditions cont.

| Stress | Reference | Test Condition | Limits |
|--|---------------------------|--|---|
| Dielectric Withstanding Voltage (DWV) | KEMET Internal | 150% of rated voltage for voltage rating of < 1,000 V 120% of rated voltage for voltage rating of ≥ 1,000 V (5 ±1 seconds and charge/discharge not exceeding 50 mA) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit Withstand test voltage without insulation breakdown or damage. |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | KEMET Internal | Capacitance measurements (including tolerance) are indexed to a referee time of 48 or 1,000 hours. Please refer to a part number specific datasheet for referee time details. | Please refer to a part number specification sheet for specific Aging rate |
| Terminal Strength | KEMET Internal | Shear stress test per specific case size, Time: 60 ±1 second. Case Size Force 0805 9N ≥ 1206 18N | No evidence of mechanical damage |
| Board Flex | AEC-Q200-005 | Standard Termination System 2.0 mm Flexible Termination System 3.0 mm Test Time: 60± 5 seconds Ramp Time: 1 mm/second | No evidence of mechanical damage |
| Solderability | J-STD-002 | Condition: 4 hours ±15 minutes at 155°C dry bake apply all methods Test 245 ±5°C (SnPb & Pb-Free) | Visual Inspection. 95% coverage on termination. No leaching |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to +125°C) 2 - 3 cycles per hour Soak Time: 1 or 5 minute | Measurement at 24 hours ±4 hours after test conclusion. Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and 200 VDC maximum Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±20% shift IR: 10% of Initial Limit DF Limit Maximum: 3.0% |
| Moisture Resistance | MIL-STD-202 Method 106 | Number of Cycles Required: 10, 24 hours per cycle. Steps 7a and 7b not required | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±20% shift IR: 10% of Initial Limit DF Limit Maximum: 3.0% |
| Thermal Shock | MIL-STD-202 Method 107 | Number of Cycles Required: 5, (-55°C to 125°C) Dwell time 15 minutes. | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |



Table 4 – Performance & Reliability: Test Methods and Conditions cont.

| Stress | Reference | Test Condition | Limits |
|---------------------------|---------------------------|---|---|
| High Temperature Life | MIL-STD-202 | 1,000 hours at 125°C with 1.2 X rated voltage applied. | Within Post Environmental Limits Cap: ±20% shift IP: 10% of Initial Limit |
| Storage Life | Method 108 | 1,000 hours at 150°C, Unpowered | DF Limit Maximum: 3.0% |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Test from 10 – 2,000 Hz | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Mechanical Shock | MIL-STD-202 Method 213 | 1,500 g's 0.5 millisecond Half-sine, Velocity Change: 15.4 feet/second (Condition F) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents. | Visual Inspection 10X Readable marking, no decoloration or stains. No physical damage. |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction





Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a "K" to identify KEMET, followed by two characters (per EIA–198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the "K" character only.

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.
- X7R dielectric products in capacitance values outlined below.

| EIA Case Size | Metric Size Code | Capacitance |
|---------------|------------------|-------------|
| 0603 | 1608 | ≤ 170 pF |
| 0805 | 2012 | ≤ 150 pF |
| 1206 | 3216 | ≤ 910 pF |
| 1210 | 3225 | ≤ 2,000 pF |
| 1808 | 4520 | ≤ 3,900 pF |
| 1812 | 4532 | ≤ 6,700 pF |
| 1825 | 4564 | ≤ 0.018 µF |
| 2220 | 5650 | ≤ 0.027 µF |
| 2225 | 5664 | ≤ 0.033 µF |

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 μ F. Orientation of marking is vendor optional.





Capacitor Marking (Optional) cont.

| | C | apacita | ance (p | F) For \ | /arious | Alpha/ | Numera | al Identif | fiers | |
|-----------|------|---------|---------|----------|---------|----------|---------|------------|------------|-------------|
| Alaba | | | | | | Numera | al | | | |
| Alpna | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Character | | | | | Сара | acitance | e (pF) | | | |
| A | 0.10 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 |
| Н | 0.20 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 |
| М | 0.30 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 |
| d | 0.40 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 |
| f | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 |
| у | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punche | d Paper |
|----------------------|------|---------|--------------------|---------|--------------------|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| | (W)* | Pitch | (P ₁)* | Pitch | (P ₁)* |
| 01005 - 0402 | 8 | | | 2 | 2 |
| 0603 | 8 | | | 2/4 | 2/4 |
| 0805 | 8 | 4 | 4 | 4 | 4 |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 |
| 1805 - 1808 | 12 | 4 | 4 | | |
| ≥ 1812 | 12 | 8 | 8 | | |
| KPS 1210 | 12 | 8 | 8 | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | |
| Array 0612 | 8 | 4 | 4 | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size. 2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions – Millimeters (Inches) | | | | | | | | | | | | |
|-----------|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|--|--|--|--|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum | | | | |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | | | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) | | | | |
| 16 mm | | (0.059) | | | | (1.181) | | | | | | | |
| | | , | Variable Dime | ensions – Mil | limeters (Incl | nes) | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ | | | | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | | | | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | te 5 | | | | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | | | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_a and B_a are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | Constant Dimensions — Millimeters (Inches) | | | | | | | | | | | | |
|-----------|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|--|--|--|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | | | | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | | | | | |
| | | Variable D | imensions — M | illimeters (Inche | es) | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | | | | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | | | | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | | | | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength | |
|--------------|----------------------------------|--|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) | |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) | |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius



Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs) Floating Electrode (FF-CAP), High Voltage with Flexible Termination X7R Dielectric, 500 – 3,000 VDC (Commercial & Automotive Grade)



Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | |
|--|---|---------------------------------------|--|---|--|
| Tape Size | А | B Minimum | C | D Minimum | |
| 8 mm | 178 ±0.20 (7.008 ±0.008) or 330 ±0.20 (13.000 ±0.008) | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | |
| 12 mm | | | | | |
| 16 mm | | | | | |
| Variable Dimensions – Millimeters (Inches) | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | |
| 8 mm | 50 (1.969) | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | Shall accommodate tape width without interference | |
| 12 mm | | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | |


Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Solder Fluxes and Cleaning

The use of water-soluble fluxes provides advantages of excellent solderability due to high activation. However, these fluxes contain organic acids that can induce arcing under high DC or AC voltages. Notable problem areas are underneath the MLCC where flux can be trapped between the ceramic material and PCB. It is therefore critical that PCBs are properly cleaned to remove all flux residue to maintain reliability.

Coating for High Voltage MLCCs

For MLCC ratings \geq 1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

| Dielectric | CTE (ppm/°C) |
|----------------------------|--------------|
| Class II BaTiO₃ | 10.7 |
| Class I CaZrO ₃ | 9.8 |

Slits in PCB

It is recommended to apply a slit in the PCB under the MLCC to improve washing of flux residue that may get trapped underneath. In some cases, it is not possible to slit entirely through the PCB due to underlying metal planes. It is also acceptable to apply a recessed slit under the MLCC which will also promote cleaning.

- Recommended for case sizes ≥1206
- The width (w) of the slit should be 1mm
- Length of the slit should be as short as possible to prevent damaging the MLCC due to mechanical stress of the PCB.
- Slits also reduce the risk of solder balls under MLCC which decreased the creepage distance.



Solder Resist

If a slit cannot be applied as above, it is recommended to not use solder resist directly under the MLCC. The use of solder resist material reduces the distance between MLCC ceramic material and PCB thus making it difficult to clean.

Solder Balls

Improper reflow techniques and/or improper washing can induce solder balls under or adjacent to the MLCC. Solder balls reduce the creepage distance between the MLCC terminations and increase the risk of arcing or damage to the ceramic material. To reduce the risk of solder balls:

- Follow KEMET's solder recommendations as outlined in the datasheet.
- If performing a cleaning procedure, properly clean the PCB per KEMET's cleaning recommendations.
- Add slit to the PCB as shown above.





Overview

KEMET's Floating Electrode (FE-CAP) high voltage multilayer ceramic capacitor in X7R dielectric utilizes a cascading / serial electrode design configured to form multiple capacitors in series within a single monolithic structure. This unique configuration results in enhanced voltage and ESD performance over standard capacitor designs while allowing for a fail-open condition if mechanically damaged (cracked). If damaged, the device may experience a drop in capacitance but a short is unlikely. The FE-CAP is designed to reduce the likelihood of a low IR or short circuit condition and the chance for a catastrophic and potentially costly failure event.

Available in a variety of case sizes and industry leading CV values (capacitance/voltage), these devices exhibit low leakage current and low ESR at high frequencies. These devices exhibit a predictable change in capacitance with respect to time and voltage and boast a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to $\pm 15\%$ from -55° C to $\pm 125^{\circ}$ C.

In addition to Commercial Grade, Automotive Grade devices are available which meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.



Ordering Information

| С | 1210 | S | 154 | К | С | R | Α | С | TU |
|---------|--|---------------------------|---|---------------------------------|---|------------|-------------------------|--|--|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ¹ | Packaging/ Grade (C-Spec) |
| | 0805 1206 1210 1808 1812 1825 2220 2225 | S = Floating Electrode | Two significant digits and number of zeros | J = ±5% K = ±10% M = ±20% | C = 500 B = 630 D = 1,000 F = 1,500 G = 2,000 Z = 2,500 H = 3,000 | R = X7R | A = N/A | C = 100% Matte Sn L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ Additional termination finish options may be available. Contact KEMET for details. ¹ SnPb termination finish option is not available on automotive grade product.

Built Into Tomorrow

1



Packaging C-Spec Ordering Options Table

| Packaging Type | Packaging/Grade Ordering Code (C-Spec) |
|---------------------|---|
| Commerc | ial Grade ¹ |
| Bulk Bag | Not required (Blank) |
| 7" Reel / Unmarked | TU |
| 13" Reel / Unmarked | 7210 |
| 7" Reel / Marked | ТМ |
| 13" Reel / Marked | 7215 |
| Automoti | ve Grade ³ |
| 7" Reel | AUTO |
| 13" Reel / Unmarked | AUT07210 |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked.

² The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

³ Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information".

³ For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information".

³ All Automotive packaging C-Specs listed exclude the option to laser mark components. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking".

Benefits

- · Floating Electrode/fail open design
- AEC-Q200 automotive qualified
- -55°C to +125°C operating temperature range
- Industry leading CV values
- · Exceptional performance at high frequencies
- · Lead (Pb)-Free, RoHS and REACH compliant
- EIA 0805, 1206, 1210, 1808, 1812, 1825, 2220 and 2225 case sizes
- DC voltage ratings of 500 V, 630 V, 1 KV, 1.5 KV, 2 KV, 2.5 KV and 3 KV
- **Applications**
- EV/HEV (drive systems, charging)
- LCD fluorescent backlight ballasts
- Power converters
- LAN/WAN interfaceVoltage multiplier circuits

- Capacitance offerings ranging from 10pF to 220 nF
- Available capacitance tolerances of ±5['], ±10% and ±20%
- Low ESR and ESL
- Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish allowing for excellent solderability
- SnPb plated termination finish option available upon request (5% Pb minimum)
- High voltage decoupling
- Filters
- DC blocking
- ESD Protection

Application Note

X7R dielectric is not recommended for AC line filtering or pulse applications. These capacitors and/or the assembled circuit board containing these capacitors may require a protective surface coating to prevent external surface arcing.



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | tion Due To: | Days Prior To |
|-----------------------------|----------------------------------|---------------|------------------|
| C-Spec | Process/Product change | Obsolescence* | Implementation |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum |
| AUTO | Yes (without approval) | Yes | 90 days minimum |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | | PPAP (Product | Part Approval | Process) Leve | I |
|-----------------------------|---|---------------|---------------|---------------|---|
| C-Spec | 1 | 2 | 3 | 4 | 5 |
| KEMET assigned ¹ | • | • | • | • | • |
| AUTO | | | 0 | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|-------------------------------|-----------------|-------------------------------|----------------------------|-----------------------|
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave or |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | | Solder Reflow |
| 1210 | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | | |
| 1808 | 4520 | 4.70 (0.185) ±0.50 (0.020) | 2.00 (0.079) ±0.20 (0.008) | See Table 2 for | 0.60 (0.024) ±0.35 (0.014) | | |
| 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | Thickness | 0.60 (0.024) ±0.35 (0.014) | N/A | Solder Reflow |
| 1825 | 4564 | 4.50 (0.177) ±0.30 (0.012) | 6.40 (0.252) ±0.40 (0.016) | _ | 0.60 (0.024) ±0.35 (0.014) | _ | Only |
| 2220 | 5650 | 5.70 (0.224) ±0.40 (0.016) | 5.00 (0.197) ±0.40 (0.016) | - | 0.60 (0.024) ±0.35 (0.014) | _ | |
| 2225 | 5664 | 5.60 (0.220) ±0.40 (0.016) | 6.40 (0.248) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | |



Table 1A - Capacitance Range/Selection Waterfall (0805 - 1812 Case Sizes)

| | | Cas S | se Si erie | ze/ s | C |)80 | 5S | | C 1 | 120 | 6S | | | C | 1210 | DS | | | | C1 | 808 | 8S | | | | | C 1 | 812 | 28 | | |
|-------------|---|------------------------|-----------------|-----------|-----|-----|-----------------------|-----|------------|----------|-------|-------|-------------|----------------|---------------|--------------|---------------|---------------|----------|---------------|-------------|--------------|------------|--------|-----|---------|------------|------|------|--------|--------|
| | Capacitance | Volt | age C | ode | C | В | D | С | В | D | F | G | С | В | D | F | G | С | В | D | F | G | z | н | С | В | D | F | G | Ζ | н |
| Capacitance | Code | Rate | ed Vol (VDC) | tage | 500 | 630 | 1,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| | | Cap To | acita leran | nce ce | | | | | | | | F | Prod See | uct / e Tal | Avai ble 2 | labil for | ity a Chir | nd C 5 Thi |) Ckn | Thic ess l | kne Dime | ss C ensi | ode ons | S | | | | | | | |
| 10 pF | 100 | J | K | M | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 11 pF | 110 | J | К | м | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 12 pF | 120 | Ĵ | к | м | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 13 pF | 130 | J | К | м | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 15 pF | 150 | J | к | м | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 16 pF | 160 | J | K | М | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 18 pF | 180 | J | к | м | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 20 pF | 200 | J | к | м | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 22 pF | 220 | J | к | м | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 24 pF | 240 | J | к | м | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 27 pF | 270 | J | K | М | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 30 pF | 300 | J | к | м | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 33 pF | 330 | J | к | м | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 36 pF | 360 | J | к | м | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 39 pF | 390 | J | к | м | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 43 pF | 430 | J | K | М | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 47 pF | 470 | J | ĸ | м | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 51 pF | 510 | J | ĸ | м | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 56 pF | 560 | J | к | м | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 62 pF | 620 | J | к | м | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 68 pF | 680 | J | K | М | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 75 pF | 750 | J | К | м | DG | DG | DG | ED | ED | ED | ED | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 82 pF | 820 | J | K | М | DG | DG | DG | ED | ED | ED | ED | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 91 pF | 910 | J | K | М | DG | DG | DG | ED | ED | ED | ED | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GD | GD | GD | GD | GD | GD | GD |
| 100 pF | 101 | J | K | М | DG | DG | DG | ED | ED | ED | ED | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LC | LB | GD | GD | GD | GD | GD | GD | GD |
| 110 pF | 111 | J | K | М | DG | DG | DG | ED | ED | ED | ED | EG | FM | FM | FM | FΜ | FM | LB | LB | LB | LB | LB | LC | LB | GD | GD | GD | GD | GD | GD | GD |
| 120 pF | 121 | J | K | М | DG | DG | DG | ED | ED | ED | ED | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LB | LC | LB | GD | GD | GD | GD | GD | GD | GD |
| 130 pF | 131 | J | K | М | DG | DG | DG | ED | ED | ED | ED | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LB | LC | LC | GD | GD | GD | GD | GD | GD | GD |
| 150 pF | 151 | J | К | М | DG | DG | DG | ED | ED | ED | EF | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LB | LC | LC | GK | GK | GK | GK | GK | GK | GK |
| 180 pF | 181 | J | K | М | DG | DG | DG | ED | ED | ED | EF | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LC | LC | LC | GK | GK | GK | GK | GK | GK | GK |
| | | Rated Voltage (VDC) | | | | 630 | 000, | 500 | 630 | 000 | ,500 | 000 | 500 | 630 | 000 | 500 | 000 | 500 | 630 | 000 | 500 | 000 | 500 | 000 | 500 | 630 | 000 | 500 | 000 | 500 | 000 |
| Capacitance | Capacitance | (VDC) Voltage Code | | | c c | B | , ~ ` ₽ | c | В | <u>г</u> | F | G | c | В | - D | F | G | c | В | т р | F | G | ∼ Z | т Н | c | В | - D | F | G | ∼ Z | т Н |
| | Code Voltage Code Case Size/ Series | | | c | 080 | 55 | - | C | 1206 | 5S | | - | C | 1210 |)S | | - | _ | - C1 | 1808 | BS S | | | - | - | - C' | 1812 | S | | | |



Table 1A - Capacitance Range/Selection Waterfall (0805 - 1812 Case Sizes) cont.

| | | Cas S | e Si erie | ze/ s | C |)80 | 5S | | C | 120 | 6S | | | C | 121 | 0S | | | | C 1 | 80 | 8S | | | | | C 1 | 81 | 2S | | |
|-------------|-------------|--------------------------------------|-----------------------|----------|-----|-----|-------|-----|-----|-------|-------|-------|------|----------------|------|--------------|----------------|-------------|------|------------|------------|---------------|------|------|-----|-----|------------|------|------|------|------|
| | Capacitance | Volt | age C | ode | C | В | D | С | В | D | F | G | С | В | D | F | G | С | В | D | F | G | z | н | C | В | D | F | G | Z | Н |
| Capacitance | Code | Rate | d Vol (VDC) | tage | 500 | 630 | 1,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| | | Cap | acita Ieran | nce | | | | | | | | F | Prod | uct . • Tal | Avai | labil for | lity a Chiu | nd (Thi | Chip | Thic | kne Dim | ess C ensi | ode | S | | | | | | | |
| 220 nF | 221 | | K | M | DG | DG | DG | FD | FD | FD | FG | FG | FG | FG | FG | FM | FM | | | 1 4 | | | | IR | GB | GB | GB | GB | GB | GD | GE |
| 220 pi | 221 | | ĸ | M | | DG | DG | FD | FD | FD | FG | FG | FG | FG | FG | FK | FK | | | | | | | | GB | GB | GB | GR | GB | GH | GH |
| 330 nF | 331 | L. | ĸ | M | DG | DG | DG | FD | FD | FF | FG | FII | FG | FG | FG | FK | FK | | IA | | IB | IC | IC | IC | GB | GB | GB | GB | GB | GH | GH |
| 390 nF | 391 | l .i | ĸ | M | DG | DG | DG | FD | FD | FF | FG | FII | FG | FG | FG | FK | FS | | IA | | IR | IA | I C | IC | GB | GB | GB | GB | GD | GK | GH |
| 470 nF | 471 | l .i | ĸ | M | DG | DG | DG | FD | FD | EG | FG | FII | FM | FM | FM | FS | FS | IR | IB | IB | IC | IA | IB | IC | GB | GB | GB | GB | GD | GK | GK |
| 560 pF | 561 | | K | M | DG | DG | DG | FD | FD | EG | EG | FII | FM | FM | FM | FS | FS | IB | LB | IB | LC | LB | LB | LC | GB | GB | GB | GD | GH | GH | GK |
| 680 pF | 681 | Ĭĭ | ĸ | M | | DG | DG | FG | FG | FG | FIL | FII | FM | FM | FM | FS | FS | | IR | IR | | ic | | I.C. | GB | GB | GB | GD | GH | GH | GK |
| 820 nF | 821 | Ĭĭ | ĸ | M | | DG | DG | FG | FG | FG | FIL | FII | FM | FM | FM | FS | FI | | IR | IR | IR | IR | I C | I.C. | GB | GB | GB | GD | GH | GH | GK |
| 1 000 pF | 1021 | Ĭĭ | ĸ | M | | DG | DG | FG | FG | FG | FIL | FIL | FM | FM | FM | FS | FI | | IR | IR | IR | IR | IC | I.C. | GR | GB | GB | GH | GK | GK | GK |
| 1,000 pr | 102 | Ĭ | ĸ | M | DG | DG | DG | FS | ES | FS | FII | FII | FK | FK | FK | FS | FM | lic | I.C. | IC | IC | IC | ΙA | 20 | GB | GB | GB | GH | GK | GK | GK |
| 1,200 pF | 152 | L. | K | M | DG | DG | DG | ES | ES | ES | FII | FII | ES | FS | FS | FI | FM | LC | LC | IC | LC | LC | LC | | GB | GB | GB | GH | GK | GK | |
| 1,800 pF | 182 | Ĭ | ĸ | M | DG | DG | DG | FF | FF | FF | FII | FII | FS | FS | FS | FI | FM | I.C. | I.C. | IC | IR | IC | I.C. | | GD | GD | GD | GH | GK | GK | |
| 2 200 pF | 222 | Ĭ | ĸ | M | DG | DG | DG | FF | FF | FF. | FII | FII | FS | FS | FS | FI | FM | IR | IB | IB | IB | I C | IC | | GH | GH | GH | GH | GK | GK | |
| 2,200 pr | 272 | Ĭ | ĸ | M | DG | DG | DG | FF | FF | FF | FII | 20 | FS | FS | FS | FL | FM | I.C. | IC | IC | IB | I.C. | 20 | | GB | GB | GB | GH | GM | GM | |
| 3,300 pF | 332 | Ĩ | ĸ | M | DG | DG | DG | FF | FF | FF | FII | | FI | FI | FI | FI | FS | | IB | IB | IB | ΙA | | | GB | GB | GB | GH | GM | GM | |
| 3 900 pF | 392 | Ĵ | ĸ | M | DG | | | FF | EFF | EF. | FU | | FI | FL | FL | FL | FS | IA | IB | I B | I B | IB | | | GB | GB | GB | GH | GM | GO | |
| 4 700 pF | 472 | Ĵ | ĸ | M | DG | | | FF | FF | FF | FU | | FI | FL | FI | FI | FS | | IB | IB | IB | IC | | | GH | GH | GH | GH | GH | GO | |
| 5 600 pF | 562 | Ĵ | ĸ | M | DG | | | FF | FF | FF | FU | | FO | FL | FI | FM | FS | IA | IB | IB | I C | | | | GH | GH | GH | GK | GK | | |
| 6 800 pF | 682 | Ĵ | ĸ | M | DG | | | FF | FF | FF | FU | | FO | FL | FI | FM | FS | IA | IB | IB | I C | | | | GH | GH | GH | GK | GM | | |
| 8 200 pF | 822 | Ĵ | ĸ | M | DG | | | FU | FU | EU | FU | | FO | FI | FI | FK | | IA | IC | I C | I C | | | | GH | GH | GH | GK | GM | | |
| 10 000 pF | 103 | J | K | M | 1.0 | | | FU | FU | FU | FU | | FO | FL | FL | FK | | IA | IC | IC | LC | | | | GH | GH | GH | GK | GO | | |
| 12 000 pF | 123 | Ĵ | ĸ | M | | | | FU | | | | | FO | FI | FL | FS | | IA | IC | I C | IC | | | | GB | GK | GK | GK | | | |
| 15 000 pF | 153 | Ĵ | ĸ | M | | | | FU | | | | | FO | FH | FH | FI | | IA | IC | I C | IC | | | | GB | GK | GK | GK | | | |
| 18,000 pF | 183 | Ĵ | ĸ | M | | | | | | | | | FO | FI | FI | FM | | IA | | | | | | | GB | GM | GM | GM | | | |
| 22 000 pF | 223 | Ĵ | ĸ | M | | | | | | | | | FH | FK | FK | FM | | IA | | | | | | | GB | GI | GI | GM | | | |
| 27.000 pF | 273 | J | K | M | | | | | | - | - | | FM | FK | FK | FK | | LB | | | | | | | GH | GO | GO | GO | | | |
| 33.000 pF | 333 | J | ĸ | M | | | | | | | | | FK | FS | FS | FS | | LC | | | | | | | GH | GO | GO | GO | | | |
| 39.000 pF | 393 | J | ĸ | M | | | | | | | | | FK | FS | FS | FS | | LC | | | | | | | GH | | | | | | |
| 47.000 pF | 473 | J | ĸ | M | | | | | | | | | FS | | | | | LC | | | | | | | GH | | | | | | |
| 56.000 pF | 563 | Ĵ | K | M | | | | | | | | | | | | | | LC | | | | | | | GK | | | | | | |
| · · | | Rate | | tage | 500 | 630 | 000 | 500 | 630 | 000 | ,500 | ,000 | 500 | 630 | 000 | 1500 | 2000 | 500 | 630 | 000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 000 | 1500 | 2000 | 2500 | 3000 |
| Capacitance | Capacitance | Volt | (VDC) Voltage Code | | | В | D | c | В | D | F | G | c | В | D | F | G | c | В | D | F | G | Z | H | c | В | D | F | G | Z | H |
| | Code | Voltage Code Case Size/ Series | | | c | 080 | 5S | | C | 1206 | 6S | - | | C | 121(|)S | | | | C | 1808 | BS | | l | | | C | 1812 | 25 | | |



Table 1B - Capacitance Range/Selection Waterfall (1825 - 2225 Case Sizes)

| | | Cas S | se Si Serie | ize/ es | | | C | 1825 | 55 | | | | | C | 2220 | S | | | | | C | 2225 | 5S | | |
|------------------|-----------------------------------|---------------|----------------|------------|-----|-----|------|-----------|-----|-------|-------|--------|--------|--------|--------|------------|--------|--------|----------|-----|-----------------|-------|-----|-------|----------|
| Canacitance | Сар | Vol | tage C | ode | С | В | D | F | G | z | н | С | В | D | F | G | z | н | С | В | D | F | G | z | н |
| oupacitance | Code | Rat | ed Vol | tage | 200 | 630 | 80, | ,500 | 00(| ,500 | 000' | 500 | 630 | 000 | ,500 | 000' | ,500 | 000 | 500 | 630 | 00 ⁽ | ,500 | 000 | ,500 | 000' |
| | | Cap | pacita | nce | | | - | - | 7 | 7 | Pro | duct / | vaila | bility | and C | hip Tł | nickne | ess Co | des | | - | - | 3 | 2 | 3 |
| 100 pF | 101 | To | bleran | ice M | | 110 | 110 | 110 | 110 | 110 | Se | e Tab | le 2 f | or Chi | p Thio | knes | s Dim | ensio | ns Vr | VE | VE | KL. | VE | νr | ИГ |
| 100 pF 110 pE | 101 | J | r v | M | | ПС | | | | | | | | | | | | | | | | | | | |
| 120 pF | 121 | | K | M | НС | HC | НС | НС | HC | НС | HC | | IK | IK | IK | | IK | IK | KE | KE | KE | KE | KE | KE | KE |
| 120 pi 130 pF | 121 | 1 | K | M | нс | HC | нс | НС | HG | НС | нс | | IK | IK | | IK | IK | IK | KE | KE | KE | KE | KE | KE | KE |
| 150 pF | 151 | | ĸ | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 180 pF | 181 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 220 nF | 221 | J | ĸ | M | HF | HF | HF | HF | HF | HF | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 270 pF | 271 | J | ĸ | M | HF | HF | HE | HE | HE | HE | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 330 nF | 331 | J | ĸ | M | HF | HF | HF | HE | HF | HF | HG | JF | JF | JF | JF | JF | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 390 nF | 391 | J | ĸ | M | HF | HF | HF | HE | HF | HF | HG | JF | JF | JE | JF | JF | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 470 pF | 471 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JF | JE | JE | JF | JE | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 560 pF | 561 | J | ĸ | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 680 pF | 681 | J | ĸ | M | HG | HG | HG | HG | HG | HG | HG | JF | JF | JF | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 820 pF | 821 | Ĵ | K | M | HG | HG | HG | HG | HG | HG | HG | JE | JE | JE | JK | JK | JK | JK | KE | KE | KE | KF | KE | KF | KF |
| 1.000 pF | 102 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KF | KE | KF | KF |
| 1.200 pF | 122 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KF | KF | KF | KF |
| 1.500 pF | 152 | J | K | M | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KF | KF | KF | KF |
| 1.800 pF | 182 | Ĵ | ĸ | M | HE | HE | HE | HE | HE | HG | HG | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KF | KF | KF | KF |
| 2.200 pF | 222 | J | K | M | HE | HE | HE | HE | HE | HG | HJ | JK | JK | JK | JE | JK | JL | JL | KE | KE | KE | KF | KF | KF | KF |
| 2.700 pF | 272 | J | K | M | HE | HE | HE | HE | HE | HG | | JK | JK | JK | JE | JK | JL | JL | KE | KE | KE | KE | KE | KF | KF |
| 3.300 pF | 332 | J | K | M | HE | HE | HE | HE | HE | HG | | JK | JK | JK | JE | JK | JE | JE | KE | KE | KE | KE | KE | KF | KF |
| 3.900 pF | 392 | J | K | M | HE | HE | HE | HE | HE | HG | | JK | JK | JK | JE | JK | JE | JE | KF | KF | KF | KE | KE | KF | KF |
| 4.700 pF | 472 | Ĵ | К | м | HE | HE | HE | HE | HG | HG | | JK | JK | JK | JE | JK | JK | JK | KF | KF | KF | KE | KE | KF | KF |
| 5.600 pF | 562 | J | К | м | HE | HE | HE | HE | HJ | HJ | | JK | JK | JK | JE | JK | JK | JK | KF | KF | KF | KE | KE | KE | KE |
| 6.800 pF | 682 | J | К | м | HE | HE | HE | HE | HJ | HJ | | JE | JE | JE | JE | JK | JK | JK | KF | KF | KF | KE | KF | KE | KE |
| 8,200 pF | 822 | J | К | М | HE | HE | HE | HE | HG | HJ | | JE | JE | JE | JE | JK | JK | JK | KE | KE | KE | KE | KF | KF | KF |
| 10,000 pF | 103 | J | К | М | HE | HE | HE | HE | HJ | нк | | JE | JE | JE | JE | JL | JL | JL | KE | KE | KE | KE | КН | KH | KH |
| 12,000 pF | 123 | J | К | М | HE | HE | HE | HG | HJ | | | JE | JK | JK | JK | JL | JL | JL | KE | KE | KE | KE | КН | KJ | KJ |
| 15,000 pF | 153 | J | К | М | HE | HE | HE | HG | нк | | | JE | JK | JK | JK | JL | JN | JN | KE | KE | KE | KE | КН | KJ | KJ |
| 18,000 pF | 183 | J | K | М | HE | HE | HE | HG | | | | JE | JK | JK | JK | JN | | | KE | KE | KE | KE | KJ | | |
| 22,000 pF | 223 | J | K | М | HE | HG | HG | HG | | | | JE | JK | JK | JK | JN | | | KE | KF | KF | KF | KJ | | |
| 27,000 pF | 273 | J | K | М | HE | HG | HG | HG | | | | JE | JK | JK | JK | | | | KE | KF | KF | KF | KJ | | |
| 33,000 pF | 333 | J | K | M | HE | HG | HG | HE | | | | JE | JK | JK | JK | | | | KE | KF | KF | KF | | | |
| 39,000 pF | 393 | J | K | M | HE | HG | HG | HG | | | | JE | JK | JK | JK | | | | KE | KF | KF | KF | | | |
| 47,000 pF | 473 | J | K | M | HE | HJ | HJ | HJ | | | | JE | JG | JG | JG | | | | KE | KF | KF | KH | | | |
| 56,000 pF | 563 | J | K | M | HE | HG | HG | HJ | | | | JE | JE | JE | JL | | | | KE | KH | KH | KH | | | |
| 68,000 pF | 683 | J | K | M | HG | HJ | HJ | HK | | | | JE | JK | JK | JN | | | | KE | KH | KH | KJ | | | |
| 82,000 pF | 823 | J | K | M | HG | HJ | HJ | | | | | JE | JL | JL | JN | | | | KE | KF | KF | KJ | | | |
| 0.10 µF | 104 | J | K | M | HG | ΗK | HK | | | | | JE | JN | JN | | | | | KE | KH | KH | KJ | | | |
| 0.12 µF | 124 | J | K | M | HG | | | | | | | JE | JN | JN | | | | | KE | KJ | KJ | | | | |
| 0.15 µF | 154 | J | K | M | HG | | | | | | | JK | | | | | | | KF | KJ | KJ | | | | |
| 0.18 µF | 184 | J | K | M | HG | | | | | | | JK | | | | | | | KF | | | | | | |
| 0.22 µF | 224 | J K M | | | HG | | | | | | | | | | | | | | KF | | | | | | |
| | | Rated Voltage | | | 500 | 630 | 000(| 1,500 | 000 | 2,500 | 3,000 | 500 | 630 | 000' | l,500 | 000 | 2,500 | 3,000 | 500 | 630 | 000' | 1,500 | 000 | 2,500 | 3,000 |
| Capacitance | Capacitance Cap Code Voltage Code | | | ode | С | В | D | F | G | Z | H | С | В | D | F | G | Z | H | С | В | D | F | G | Z | .,, Н |
| Case Size | | | | ze/ | | | C | ; 1825 | S | 1 | | | | | 2220 | S | | | | | C | 2225 | S | | |



Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic | Quantity |
|-----------|-------------------|------------------------------------|---------|----------------------|------------|---------------|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| ED | 1206 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| ES FF | 1200 | 1.00 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| | 1200 | 1.20 ± 0.10 1.60 ± 0.15 | | 0 | 2,500 | |
| EG | 1200 | 1.00 ± 0.15 1.60 ± 0.25 | 0 | 0 | 2,000 | 8,000 |
| FG | 1200 | 1.00 ± 0.25 | 0 | 0 | 2,000 | 10 000 |
| FI | 1210 | 1.20 ± 0.10 1 40 + 0 15 | 0 | 0 | 2,000 | 8 000 |
| FO | 1210 | 1.50 + 0.20 | Ő | Ő | 2,000 | 8,000 |
| FH | 1210 | 1.55 ± 0.15 | 0 | 0 | 2.000 | 8,000 |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FK | 1210 | 2.10 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1,000 | 4,000 |
| LA | 1808 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| LB | 1808 | 1.60 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| LC | 1808 | 2.00 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GD | 1812 | 1.25 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GE | 1812 | 1.30 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GH | 1812 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GK | 1012 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GL | 1012 | 1.90 ± 0.20 | 0 | 0 | 500 | 2,000 |
| | 1012 | 2.00 ± 0.20 2.50 + 0.20 | | | 500 | 2,000 |
| HF | 1825 | 1.40 ± 0.20 | 0 | 0 | 1 000 | 4 000 |
| HG | 1825 | 1.40 ± 0.10 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| HJ | 1825 | 2.00 + 0.20 | Ő | Ő | 500 | 2.000 |
| НК | 1825 | 2.50 ± 0.20 | 0 | 0 | 500 | 2.000 |
| JE | 2220 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JK | 2220 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| JG | 2220 | 1.70 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JL | 2220 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| JN | 2220 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| KE | 2225 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| KF | 2225 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| KH K.I | 2225 | 2.00 ± 0.20 2 50 + 0 20 | 0 | 0 | 500 500 | 2,000 |
| Thickness | | | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic | l Quantity |
| L | | | | • | | • |

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".



Table 2B – Bulk Packaging Quantities

| Dookoo | uing Tuno | Loose P | ackaging |
|----------|------------------------|------------------------|-------------------------|
| Раскад | ling lype | Bulk Bag | (default) |
| Packagi | ng C-Spec ¹ | N | /A ² |
| Cas | e Size | Packaging Quantities (| (pieces/unit packaging) |
| EIA (in) | Metric (mm) | Minimum | Maximum |
| 0402 | 1005 | | |
| 0603 | 1608 | | |
| 0805 | 2012 | | 50,000 |
| 1206 | 3216 | | |
| 1210 | 3225 | 1 | |
| 1808 | 4520 | | |
| 1812 | 4532 | | |
| 1825 | 4564 | | 20,000 |
| 2220 | 5650 | | |
| 2225 | 5664 | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial Grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive Grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size | Metric Size | | Dens Maxi Land Pi | sity Lev mum (I rotrusio | vel A: Most) on (mm |) | | Dens Media Land Pi | sity Lev an (Nor rotrusio | vel B: minal) on (mm |) | | Dens Minir Land Pr | sity Lev num (L rotrusio | vel C: .east) on (mm |) |
|-------------|----------------|------|-------------------------|--------------------------------|---------------------------|------|------|--------------------------|---------------------------------|----------------------------|------|------|--------------------------|--------------------------------|----------------------------|------|
| Coue | Coue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 1.50 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 |
| 1825 | 4564 | 2.15 | 1.60 | 6.90 | 6.90 | 7.90 | 2.05 | 1.40 | 6.80 | 6.00 | 7.30 | 1.95 | 1.20 | 6.70 | 5.30 | 7.00 |
| 2220 | 5650 | 2.75 | 1.70 | 5.50 | 8.20 | 6.50 | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | 2.55 | 1.30 | 5.30 | 6.60 | 5.60 |
| 2225 | 5664 | 2.70 | 1.70 | 6.90 | 8.10 | 7.90 | 2.60 | 1.50 | 6.80 | 7.20 | 7.30 | 2.50 | 1.30 | 6.70 | 6.50 | 7.00 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Termination Finish | | | |
|--|-----------------------|-----------------------|--|--|
| Tomeredure | SnPb | 100% Matte Sn | | |
| Preheat/Soak | | | | |
| Temperature Minimum (T _{Smin}) | 100°C | 150°C | | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | | |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds | | |
| Ramp-Up Rate $(T_L to T_P)$ | 3°C/second maximum | 3°C/second maximum | | |
| Liquidous Temperature (T_L) | 183°C | 217°C | | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | | |
| Peak Temperature (T _P) | 235°C | 260°C | | |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum | 30 seconds maximum | | |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | 6°C/second maximum | | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | | |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test Condition | Limits | |
|--|----------------|--|--|--|
| Visual and Mechanical | KEMET Internal | No defects that may affect performance (10X) | Dimensions according KEMET Spec Sheet | |
| Capacitance (Cap) | KEMET Internal | C ≤ 10 µF 1 kHz ±50 Hz and 1.0 ±0.2 V or 0.5 ±0.2 V ms* C > 10 µF120 Hz ±10 Hz and 0.5 ±0.1 V ms* * See part number specification sheet for voltage Capacitance measurements (including tolerance) are indexed to a referee time of 48 or 1,000 hours Please refer to a part number specification sheet for referee time details | Within Tolerance | |
| Dissipation Factor (DF) | KEMET Internal | $C \leq 10 \ \mu\text{F}$ Frequency: 1 kHz ±50 Hz Voltage*:1.0 ±0.2 V _{rms} , 0.5 ±0.2 V _{rms} , C > 10 \ \mu\text{F} Frequency: 120 Hz ±10 Hz Voltage: 0.5 ±0.1 V _{rms} * See part number specification sheet for voltage | Within Specification Dissipation factor (DF) maximum limit at 25°C = 2.5% | |
| Insulation Resistance (IR) | KEMET Internal | 500 VDC applied for 120 ±5 seconds at 25°C | $\begin{array}{ c c c c c } Within Specification \\ To obtain IR limit, divide M\Omega-\mu F value \\ by the capacitance and compare to \\ G\Omega limit. Select the lower of the two limits. \\ \hline \hline \begin{array}{ c c c c } \hline EIA \\ \hline \hline Case Size \end{array} & \begin{array}{ c c c } 1,000 \ Megohm \\ Microfarads or \\ 100 \ G\Omega \end{array} & \begin{array}{ c c } 100 \ Megohm \\ Microfarads or \\ 100 \ G\Omega \end{array} & \begin{array}{ c c } 100 \ Megohm \\ Microfarads or \\ 10 \ G\Omega \end{array} \\ \hline \begin{array}{ c c } \hline 0805 & < 0.0039 \ \mu F \end{array} & \ge 0.0039 \ \mu F \\ \hline 1206 & < 0.012 \ \mu F \end{array} & \ge 0.012 \ \mu F \\ \hline 1210 & < 0.033 \ \mu F \end{array} & \ge 0.018 \ \mu F \\ \hline \begin{array}{ c } 1812 & < 0.027 \ \mu F \end{array} & \ge 0.027 \ \mu F \\ \hline 1825 & < 0.120 \ \mu F \end{array} & \ge 0.120 \ \mu F \\ \hline \begin{array}{ c } 2220 & < 0.150 \ \mu F \end{array} & \ge 0.150 \ \mu F \\ \hline \end{array} \\ \hline \end{array}$ | |
| Temperature Coefficient of Capacitance (TCC) | KEMET Internal | $C \leq 10 \ \mu\text{F}$ Frequency: 1 kHz ±50 Hz Voltage*: 1.0 ±0.2 V _{rms} , 0.5 ±0.2 V _{rms} , 0.2 ±0.1 V C > 10 \ \mu\text{F} Frequency: 120 Hz ±10 Hz Voltage: 0.5 ±0.1 V _{rms} * See part number specification sheet for voltage $\frac{\text{Step} \qquad \text{Temperature (°C)}}{1 \qquad +25^{\circ}\text{C}}$ $\frac{3 \qquad +25^{\circ}\text{C} (\text{Reference Temperature})}{4 \qquad +125^{\circ}\text{C}}$ | Capacitance ±15% over -55°C to +125°C | |



Table 4 – Performance & Reliability: Test Methods and Conditions cont.

| Stress | Reference | Test Condition | Limits |
|--|---------------------------|--|---|
| Dielectric Withstanding Voltage (DWV) | KEMET Internal | 150% of rated voltage for voltage rating of < 1,000 V 120% of rated voltage for voltage rating of ≥ 1,000 V (5 ±1 seconds and charge/discharge not exceeding 50 mA) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit Withstand test voltage without insulation breakdown or damage. |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | KEMET Internal | Capacitance measurements (including tolerance) are indexed to a referee time of 48 or 1,000 hours. Please refer to a part number specific datasheet for referee time details. | Please refer to a part number specification sheet for specific Aging rate |
| Terminal Strength | KEMET Internal | Shear stress test per specific case size, Time: 60 ±1 second. Case Size Force 0805 9N ≥ 1206 18N | No evidence of mechanical damage |
| Board Flex | AEC-Q200-005 | Standard Termination System 2.0 mm Flexible Termination System 3.0 mm Test Time: 60± 5 seconds Ramp Time: 1 mm/second | No evidence of mechanical damage |
| Solderability | J-STD-002 | Condition: 4 hours ±15 minutes at 155°C dry bake apply all methods Test 245 ±5°C (SnPb & Pb-Free) | Visual Inspection. 95% coverage on termination. No leaching |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to +125°C) 2 - 3 cycles per hour Soak Time: 1 or 5 minute | Measurement at 24 hours ±4 hours after test conclusion. Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and 200 VDC maximum Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±20% shift IR: 10% of Initial Limit DF Limit Maximum: 3.0% |
| Moisture Resistance | MIL-STD-202 Method 106 | Number of Cycles Required: 10, 24 hours per cycle. Steps 7a and 7b not required | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±20% shift IR: 10% of Initial Limit DF Limit Maximum: 3.0% |
| Thermal Shock | MIL-STD-202 Method 107 | Number of Cycles Required: 5, (-55°C to 125°C) Dwell time 15 minutes. | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |



Table 4 – Performance & Reliability: Test Methods and Conditions cont.

| Stress | Reference | Test Condition | Limits | |
|--|---------------------------|---|---|--|
| High Temperature Life | MIL-STD-202 | 1,000 hours at 125°C with 1.2 X rated voltage applied. | Within Post Environmental Limits Cap: ±20% shift | |
| Storage Life | Method 108 | 1,000 hours at 150°C, Unpowered | DF Limit Maximum: 3.0% | |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Test from 10 – 2,000 Hz | Cap: Initial Limit DF: Initial Limit IR: Initial Limit | |
| Mechanical MIL-STD-202 Shock Method 213 | | 1,500 g's 0.5 millisecond Half-sine, Velocity Change: 15.4 feet/second (Condition F) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit | |
| Resistance to MIL-STD-202 Solvents Method 215 | | Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents. | Visual Inspection 10X Readable marking, no decoloration or stains. No physical damage. | |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction



Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs) Floating Electrode (FE-CAP), High Voltage X7R Dielectric, 500 – 3,000 VDC (Commercial & Automotive Grade)



Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a "K" to identify KEMET, followed by two characters (per EIA–198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the "K" character only.

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.
- X7R dielectric products in capacitance values outlined below.

| EIA Case Size | Metric Size Code | Capacitance |
|---------------|------------------|-------------|
| 0603 | 1608 | ≤ 170 pF |
| 0805 | 2012 | ≤ 150 pF |
| 1206 | 3216 | ≤ 910 pF |
| 1210 | 3225 | ≤ 2,000 pF |
| 1808 | 4520 | ≤ 3,900 pF |
| 1812 | 4532 | ≤ 6,700 pF |
| 1825 | 4564 | ≤ 0.018 µF |
| 2220 | 5650 | ≤ 0.027 µF |
| 2225 | 5664 | ≤ 0.033 µF |

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 μ F. Orientation of marking is vendor optional.





Capacitor Marking (Optional) cont.

| | Capacitance (pF) For Various Alpha/Numeral Identifiers | | | | | | | | | |
|-----------|--|-----|----|-----|-------|--------|---------|-----------|------------|-------------|
| Aluka | | | | | | Numera | l I | | | |
| Alpna | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Character | ter Capacitance (pF) | | | | | | | | | |
| A | 0.10 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 |
| Н | 0.20 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 |
| М | 0.30 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 |
| d | 0.40 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 |
| f | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 |
| у | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punched Paper | |
|----------------------|------|---------|--------------------|---------------|--------------------|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| | (W)* | Pitch | (P ₁)* | Pitch | (P ₁)* |
| 01005 - 0402 | 8 | | | 2 | 2 |
| 0603 | 8 | | | 2/4 | 2/4 |
| 0805 | 8 | 4 | 4 | 4 | 4 |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 |
| 1805 - 1808 | 12 | 4 | 4 | | |
| ≥ 1812 | 12 | 8 | 8 | | |
| KPS 1210 | 12 | 8 | 8 | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | |
| Array 0612 | 8 | 4 | 4 | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size. 2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|--|---------------------------------------|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 16 mm | | (0.059) | 159) | | | (1.181) | | | |
| | | , | Variable Dime | ensions — Mil | limeters (Incl | nes) | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | te 5 |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_a and B_a are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | | | |
|--|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|
| Tape Size | D ₀ | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | Note 1 | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius



Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs) Floating Electrode (FE-CAP), High Voltage X7R Dielectric, 500 – 3,000 VDC (Commercial & Automotive Grade)



Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | |
|--|----------------------|---------------------------------------|--|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | |
| 8 mm | 178 ±0.20 | | | | | | |
| 12 mm | (7.008 ±0.008) Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | |
| 16 mm | (13.000 ±0.008) | | X X X X | | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Solder Fluxes and Cleaning

The use of water-soluble fluxes provides advantages of excellent solderability due to high activation. However, these fluxes contain organic acids that can induce arcing under high DC or AC voltages. Notable problem areas are underneath the MLCC where flux can be trapped between the ceramic material and PCB. It is therefore critical that PCBs are properly cleaned to remove all flux residue to maintain reliability.

Coating for High Voltage MLCCs

For MLCC ratings \geq 1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

| Dielectric | CTE (ppm/°C) |
|----------------------------|--------------|
| Class II BaTiO₃ | 10.7 |
| Class I CaZrO ₃ | 9.8 |

Slits in PCB

It is recommended to apply a slit in the PCB under the MLCC to improve washing of flux residue that may get trapped underneath. In some cases, it is not possible to slit entirely through the PCB due to underlying metal planes. It is also acceptable to apply a recessed slit under the MLCC which will also promote cleaning.

- Recommended for case sizes ≥1206
- The width (w) of the slit should be 1mm
- Length of the slit should be as short as possible to prevent damaging the MLCC due to mechanical stress of the PCB.
- Slits also reduce the risk of solder balls under MLCC which decreased the creepage distance.



Solder Resist

If a slit cannot be applied as above, it is recommended to not use solder resist directly under the MLCC. The use of solder resist material reduces the distance between MLCC ceramic material and PCB thus making it difficult to clean.

Solder Balls

Improper reflow techniques and/or improper washing can induce solder balls under or adjacent to the MLCC. Solder balls reduce the creepage distance between the MLCC terminations and increase the risk of arcing or damage to the ceramic material. To reduce the risk of solder balls:

- Follow KEMET's solder recommendations as outlined in the datasheet.
- If performing a cleaning procedure, properly clean the PCB per KEMET's cleaning recommendations.
- Add slit to the PCB as shown above.







Overview

KEMET's Floating Electrode (FE-CAP) high voltage multilayer ceramic capacitor in COG dielectric utilizes a cascading / serial electrode design configured to form multiple capacitors in series within a single monolithic structure. This unique configuration results in enhanced voltage and ESD performance over standard capacitor designs while allowing for a fail-open condition if mechanically damaged (cracked). If damaged, the device may experience a drop in capacitance but a short is unlikely. The FE-CAP is designed to reduce the likelihood of a low IR or short circuit condition and the chance for a catastrophic and potentially costly failure event.

KEMET's Floating Electrode High Voltage surface mount MLCCs in COG dielectric are temperature compensating and are suited for resonant circuit applications or those where Q and stability of capacitance characteristics are required. COG exhibits no change in capacitance with respect to time and voltage and boasts a negligible change in capacitance with reference to ambient temperature. Capacitance change is limited to ± 30 ppm/°C from -55°C to ± 125 °C. Whether under-hood or in-cabin, these capacitors are designed to provide reliable performance in mission and safety critical automotive circuits. Stricter testing protocol and inspection criteria have been established for automotive grade products in recognition of potentially harsh environmental conditions. KEMET automotive grade series capacitors meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.



Ordering Information

| С | 1210 | S | 332 | J | С | G | Α | С | TU |
|---------|--|---------------------------|--|---|--|------------|-------------------------|--|--|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ¹ | Packaging/ Grade (C-Spec) |
| | 0805 1206 1210 1808 1812 1825 2220 2225 | S = Floating Electrode | Two significant digits and number of zeros | $B = \pm 0.10 pF$ $C = \pm 0.25 pF$ $D = \pm 0.5 pF$ $F = \pm 1\%$ $G = \pm 2\%$ $J = \pm 5\%$ $K = \pm 10\%$ $M = \pm 20\%$ | C = 500 B = 630 D = 1000 F = 1500 G = 2000 Z = 2500 H = 3000 | G = COG | A = N/A | C = 100% Matte Sn L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ Additional termination finish options may be available. Contact KEMET for details.

¹ SnPb termination finish option is not available on automotive grade product.

Built Into Tomorrow

1



Packaging C-Spec Ordering Options Table

| Packaging Type | Packaging/Grade Ordering Code (C-Spec) |
|---------------------|---|
| Commerc | ial Grade ¹ |
| Bulk Bag | Not required (Blank) |
| 7" Reel / Unmarked | TU |
| 13" Reel / Unmarked | 7210 |
| Automoti | ve Grade ² |
| 7" Reel | AUTO |
| 13" Reel / Unmarked | AUT07210 |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices. For more information see "Capacitor Marking". ² Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information".

² For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information".

² All Automotive packaging C-Specs listed exclude the option to laser mark components. The option to laser mark is not available on these devices. For more information see "Capacitor Marking".

Benefits

- Floating Electrode/fail open design
- · AEC-Q200 automotive qualified
- Operating temperature range of -55°C to +125°C
- Capacitance offerings ranging from 1 pF to 0.15 µF
- DC voltage ratings of 500 V, 630 V, 1 KV, 1.5 KV, 2 KV, 2.5 KV and 3 KV
- EIA 0805, 1206, 1210, 1808, 1812, 1825, 2220 and 2225 case sizes
- · Extremely low ESR and ESL
- · High ripple current capability
- · No capacitance shift with voltage
- · Negligible capacitance shift with respect to temperature
- No piezoelectric noise
- · Lead (Pb)-Free, RoHS and REACH compliant

Applications

- EV/HEV (drive systems, charging)
- High frequency power converters
- Wide bandgap (WBG), silicon carbide (SiC) and gallium nitride (GaN) systems
- Snubber (high dV/dT)
- Resonant circuits (LLC, Wireless Charging, etc)
- Timing
- Filtering
- ESD protection



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | tion Due To: | Days Prior To |
|-----------------------------|----------------------------------|---------------|------------------|
| C-Spec | Process/Product change | Obsolescence* | Implementation |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum |
| AUTO | Yes (without approval) | Yes | 90 days minimum |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | | PPAP (Product | Part Approval | Process) Leve | I |
|-----------------------------|---|---------------|---------------|---------------|---|
| C-Spec | 1 | 2 | 3 | 4 | 5 |
| KEMET assigned ¹ | • | • | • | • | • |
| AUTO | | | 0 | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|-------------------------------|-----------------|-------------------------------|----------------------------|-----------------------|
| 0805 | 2012 | 2.00 (0.079) ±0.20 (0.008) | 1.25 (0.049) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave or |
| 1206 | 3216 | 3.20 (0.126) ±0.20 (0.008) | 1.60 (0.063) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | | Solder Reflow |
| 1210 | 3225 | 3.20 (0.126) ±0.20 (0.008) | 2.50 (0.098) ±0.20 (0.008) | | 0.50 (0.02) ±0.25 (0.010) | | |
| 1808 | 4520 | 4.70 (0.185) ±0.50 (0.020) | 2.00 (0.079) ±0.20 (0.008) | See Table 2 for | 0.60 (0.024) ±0.35 (0.014) | | |
| 1812 | 4532 | 4.50 (0.177) ±0.30 (0.012) | 3.20 (0.126) ±0.30 (0.012) | Thickness | 0.60 (0.024) ±0.35 (0.014) | N/A | Solder Reflow |
| 1825 | 4564 | 4.50 (0.177) ±0.30 (0.012) | 6.40 (0.252) ±0.40 (0.016) | _ | 0.60 (0.024) ±0.35 (0.014) | _ | Only |
| 2220 | 5650 | 5.70 (0.224) ±0.40 (0.016) | 5.00 (0.197) ±0.40 (0.016) | - | 0.60 (0.024) ±0.35 (0.014) | _ | |
| 2225 | 5664 | 5.60 (0.220) ±0.40 (0.016) | 6.40 (0.248) ±0.40 (0.016) | | 0.60 (0.024) ±0.35 (0.014) | | |



Table 1A - Capacitance Range/Selection Waterfall (0805 - 1812 Case Sizes)

| | | (| Cas S | e S eri | Size es | ./ | c |)80 | 5S | | C 1 | 120 | 6S | | | C | 121 | 0 S | | | | C 1 | 180 | 8S | | | | | C 1 | 1812 | 28 | | |
|-------------------------|-----------------|----------|----------------|--------------|------------|------|----|-----|------|----|------------|------|------|-------------|-----|--------------|---------------|-------------|---------|----------------|------|------------|------|------|-----|--------|----|-----|------------|------|-----|-----|-----|
| · · · | Capacitance | , | Volt | age | Cod | e | С | В | D | С | В | D | F | G | С | В | D | F | G | С | В | D | F | G | z | Н | С | В | D | F | G | z | н |
| Capacitance | Code | F | Rate | d Vo | oltag | e | 8 | 30 | 000 | 8 | 30 | 000 | 500 | 000 | 8 | 30 | 00 | 009 | 8 | 8 | 30 | 00 | 009 | 00 | 000 | 00 | 8 | 30 | 00 | 009 | 000 | 009 | 000 |
| | | | (| (VDC | C) | | 2 | و | ÷ | 2 | و | - | ÷ | , , , | °. | • | 2 | 2 | 50 | 0 | 0 | ₩ 71.1 | 12 | 5 | 5 | ы В | ŝ | ø | 2 | 12 | 50 | 56 | 30 |
| | | | Tol | acit lera | nce | e | | | | | | | | ł | See | uct e Tal | Avai ble 2 | for | Chi | ana C p Thi | ickn | ess | Dim | ensi | ons | S | | | | | | | |
| 1.0 - 9.1 pF* | 109 - 919* | В | | C | | D | DG | DG | DG | | | | | | | | | F 14 | | LB | LB | LB | LB | LB | LB | LB | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10 pF - 47 pF^ 47 nF | 100-470* 470 | F | G | J | K | M | DG | DG | DG | FD | FD | FD | FD | FD | FM | FM | FM | FM | FM | LD I R | LD | LD | LD | | | LD | GB | GB | GB | GB | GB | GB | GB |
| 51 pF | 510 | F | G | J | K | M | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 56 pF | 560 | F | G | J | K | М | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 62 pF | 620 | F | G | J | K | М | DG | DG | DG | ED | ED | ED | ED | ED | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 68 pF | 680 | F | G | J | K | M | DG | DG | DG | ED | ED | ED | ED | ED | FΜ | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 75 pF | 750 | F | G | J | K | M | DG | DG | DG | ED | ED | ED | ED | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB | GB | GB | GB | GB | GB | GB | GB |
| 82 pF | 820 | F | G | J | K | M | DG | DG | DG | ED | ED | ED | ED | EF | FM | FM | FM | FM | FM | | | | | | | | GB | GB | GB | GB | GB | GB | GB |
| 91 pF | 910 | | G | J | K | M | | DG | | ED | ED | ED | ED | | FM | FM | FM | FM | FIM | LB | LB | LB | LB | LB | LB | LB | GD | GD | GD | GD | GD | GD | GD |
| 110 pF | 111 | F | G | 1 | K | M | | DG | | FD | FD | FD | FD | FG | FM | FM | FM | FM | FM | | IB | | IR | | | | GD | GD | GD | GD | GD | GD | GD |
| 120 pF | 121 | F | G | J | K | M | DG | DG | DG | ED | ED | ED | ED | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LB | LC | LB | GD | GD | GD | GD | GD | GD | GD |
| 130 pF | 131 | F | G | J | K | M | DG | DG | DG | ED | ED | ED | ED | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LB | LC | LC | GD | GD | GD | GD | GD | GD | GD |
| 150 pF | 151 | F | G | J | K | M | DG | DG | DG | ED | ED | ED | EF | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LB | LC | LC | GK | GK | GK | GK | GK | GK | GK |
| 160 pF | 161 | F | G | J | K | Μ | DG | DG | DG | ED | ED | ED | EF | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LC | LC | LC | GK | GK | GK | GK | GK | GK | GK |
| 180 pF | 181 | F | G | J | K | M | DG | DG | DG | ED | ED | ED | EF | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LC | LC | LC | GK | GK | GK | GK | GK | GK | GK |
| 200 pF | 201 | F | G | J | K | M | DG | DG | DG | ED | ED | ED | EG | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LC | LC | | GB | GB | GB | GB | GB | GD | GΜ |
| 220 pF | 221 | F | G | J | K | M | DG | DG | DG | ED | ED | ED | EG | EG | FG | FG | FG | FM | FM | LA | LA | LA | LA | LC | LC | | GB | GB | GB | GB | GB | GD | GM |
| 240 pF | 241 | F | G | J | K | M | DG | DG | DG | ED | ED | ED | EG | EG | FG | FG | FG | FK | FK | LA | LA | LA | LB | LC | LC | | GB | GB | GB | GB | GB | GH | GM |
| 270 pF | 2/1 | | G | J | K | M | DG | DG | DG | ED | ED | ED | EG | EG | FG | FG | FG | FK | FK | | | | LB | LC | LC | | GB | GB | GB | GB | GB | GH | GM |
| 300 pF 220 pE | 301 | | G | J | K | M | | | | | ED | | EG | | FG | FG | FG | FK | FK | | | | | | | | GB | GB | GB | GB | GB | GH | 60 |
| 360 pF | 361 | F | G | J | K | M | | | | | FD | FF | EG | | FG | FG | FG | FK | FS | | | | | | | | GB | GR | GB | GB | GD | GK | 60 |
| 390 pF | 391 | F | G | J | K | M | | | | FD | FD | FF | FG | | FG | FG | FG | FK | FS | | IA | IA | IB | | | | GB | GB | GB | GB | GD | GK | GO |
| 430 pF | 431 | F | G | J | K | M | | | | ED | ED | EG | EG | | FM | FM | FM | FS | FS | LB | LB | LB | LC | LA | | | GB | GB | GB | GB | GD | GK | |
| 470 pF | 471 | F | G | J | К | м | | | | ED | ED | EG | EG | | FM | FM | FM | FS | FS | LB | LB | LB | LC | LA | | | GB | GB | GB | GB | GD | GK | |
| 510 pF | 511 | F | G | J | K | М | | | | ED | ED | EG | EG | | FΜ | FM | FM | FS | FS | LB | LB | LB | LC | LB | | | GB | GB | GB | GD | GH | GM | |
| 560 pF | 561 | F | G | J | K | M | | | | ED | ED | EG | EG | | FΜ | FM | FM | FS | FS | LB | LB | LB | LC | LB | | | GB | GB | GB | GD | GH | GM | |
| 620 pF | 621 | F | G | J | K | Μ | | | | EG | EG | EG | | | FΜ | FM | FM | FS | FS | LB | LB | LB | LA | LC | | | GB | GB | GB | GD | GH | GO | |
| 680 pF | 681 | F | G | J | K | M | | | | EG | EG | EG | | | FM | FM | FM | FS | FS | LB | LB | LB | LA | LC | | | GB | GB | GB | GD | GH | GO | |
| 750 pF | 751 | F | G | J | K | M | | | | EG | EG | EG | | | FM | FM | FM | FS | | LB | LB | LB | LB | | | | GB | GB | GB | GD | GK | | |
| 820 pF | 821 | | G | J | K | M | | | | EG | EG | EG | | | FM | FM | FM | FS | | LB | LB | LB | LB | | | | GB | GB | GB | GD | GK | | |
| 910 pF | 911 | | G | J | K | M | | | | EG | EG | EG | | | | FIN | FIN | F5 | | | LB | | LB | | | | GB | GB | GB | GH | GM | | |
| 1,000 pF | 102 | F | G | 1 | K | M | | | | LO | LO | LO | | | FK | FK | FK | FS | | | | | | | | | GB | GB | GB | GH | GO | | |
| 1,100 pr | 12 | F | G | J | K | M | | | | | | | | | FK | FK | FK | FS | | I C | IC | IC | I C | | | | GB | GB | GB | GH | GO | | |
| 1,300 pF | 132 | F | G | J | K | M | | | | | | | | | FS | FS | FS | | | LC | LC | LC | LC | | | | GB | GB | GB | GH | GO | | |
| 1,500 pF | 152 | F | G | J | К | м | 1 | | | | | | | | FS | FS | FS | | | LC | LC | LC | LC | | | | GB | GB | GB | GH | GO | | |
| 1,600 pF | 162 | F | G | J | K | Μ | | | | | | | | | FS | FS | FS | | | LC | LC | LC | | | | | GD | GD | GD | GM | | | |
| 1,800 pF | 182 | F | G | J | K | Μ | | | | | | | | | FS | FS | FS | | | LC | LC | LC | | | | | GD | GD | GD | GM | | | |
| 2,000 pF | 202 | F | G | J | K | M | | | | | | | | | FS | FS | FS | | | LB | LB | LB | | | | | GH | GH | GH | GO | | | |
| 2,200 pF | 222 | F | G | J | K | M | | | | | | | | | FS | FS | FS | | | LB | LB | LB | | | | | GH | GH | GH | GO | | | |
| 2,400 pF | 242 | | G | J | K | M | | | | | | | | | FS | FS | FS | | | | LC | LC | | | | | GK | GK | GK | 60 | | | |
| 2,700 pr 3,000 pF | 302 | F | G | J | K | M | | | | | | | | | 13 | 13 | 13 | | | 10 | LC | LC | | | | | GK | GK | GK | 60 | | | |
| 3.300 pF | 332 | F | G | J | ĸ | M | 1 | | | | | | | | | | | | | | | | | | | | GK | GK | GK | | | | |
| 3,600 pF | 362 | F | G | J | K | M | 1 | | | | | | | | | | | | | | | | | | | | GM | GM | GM | | | | |
| 3,900 pF | 392 | F | G | J | К | м | 1 | | | | | | | | | | | | | | | | | | | | GM | GM | GM | | | | |
| 4,300 pF | 432 | F | G | J | Κ | М | | | | | | | | | | | | | | | | | | | | | GO | GO | GO | | | | |
| 4,700 pF | 472 | F | G | J | K | Μ | | | | | | | | | | | | | | | | | | | | | GO | GO | GO | | | | |
| 5,100 pF | 512 | F | G | J | K | M | | | | | | | | | | | | | | | | | | | | | GO | GO | GO | | | | |
| 5,600 pF | 562 | F | G | J | K | M | | e | 2 | | e | 2 | 2 | 2 | _ | e | 0 | 0 | 0 | - | 0 | 0 | 0 | 0 | 0 | 0 | 60 | GO | <u>60</u> | 0 | | 9 | 0 |
| | Canacitance | | (| (VD | C) | - | 50 | 631 | 1,0(| 50 | 631 | 1,0(| 1,5(| 2,0(| 50 | 631 | 100 | 150 | 200 | 50 | 631 | 100 | 150 | 200 | 250 | 300 | 50 | 631 | 100 | 150 | 200 | 250 | 300 |
| Capacitance | Code | <u>'</u> | Voltage Code (| | C | B | D | C | B | D | F | G | C | B | D | F | G | C | B | D | F | G | Z | H | C | B | D | F | G | Z | Η | | |
| | | Ca | se S | Size | /Se | ries | C | 080 | 5S | | C | 1206 | őS | | | C | 1210 |)S | | | | C | 1808 | BS | | | | | C | 1812 | S | | |

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Table 1B - Capacitance Range/Selection Waterfall (1825 - 2225 Case Sizes)

| | | С | as So | e S eri | Siz ies | e/ | | | C | 1825 | 55 | | | | | C | 2220 | S | | | | | C | 2225 | 55 | | |
|-----------------------------------|------------|---|----------|-------------|------------|-------|-------|-------|-------|-------|-------|-------|-------|--------|--------|------------------|-------|--------|-----------------|--------|-------|-------|-------|-------|-------|-------|-------|
| Canacitance | Сар | ١ | /olta | age | Co | de | С | В | D | F | G | z | н | С | В | D | F | G | z | н | С | В | D | F | G | z | н |
| Capacitance | Code | R | ate (| d Vo VD(| olta C) | ge | 200 | 630 | 1,000 | 1,500 | 2,000 | 2,500 | 3,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 2,500 | 3,000 | 200 | 630 | 1,000 | 1,500 | 2,000 | 2,500 | 3,000 |
| | | C | apa | acit | tan | ce | | | | | | | Pro | duct / | Availa | bility or Chi | and C | hip Th | nickne s Dim | ess Co | des | | | | | | |
| 10 nF - 47nF* | 100 - 470* | F | G | J | K | M | НG | HG | HG | HG | HG | HG | HG | | JK | | JK | JK | JK | JK | KF |
| 47 pF | 470 | F | G | J | ĸ | M | HG | JK | JK | JK | JK | JK | JK | JK | KF |
| 51 pF | 510 | F | G | J | K | M | HG | JK | JK | JK | JK | JK | JK | JK | KF |
| 56 pF | 560 | F | G | J | K | M | HG | JK | JK | JK | JK | JK | JK | JK | KF |
| 62 pF | 620 | F | G | J | ĸ | М | HG | JK | JK | JK | JK | JK | JK | JK | KF |
| 68 pF | 680 | F | G | J | K | M | HG | JK | JK | JK | JK | JK | JK | JK | KF |
| 75 pF | 750 | F | G | J | ĸ | М | HG | JK | JK | JK | JK | JK | JK | JK | KF |
| 82 pF | 820 | F | G | J | K | M | HG | JK | JK | JK | JK | JK | JK | JK | KF |
| 91 pF | 910 | F | G | J | K | M | HG | JK | JK | JK | JK | JK | JK | JK | KF |
| 100 pF | 101 | F | G | J | K | M | HG | JK | JK | JK | JK | JK | JK | JK | KF |
| 110 pF | 111 | F | G | J | K | M | HG | JK | JK | JK | JK | JK | JK | JK | KF |
| 120 pF | 121 | F | G | J | K | M | HG | JK | JK | JK | JK | JK | JK | JK | KF |
| 130 pF | 131 | F | G | J | K | M | HG | JK | JK | JK | JK | JK | JK | JK | KF |
| 150 pF | 151 | F | G | J | K | M | HG | JK | JK | JK | JK | JK | JK | JK | KF |
| 160 pF | 161 | F | G | J | K | M | HG | JK | JK | JK | JK | JK | JK | JK | KF |
| 180 pF | 181 | F | G | J | K | M | HG | JK | JK | JK | JK | JK | JK | JK | KF |
| 200 pF | 201 | F | G | J | K | M | HE | HE | HE | HE | HE | HE | HG | JK | JK | JK | JK | JK | JK | JK | KF |
| 220 pF | 221 | F | G | J | K | M | HE | HE | HE | HE | HE | HE | HG | JK | JK | JK | JK | JK | JK | JK | KF |
| 240 pF | 241 | F | G | J | K | M | HE | HE | HE | HE | HE | HE | HG | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 270 pF | 271 | F | G | J | K | M | HE | HE | HE | HE | HE | HE | HG | JK | JK | JK | JK | JK | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 300 pF | 301 | F | G | J | K | M | HE | HE | HE | HE | HE | HE | HG | JE | JE | JE | JE | JE | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 330 pF | 331 | F | G | J | K | M | HE | HE | HE | HE | HE | HE | HG | JE | JE | JE | JE | JE | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 360 pF | 361 | F | G | J | K | M | HE | HE | HE | HE | HE | HE | HG | JE | JE | JE | JE | JE | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 390 pF | 391 | F | G | J | K | M | HE | HE | HE | HE | HE | HE | HG | JE | JE | JE | JE | JE | JK | JK | KE | KE | KE | KE | KE | KE | KF |
| 430 pF | 431 | F | G | J | K | M | HE | HE | HE | HE | HE | HE | HJ | JE | JE | JE | JE | JE | JK | JK | KF | KF | KF | KF | KE | KE | KF |
| 470 pF | 471 | F | G | J | K | : M | HE | HE | HE | HE | HE | HE | HJ | JE | JE | JE | JE | JE | JK | JK | KF | KF | KF | KF | KE | KE | KF |
| 510 pF | 511 | F | G | J | K | M | HE | HE | HE | HE | HG | HE | HJ | JK | JK | JK | JK | JK | JK | JL | KF | KF | KF | KF | KE | KE | KF |
| 560 pF | 561 | F | G | J | K | M | HE | HE | HE | HE | HG | HE | HJ | JK | JK | JK | JK | JK | JK | JL | KF | KF | KF | KF | KE | KE | KF |
| 620 pF | 621 | F | G | J | K | M | HE | HE | HE | HE | HG | HG | HK | JE | JE | JE | JK | JK | JK | JL | KF | KF | KF | KF | KE | KF | KH |
| 680 pF | 681 | F | G | J | K | M | HE | HE | HE | HE | HG | HG | НК | JE | JE | JE | JK | JK | JK | JL | KF | KF | KF | KF | KE | KF | KH |
| Rated Voltage (VDC) | | | | ge | 500 | 630 | 1,000 | 1,500 | 2,000 | 2,500 | 3,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 2,500 | 3,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 2,500 | 3,000 | | |
| Capacitance Cap Code Voltage Code | | | | de | С | В | D | F | G | z | н | С | В | D | F | G | Z | Н | C | В | D | F | G | z | Н | | |
| | | | Cas S | se S eri | Size es | e/ | | | C | 1825 | S | | 1 | | | C | 2220 | S | | | | | C | 2225 | S | | |

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Table 1B – Capacitance Range/Selection Waterfall (1825 – 2225 Case Sizes) cont.

| | | C | as S | e e | Si rie | ze s | e/ | | | C | 1825 | 55 | | | | | C | 2220 | os | | | | | C | 2225 | 55 | | |
|-------------|-----------------------|------------------------|---------|--------|-----------|---------|----|-----|-----|-----------------|-------|-------|-------|-------|--------|--------|--------|---------|---------------|-------|-------|-----|-----|-------|-------|-------|-------|-------|
| Canacitance | Сар | · ا | Volt | ag | e C | ode | e | С | В | D | F | G | z | н | C | В | D | F | G | z | н | С | В | D | F | G | z | н |
| Gapacitance | Code | F | ate | ed \ | Volt | ag | e | 500 | 630 | 00 ⁽ | ,500 | 000 | ,500 | 000 | 500 | 630 | 000 | ,500 | 000 | ,500 | 000 | 200 | 630 | 8 | ,500 | 000 | ,500 | 000' |
| | | | Cap | | ita | nc | e | | _ | - | - | 7 | 7 | Pro | duct A | vaila | bility | and C | ∣ ∾ hip Tl | ickne | ss Co | des | - | - | - | 7 | 7 | m |
| | | | To | ler | ran | ce | - | | | | | | | S | ee Tab | le 2 f | or Chi | ip Thio | cknes | s Dim | ensio | ns | | | | | | |
| 750 pF | 751 | F | G | | J | K | М | HE | HE | HE | HG | HG | HG | | JE | JE | JE | JK | JK | JK | JN | KE | KE | KE | KF | KE | KF | KJ |
| 820 pF | 821 | F | G | | J | Κ | М | HE | HE | HE | HG | HG | HG | | JE | JE | JE | JK | JK | JK | JN | KE | KE | KE | KF | KE | KF | KJ |
| 910 pF | 911 | F | G | | J | K | М | HE | HE | HE | HG | HG | HG | | JK | JK | JK | JK | JK | JK | JN | KE | KE | KE | KF | KE | KF | KJ |
| 1,000 pF | 102 | F | G | | J | K | М | HE | HE | HE | HG | HG | HG | | JK | JK | JK | JK | JK | JK | JN | KE | KE | KE | KF | KE | KF | KJ |
| 1,100 pF | 112 | F | G | | J | K | М | HE | HE | HE | HG | HG | HJ | | JK | JK | JK | JK | JK | JL | | KE | KE | KE | KF | KF | KF | |
| 1,200 pF | 122 | F | G | | J | Κ | М | HE | HE | HE | HG | HG | HJ | | JK | JK | JK | JK | JK | JL | | KE | KE | KE | KF | KF | KF | |
| 1,300 pF | 132 | F | G | | J | Κ | М | HE | HE | HE | HG | HE | HK | | JK | JK | JK | JK | JE | JL | | KE | KE | KE | KF | KF | KH | |
| 1,500 pF | 152 | F | G | • | J | K | М | HE | HE | HE | HG | HE | HK | | JK | JK | JK | JK | JE | JL | | KE | KE | KE | KF | KF | KH | |
| 1,600 pF | 162 | F | G | • | J | K | М | HG | HG | HG | HG | HG | | | JK | JK | JK | JK | JE | JN | | KE | KE | KE | KF | KE | KH | |
| 1,800 pF | 182 | F | G | • | J | K | М | HG | HG | HG | HG | HG | | | JK | JK | JK | JK | JE | JN | | KE | KE | KE | KF | KE | KH | |
| 2,000 pF | 202 | F | G | | J | K | М | HG | HG | HG | HE | HJ | | | JK | JK | JK | JE | JK | | | KE | KE | KE | KF | KF | KJ | |
| 2,200 pF | 222 | F | G | | J | K | М | HG | HG | HG | HE | HJ | | | JK | JK | JK | JE | JK | | | KE | KE | KE | KF | KF | KJ | |
| 2,400 pF | 242 | F | G | | J | K | М | HG | HG | HG | HE | HK | | | JK | JK | JK | JE | JL | | | KE | KE | KE | KE | KH | | |
| 2,700 pF | 272 | F | G | | J | K | М | HG | HG | HG | HE | HK | | | JK | JK | JK | JE | JL | | | KE | KE | KE | KE | KH | | |
| 3,000 pF | 302 | F | G | | J | K | М | HG | HG | HG | HG | HK | | | JK | JK | JK | JK | JN | | | KE | KE | KE | KE | KJ | | |
| 3,300 pF | 332 | F | G | | J | K | М | HG | HG | HG | HG | HK | | | JK | JK | JK | JK | JN | | | KE | KE | KE | KE | KJ | | |
| 3,600 pF | 362 | F | G | | J | K | М | HG | HG | HG | HJ | | | | JK | JK | JK | JK | JN | | | KF | KF | KF | KF | KJ | | |
| 3,900 pF | 392 | F | G | | J | Κ | М | HG | HG | HG | HJ | | | | JK | JK | JK | JK | JN | | | KF | KF | KF | KF | KJ | | |
| 4,300 pF | 432 | F | G | | J | Κ | М | HG | HG | HG | HJ | | | | JK | JK | JK | JL | | | | KF | KF | KF | KH | | | |
| 4,700 pF | 472 | F | G | | J | K | М | HG | HG | HG | HJ | | | | JK | JK | JK | JL | | | | KF | KF | KF | KH | | | |
| 5,100 pF | 512 | F | G | | J | K | М | HG | HG | HG | HK | | | | JK | JK | JK | JN | | | | KF | KF | KF | KH | | | |
| 5,600 pF | 562 | F | G | | J | K | М | HG | HG | HG | HK | | | | JK | JK | JK | JN | | | | KF | KF | KF | KH | | | |
| 6,200pF | 622 | F | G | | J | K | М | HJ | HJ | HJ | | | | | JK | JK | JK | JN | | | | KF | KF | KF | KJ | | | |
| 6,800pF | 682 | F | G | | J | K | М | HJ | HJ | HJ | | | | | JK | JK | JK | JN | | | | KF | KF | KF | KJ | | | |
| 7,500pF | 752 | F | G | | J | K | М | HJ | HJ | HJ | | | | | JL | JL | JL | | | | | KF | KF | KF | | | | |
| 8,200 pF | 822 | F | G | | J | κ | М | HJ | HJ | HJ | | | | | JL | JL | JL | | | | | KF | KF | KF | | | | |
| 9,100 pF | 912 | F | G | | J | Κ | М | ΗK | HK | HK | | | | | JL | JL | JL | | | | | KH | KH | KH | | | | |
| 10,000 pF | 103 | F | G | | J | Κ | М | ΗK | HK | HK | | | | | JL | JL | JL | | | | | KH | KH | KH | | | | |
| 12,000 pF | 123 | F | G | | J | Κ | М | | | | | | | | JN | JN | JN | | | | | КН | KH | KH | | | | |
| 15,000 pF | 153 | F | G | | J | K | М | | | | | | | | | | | | | | | KJ | KJ | KJ | | | | |
| | | Rated Voltage (VDC) | | | | | e | 500 | 630 | 1,000 | 1,500 | 2,000 | 2,500 | 3,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 2,500 | 3,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 2,500 | 3,000 |
| Capacitance | Cap Code Voltage Code | | | | e | C | В | D | F | G | Z | н | С | В | D | F | G | z | Н | С | В | D | F | G | Z | Н | | |
| | Case Size/ Series | | | | | | | | (| C1825 | S | | | | | C | 2220 | S | | | | | C | 2225 | S | | | |

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Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic | Quantity |
|-----------|-------------------|------------------------------------|---------|----------------------|---------|----------|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| ED | 1200 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| | 1200 | 1.00 ± 0.20 | 0 | | 2,500 | |
| | 1200 | 1.20 ± 0.15 1.60 ± 0.15 | 0 | | 2,500 | |
| EG | 1200 | 1.00 ± 0.15 1.60 ± 0.25 | 0 | 0 | 2,000 | 8,000 |
| FG | 1200 | 1.00 ± 0.25 | 0 | 0 | 2,000 | 10 000 |
| FI | 1210 | 1.25 ± 0.15 1 40 + 0 15 | 0 | 0 | 2,000 | 8 000 |
| FO | 1210 | 1 50 + 0 20 | 0 | 0 | 2,000 | 8 000 |
| FH | 1210 | 1.55 + 0.15 | 0 | 0 | 2,000 | 8,000 |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FK | 1210 | 2.10 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1,000 | 4,000 |
| LA | 1808 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| LB | 1808 | 1.60 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| LC | 1808 | 2.00 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GD | 1812 | 1.25 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GE | 1812 | 1.30 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GH | 1812 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GK | 1812 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GL | 1812 | 1.90 ± 0.20 | 0 | 0 | 500 | 2,000 |
| GM | 1812 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| GO | 1812 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| HE | 1825 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| HG | 1825 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| | 1020 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| | 1020 | 2.50 ± 0.20 1 40 \pm 0.15 | 0 | 0 | 1 000 | 2,000 |
| JE | 2220 | 1.40 ± 0.13 1.60 + 0.20 | 0 | 0 | 1,000 | 4,000 |
| IG | 2220 | 1 70 + 0 15 | 0 | 0 | 1,000 | 4,000 |
| JI | 2220 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| JN | 2220 | 2 50 + 0 20 | Ő | Ő | 500 | 2,000 |
| KE | 2225 | 1.40 ± 0.15 | Ő | 0 | 1.000 | 4.000 |
| KF | 2225 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| KH | 2225 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| KJ | 2225 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic | Quantity |

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".



Table 2B – Bulk Packaging Quantities

| Dookoo | uing Tuno | Loose P | ackaging |
|----------|------------------------|------------------------|-------------------------|
| Раскад | ling lype | Bulk Bag | (default) |
| Packagi | ng C-Spec ¹ | N | /A ² |
| Cas | e Size | Packaging Quantities (| (pieces/unit packaging) |
| EIA (in) | Metric (mm) | Minimum | Maximum |
| 0402 | 1005 | | |
| 0603 | 1608 | | |
| 0805 | 2012 | | 50,000 |
| 1206 | 3216 | | |
| 1210 | 3225 | 1 | |
| 1808 | 4520 | | |
| 1812 | 4532 | | |
| 1825 | 4564 | | 20,000 |
| 2220 | 5650 | | |
| 2225 | 5664 | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial Grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive Grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size | Metric Size | | Dens Maxi Land Pi | sity Lev mum (I rotrusio | vel A: Most) on (mm |) | | Dens Media Land Pi | sity Lev an (Nor rotrusio | vel B: minal) on (mm |) | | Dens Minir Land Pr | sity Lev num (L rotrusio | vel C: .east) on (mm |) |
|-------------|----------------|------|-------------------------|--------------------------------|---------------------------|------|------|--------------------------|---------------------------------|----------------------------|------|------|--------------------------|--------------------------------|----------------------------|------|
| Coue | Coue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 1.50 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 |
| 1812 | 4532 | 2.15 | 1.60 | 3.60 | 6.90 | 4.60 | 2.05 | 1.40 | 3.50 | 6.00 | 4.00 | 1.95 | 1.20 | 3.40 | 5.30 | 3.70 |
| 1825 | 4564 | 2.15 | 1.60 | 6.90 | 6.90 | 7.90 | 2.05 | 1.40 | 6.80 | 6.00 | 7.30 | 1.95 | 1.20 | 6.70 | 5.30 | 7.00 |
| 2220 | 5650 | 2.75 | 1.70 | 5.50 | 8.20 | 6.50 | 2.65 | 1.50 | 5.40 | 7.30 | 5.90 | 2.55 | 1.30 | 5.30 | 6.60 | 5.60 |
| 2225 | 5664 | 2.70 | 1.70 | 6.90 | 8.10 | 7.90 | 2.60 | 1.50 | 6.80 | 7.20 | 7.30 | 2.50 | 1.30 | 6.70 | 6.50 | 7.00 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.




Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Termination Finish | | | |
|--|-----------------------|-----------------------|--|--|
| Tomeredure | SnPb | 100% Matte Sn | | |
| Preheat/Soak | | | | |
| Temperature Minimum (T _{smin}) | 100°C | 150°C | | |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C | | |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds | | |
| Ramp-Up Rate (T_L to T_P) | 3°C/second maximum | 3°C/second maximum | | |
| Liquidous Temperature (T _L) | 183°C | 217°C | | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds | | |
| Peak Temperature (T _P) | 235°C | 260°C | | |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 30 seconds maximum | | |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | 6°C/second maximum | | |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum | | |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test Condition | Limits |
|--|----------------|---|--|
| Visual and Mechanical | KEMET Internal | No defects that may affect performance (10X) | Dimensions according KEMET Spec Sheet |
| Capacitance (Cap) | KEMET Internal | C ≤ 1,000 pF Frequency: 1 MHz ±100 kHz Voltage*:1.0 V _{rms} ±0.2 V C > 1,000 pF Frequency: 1 kHz ±50 Hz Voltage: 1.0 V _{rms} ±0.2 V * See part number specification sheet for voltage | Within Tolerance |
| Dissipation Factor (DF) | KEMET Internal | C ≤ 1,000 pF Frequency: 1 MHz ±100 kHz Voltage*:1.0 V_{rms} ±0.2 V C > 1,000 pF Frequency: 1 kHz ±50 Hz Voltage: 1.0 V_{rms} ±0.2 V * See part number specification sheet for voltage | Within Specification Dissipation factor (DF) maximum limit at 25°C = 0.1% |
| Insulation Resistance (IR) | KEMET Internal | 500 VDC applied for 120 ±5 seconds at 25°C | Within Specification To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ limit. Select the lower of the two limits. 1,000 megohm microfarads or 100 GΩ. |
| Temperature Coefficient of Capacitance (TCC) | KEMET Internal | Capacitance change with reference to +25°C and 0 VDC applied.* See part number specification sheet for voltageStepTemperature (°C)1+25°C2-55°C3+25°C (Reference Temperature)4+125°C | Within Specification: ±30 ppm / °C |



Table 4 – Performance & Reliability: Test Methods and Conditions cont.

| Stress | Reference | Test Condition | Limits | |
|--|-------------------------|--|--|--|
| | | See Dielectric Withstanding Voltage (DWV) Table (5 ±1 seconds and charge/discharge not exceeding 50 mA) | | |
| | | EIA Case Size 500 V 630 V ≥ 1,000 V | | |
| | | 0603 130% of rated voltage | Contract Limit | |
| Dielectric | | 0805 < 620pF 150% of rated voltage ≥ 620pF 130% of rated voltage | DF: Initial Limit | |
| Withstanding | KEMET Internal | 1206 < 5.1nF 150% of rated voltage ≥ 5.1nF 130% of rated voltage | IR: Initial Limit | |
| Voltage (DWV) | | 1210 < 7.5 150% of rated voltage ≥ 7.5 150% of rated voltage 120% | Withstand test voltage without | |
| | | 1808 of rated voltage voltage | insulation breakdown of damage. | |
| | | $\frac{1812}{212} \ge 121F + 130\% \text{ of rated voltage}$ | | |
| | | 1825 ≥ 22nF 130% of rated voltage | | |
| | | 2220 ≥ 27nF 130% of rated voltage < 33nF 150% of rated voltage | | |
| | | 2225 ≥ 33nF 130% of rated voltage | | |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | KEMET Internal | Maximum % capacitance loss/decade hour | 0% Loss/Decade Hour | |
| | | Shear stress test per specific case size, Time: 60 ±1 second. | | |
| Terminal Strength | KEMET Internal | Case Size Force 0603 5N 0805 9N ≥ 1206 18N | No evidence of mechanical damage | |
| Board Flex | AEC-Q200-005 | Standard Termination System 2.0 mm Flexible Termination System 3.0 mm Test Time: 60± 5 seconds Ramp Time: 1 mm/second | No evidence of mechanical damage | |
| Solderability | J-STD-002 | Condition: 4 hours ±15 minutes at 155°C dry bake apply all methods Test 245 ±5°C (SnPb & Pb-Free) | Visual Inspection. 95% coverage on termination. No leaching | |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (~55°C to +125°C) 2 - 3 cycles per hour Soak Time: 1 or 5 minute | Measurement at 24 hours ±4 hours after test conclusion. Cap: Initial Limit DF: Initial Limit IR: Initial Limit | |



Table 4 – Performance & Reliability: Test Methods and Conditions cont.

| Stress | Reference | Test Condition | Limits |
|---------------------------|---------------------------|---|---|
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and 200 VDC maximum Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5% |
| Moisture Resistance | MIL-STD-202 Method 106 | Number of Cycles Required: 10, 24 hours per cycle. Steps 7a and 7b not required | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Thermal Shock | MIL-STD-202 Method 107 | Number of Cycles Required: 5, (-55°C to 125°C) Dwell time 15 minutes. | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| High Temperature Life | MIL-STD-202 | 1,000 hours at 125°C with 1.2 X rated voltage applied. | Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift |
| Storage Life | Method 108 | 1,000 hours at 150°C, Unpowered | IR: 10% of Initial Limit DF Limits Maximum: 0.5% |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Test from 10 – 2,000 Hz | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Mechanical Shock | MIL-STD-202 Method 213 | 1,500 g's 0.5 millisecond Half-sine, Velocity Change: 15.4 feet/second (Condition F) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents. | Visual Inspection 10X Readable marking, no decoloration or stains. No physical damage. |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction



Capacitor Marking (Optional)

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punched Paper | | |
|----------------------|------|---------|--------------------|---------------|--------------------|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | (W)* | Pitch | (P ₁)* | Pitch | (P ₁)* | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 | |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | |
| Array 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|---|---------------------------------------|----------------------------------|------------------------------|-----------------------------|------------------------------|-----------------------------|----------------------------------|---------------------|---------------------------|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.60 30 (0.02 (1.181) | 0.600 (0.024) | 0.600 4) (0.024) | 0.100 (0.004) |
| 16 mm | | (0.059) | | | | | | | |
| | | , | Variable Dime | ensions — Mil | limeters (Incl | nes) | | | |
| Tape Size Pitch B ₁ Maximum E ₂ Minimum F P ₁ T ₂ Maximum W Maximum A ₀ ,B ₀ & F | | | | | | | | , & K ₀ | |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | Note 5 | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_a and B_a are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | | | |
|--|---------------------------------------|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|--|
| Tape Size | D _o | G Minimum | R Reference Note 2 | | | | | | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) | | |
| | | Variable D | imensions — M | illimeters (Inche | es) | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | | |
| 8 mm | n Single (4 mm) (0.246) (0 | | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius



Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs) Floating Electrode (FE-CAP), High Voltage COG Dielectric, 500 – 3,000 VDC (Commercial & Automotive Grade)



Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | |
|--|----------------------|---------------------------------------|--|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | |
| 8 mm | 178 ±0.20 | | | | | | |
| 12 mm | (7.008 ±0.008) Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | |
| 16 mm | (13.000 ±0.008) | | | | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Solder Fluxes and Cleaning

The use of water-soluble fluxes provides advantages of excellent solderability due to high activation. However, these fluxes contain organic acids that can induce arcing under high DC or AC voltages. Notable problem areas are underneath the MLCC where flux can be trapped between the ceramic material and PCB. It is therefore critical that PCBs are properly cleaned to remove all flux residue to maintain reliability.

Coating for High Voltage MLCCs

For MLCC ratings \geq 1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

| Dielectric | CTE (ppm/°C) |
|----------------------------|--------------|
| Class II BaTiO₃ | 10.7 |
| Class I CaZrO ₃ | 9.8 |

Slits in PCB

It is recommended to apply a slit in the PCB under the MLCC to improve washing of flux residue that may get trapped underneath. In some cases, it is not possible to slit entirely through the PCB due to underlying metal planes. It is also acceptable to apply a recessed slit under the MLCC which will also promote cleaning.

- Recommended for case sizes ≥1206
- The width (w) of the slit should be 1mm
- Length of the slit should be as short as possible to prevent damaging the MLCC due to mechanical stress of the PCB.
- Slits also reduce the risk of solder balls under MLCC which decreased the creepage distance.



Solder Resist

If a slit cannot be applied as above, it is recommended to not use solder resist directly under the MLCC. The use of solder resist material reduces the distance between MLCC ceramic material and PCB thus making it difficult to clean.

Solder Balls

Improper reflow techniques and/or improper washing can induce solder balls under or adjacent to the MLCC. Solder balls reduce the creepage distance between the MLCC terminations and increase the risk of arcing or damage to the ceramic material. To reduce the risk of solder balls:

- Follow KEMET's solder recommendations as outlined in the datasheet.
- If performing a cleaning procedure, properly clean the PCB per KEMET's cleaning recommendations.
- Add slit to the PCB as shown above.





Floating Electrode (FF-CAP), High Voltage with Flexible Termination COG Dielectric, 500 – 3,000 VDC (Commercial & Automotive Grade)



Overview

KEMET's Floating Electrode High Voltage with Flexible Termination capacitor (FF-CAP) combines two existing KEMET technologies - Floating Electrode and Flexible Termination. The floating electrode component utilizes a a cascading / serial electrode design configured to form multiple capacitors in series within a single monolithic structure. This unique configuration results in enhanced voltage and ESD performance over standard capacitor designs while allowing for a fail-open condition if mechanically damaged (cracked). The flexible termination component utilizes a conductive silver epoxy between the base metal and nickel barrier layers of KEMET's standard termination system in order to establish pliability while maintaining terminal strength, solderability and electrical performance. Both technologies address the primary failure mode of MLCCs-flex cracks, which are typically the result of excessive tensile and shear stresses produced during board flexure and thermal cycling.

Combined with the COG (NP0) are suited for resonant circuit applications or those where Q and stability of capacitance characteristics are required, exhibit no change in capacitance with respect to time and voltage and boasts a negligible change in capacitance with reference to ambient temperature. Capacitance change is limited to ± 30 ppm/°C from -55°C to ± 125 °C.

Whether under-hood or in-cabin, these capacitors are designed to provide reliable performance in mission and safety critical automotive circuits. Stricter testing protocol and inspection criteria have been established for automotive grade products in recognition of potentially harsh environmental conditions. KEMET automotive grade series capacitors meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.



Ordering Information

| С | 2225 | Y | 393 | J | С | G | Α | С | TU |
|---------|--|--|---|---|---|------------|-------------------------|--|--|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ¹ | Packaging/ Grade (C-Spec) |
| | 0805 1206 1210 1808 1812 1825 2220 2225 | Y = Floating Electrode with Flexible Termination | Two significant digits and number of zeros | $B = \pm 0.10 \text{ pF}$ C = ±0.25 pF D = ±0.5 pF F = ±1% G = ±2% J = ±5% K = ±10% M = ±20% | C = 500 B = 630 D = 1,000 F = 1,500 G = 2,000 Z = 2,500 H = 3,000 | G = COG | A = N/A | C = 100% Matte Sn L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

¹ Additional termination finish options may be available. Contact KEMET for details. ¹ SnPb termination finish option is not available on automotive grade product.

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Packaging C-Spec Ordering Options Table

| Packaging Type | Packaging/Grade Ordering Code (C-Spec) |
|---------------------|---|
| Commerc | ial Grade ¹ |
| Bulk Bag | Not required (Blank) |
| 7" Reel / Unmarked | TU |
| 13" Reel / Unmarked | 7210 |
| Automoti | ve Grade ² |
| 7" Reel | AUTO |
| 13" Reel / Unmarked | AUT07210 |

¹ Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging.

¹ The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices. For more information see "Capacitor Marking". ² Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information".

² For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information".

² All Automotive packaging C-Specs listed exclude the option to laser mark components. The option to laser mark is not available on these devices. For more information see "Capacitor Marking".

Benefits

- Floating Electrode/fail open design
- · AEC-Q200 automotive qualified
- Operating temperature range of -55°C to +125°C
- Superior flex performance (up to 5 mm)
- Capacitance offerings ranging from 1 pF to 0.15 μF
- DC voltage ratings of 500 V, 630 V, 1 KV, 1.5 KV, 2 KV, 2.5 KV and 3 KV
- EIA 0805, 1206, 1210, 1808, 1812, 1825, 2220 and 2225
- Extremely low ESR and ESL
- High ripple current capability
- · No capacitance shift with voltage
- Negligible capacitance shift with respect to temperature
- No piezoelectric noise
- · Lead (Pb)-Free, RoHS and REACH compliant

Applications

- EV/HEV (drive systems, charging)
- High frequency power converters
- Wide bandgap (WBG), silicon carbide (SiC) and gallium nitride (GaN) systems
- Snubber (high dV/dT)
- · Resonant circuits (LLC, Wireless Charging, etc)
- Timing
- Filtering
- ESD protection



Automotive C-Spec Information

KEMET automotive grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC-Q200, Stress Test Qualification for Passive Components. These products are supported by a Product Change Notification (PCN) and Production Part Approval Process warrant (PPAP).

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO." This C-Spec was developed in order to better serve small and medium-sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET OEM automotive customers and are not granted the same "privileges" as other automotive C-Specs. Customer PCN approval and PPAP request levels are limited (see details below.)

Product Change Notification (PCN)

The KEMET product change notification system is used to communicate primarily the following types of changes:

- · Product/process changes that affect product form, fit, function, and/or reliability
- Changes in manufacturing site
- Product obsolescence

| KEMET Automotive | Customer Notifica | tion Due To: | Days Prior To |
|-----------------------------|----------------------------------|---------------|------------------|
| C-Spec | Process/Product change | Obsolescence* | Implementation |
| KEMET assigned ¹ | Yes (with approval and sign off) | Yes | 180 days minimum |
| AUTO | Yes (without approval) | Yes | 90 days minimum |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

Production Part Approval Process (PPAP)

The purpose of the Production Part Approval Process is:

- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive | | PPAP (Product | Part Approval | Process) Leve | I |
|-----------------------------|---|---------------|---------------|---------------|---|
| C-Spec | 1 | 2 | 3 | 4 | 5 |
| KEMET assigned ¹ | • | • | • | • | • |
| AUTO | | | 0 | | |

¹ KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

• Part number specific PPAP available

• Product family PPAP only



Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|-------------------------------|-----------------|-------------------------------|----------------------------|-----------------------|
| 0805 | 2012 | 2.00 (0.079) ±0.30 (0.012) | 1.25 (0.049) ±0.30 (0.012) | | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder Wave or |
| 1206 | 3216 | 3.30 (0.130) ±0.40 (0.016) | 1.60 (0.063) ±0.35(0.013) | | 0.60 (0.024) ±0.25 (0.010) | | Solder Reflow |
| 1210 | 3225 | 3.30 (0.130) ±0.40 (0.016) | 2.60(0.102) ±0.30(0.012) | | 0.60 (0.024) ±0.25 (0.010) | | |
| 1808 | 4520 | 4.70 (0.185) ±0.50 (0.020) | 2.00 (0.079) ±0.20 (0.008) | See Table 2 for | 0.70 (0.028) ±0.35 (0.014) | | |
| 1812 | 4532 | 4.50 (0.178) ±0.40 (0.016) | 3.20 (0.126) ±0.30 (0.012) | Thickness | 0.70 (0.028) ±0.35 (0.014) | N/A | Solder Reflow |
| 1825 | 4564 | 4.60 (0.181) ±0.40 (0.016) | 6.40 (0.252) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | Only |
| 2220 | 5650 | 5.90 (0.232) ±0.75 (0.030) | 5.00 (0.197) ±0.40 (0.016) | _ | 0.70 (0.028) ±0.35 (0.014) | _ | |
| 2225 | 5664 | 5.90 (0.232) ±0.75 (0.030) | 6.40 (0.248) ±0.40 (0.016) | | 0.70 (0.028) ±0.35 (0.014) | | |



Table 1A – Capacitance Range/Selection Waterfall (0805 – 1808 Case Sizes)

| | | | Cas S | e S erie | ize/ es | 1 | C | 080 | 5Y | | C | 1206 | 5Y | | | С | 1210 | Y | | | | С | 1808 | BY | | |
|----------------|---------------------|---|-----------|----------------|-------------|-----|-----|------|-------|----------|-----|----------|---------------|----------------|-----------------|------------------|---------------|---------------|---------------|---------------|-----------|------|------|------|------|------|
| a | Capacitance | | Volt | age (| Code | | C | В | D | C | В | D | F | G | С | В | D | F | G | C | В | D | F | G | z | Н |
| Capacitance | Code | | Rate | d Vo (VDC | ltage ;) | | 500 | 630 | 1,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| | | Γ | Cap To | acita lerai | ance nce | | | | | | | Pro S | duct ee Ta | Avail ble 2 | labili for (| ty and Chip T | d Chi hick | p Thi ness | ckne: Dime | ss Co nsio | des ns | | | | | |
| 1.0 - 9.1 pF* | 109 - 169* | В | 10 | C | | D | DG | DG | DG | | | | | | | | | | 2 mile | LB | LB | LB | LB | LB | LB | LB |
| 10 pF | 100 | F | G | J | К | м | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 11 pF | 110 | F | G | J | К | м | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 12 pF | 120 | F | G | J | К | м | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 13 pF | 130 | F | G | J | к | м | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 15 pF | 150 | F | G | J | К | м | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 16 pF | 160 | F | G | J | ĸ | M | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 18 nF | 180 | F | G | J | ĸ | M | DG | DG | DG | FS | FS | FS | FS | FS | FM | FM | FM | FM | FM | I B | IB | IB | IB | IB | IB | IB |
| 20 nF | 200 | F | G | Ĵ | ĸ | м | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LR | LR | LB | LR | LB | LB | LR |
| 20 pr 22 nF | 220 | F | G | , i | ĸ | м | DG | DG | DG | ES | ES | FS | FS | FS | FM | FM | FM | FM | FM | IB | IR | IB | IR | IR | IB | IB |
| 22 pT 24 nF | 240 | F | G | Ĭ | K | M | DG | DG | DG | ES | FS | FS | FS | ES | FM | FM | FM | FM | FM | IR | IR | LB | LB | LB | LB | LB |
| 27 pF | 240 | F | G | Ĭ | ĸ | M | | DG | DG | FS | FS | FS | FS | FS | FM | FM | FM | FM | FM | IR | IR | IR | IR | IR | IB | IB |
| 27 pi 30 pE | 300 | F | G | 1 | ĸ | M | | DG | DC | FS | FS | FS | FS | FS | EM | FM | FM | FM | FM | | IR | IB | IR | IR | | |
| 22 pE | 220 | | G | 1 | | M | | DC | DC | EQ | EQ | EQ | EQ | EQ | EM | EM | EM | | EM | | | | | | | |
| 35 pF 26 pE | 260 | | 0 | 1 | | | | | | EO | EO | EO | EO | EO | | EM | EM | | EM | | | | | | | |
| 30 µF | 200 | | G | J | N IV | IVI | | | | EO | EO | EO | EO | EO | | | | | | | | | | | | |
| 39 µF | 390 | | 6 | J | ĸ | | | | | ES | ES | ES | ES | ES | | | | | | | | | | | | LD |
| 43 pF | 430 | | 6 | J | K | M | | DG | DG | ES FO | ES | ES | ES | ES | FM | | FM | | | LB | LB | LB | LB | | | LB |
| 47 pF | 470 | | 6 | J | K | M | | DG | DG | ES FO | ES | ES | ES | ES | FM | FM | FM | FIM | FM | LB | LB | LB | LB | LB | LB | LB |
| 51 pF | 510 | | G | J | K | M | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 56 pF | 560 | F | G | J | K | M | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 62 pF | 620 | | G | J | K | M | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 68 p⊦ | 680 | | G | J | K | M | DG | DG | DG | ES | ES | ES | ES | ES | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 75 pF | 750 | F | G | J | K | M | DG | DG | DG | ES | ES | ES | ES | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 82 pF | 820 | F | G | J | K | M | DG | DG | DG | ES | ES | ES | ES | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 91 pF | 910 | F | G | J | K | M | DG | DG | DG | ES | ES | ES | ES | EF | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LB | LB |
| 100 pF | 101 | F | G | J | K | M | DG | DG | DG | ES | ES | ES | ES | EF | FΜ | FM | FM | FM | FM | LB | LB | LB | LB | LB | LC | LB |
| 110 pF | 111 | F | G | J | K | M | DG | DG | DG | ES | ES | ES | ES | EU | FM | FM | FM | FM | FM | LB | LB | LB | LB | LB | LC | LB |
| 120 pF | 121 | F | G | J | K | M | DG | DG | DG | ES | ES | ES | ES | EU | FZ | FZ | FZ | FM | FM | LA | LA | LA | LA | LB | LC | LB |
| 130 pF | 131 | F | G | J | K | M | DG | DG | DG | ES | ES | ES | ES | EU | FZ | FZ | FZ | FM | FM | LA | LA | LA | LA | LB | LC | LC |
| 150 pF | 151 | F | G | J | K | M | DG | DG | DG | ES | ES | ES | EF | EU | FZ | FZ | FZ | FM | FM | LA | LA | LA | LA | LB | LC | LC |
| 160 pF | 161 | F | G | J | K | M | DG | DG | DG | ES | ES | ES | EF | EU | FZ | FZ | FZ | FM | FM | LA | LA | LA | LA | LC | LC | LC |
| 180 pF | 181 | F | G | J | K | M | DG | DG | DG | ES | ES | ES | EF | EU | FZ | FZ | FZ | FM | FM | LA | LA | LA | LA | LC | LC | LC |
| 200 pF | 201 | F | G | J | K | M | DG | DG | DG | ES | ES | ES | EU | EU | FZ | FZ | FZ | FM | FM | LA | LA | LA | LA | LC | LC | |
| 220 pF | 221 | F | G | J | K | M | DG | DG | DG | ES | ES | ES | EU | EU | FZ | FZ | FZ | FM | FM | LA | LA | LA | LA | LC | LC | |
| 240 pF | 241 | F | G | J | K | M | DG | DG | DG | ES | ES | ES | EU | EU | FZ | FZ | FZ | FK | FK | LA | LA | LA | LB | LC | LC | |
| | | | Rate | d Vo (VDC | ltage | | 500 | 630 | 1,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| Capacitance | Capacitance Code | | Volt | age (| , Code | | c | В | D | С | В | D | F | G | С | В | D | F | G | C | В | D | F | G | Z | H |
| | Gue | C | ase S | Size/ | /Seri | es | c | 0805 | ξY | | C | 1206 | Ŷ | | | C | 1210 | Y | | | | C | 1808 | Y | | |



Table 1A - Capacitance Range/Selection Waterfall (0805 - 1808 Case Sizes) cont.

| | | | Cas S | se S Serie | ize, es | / | С | 080 | 5Y | | С | 1200 | 5Y | | | С | 121(| Y | | | | С | 1808 | BY | | |
|-------------|-------------|---|-----------|---------------|-------------|----|-----|-------|---------|-----|-----|-----------|---------------|----------------|-----------------|------------------|----------------|---------------|---------------|---------------|-----------|------|------|------|------|------|
| Osmasitanaa | Capacitance | | Volt | age | Code | | c | B | D | С | В | D | F | G | С | В | D | F | G | С | В | D | F | G | z | н |
| Сарасіталсе | Code | | Rate | ed Vo (VDC | ltage ;) | 9 | 500 | 630 | 1,000 | 500 | 630 | 1,000 | 1,500 | 2,000 | 500 | 630 | 1000 | 1500 | 2000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| | | | Cap To | acit lera | ance nce | | | | | | | Pro S | duct ee Ta | Avail ble 2 | labili for (| ty and Chip 1 | d Chi Thick | p Thi ness | cknes Dime | ss Co nsio | des ns | | | | | |
| 270 pF | 271 | F | G | J | K | М | DG | DG | DG | ES | ES | ES | EU | EU | FZ | FZ | FZ | FK | FK | LA | LA | LA | LB | LC | LC | |
| 300 pF | 301 | F | G | J | K | M | | | | ES | ES | EF | EU | | FΖ | FZ | FZ | FK | FK | LA | LA | LA | LB | LC | LC | |
| 330 pF | 331 | F | G | J | K | M | | | | ES | ES | EF | EU | | FZ | FZ | FZ | FK | FK | LA | LA | LA | LB | LC | LC | |
| 360 pF | 361 | F | G | J | K | M | | | | ES | ES | EF | EU | | FZ | FZ | FZ | FK | FS | LA | LA | LA | LB | LA | LC | |
| 390 pF | 391 | F | G | J | K | M | | | | ES | ES | EF | EU | | FZ | FZ | FZ | FK | FS | LA | LA | LA | LB | LA | LC | |
| 430 pF | 431 | F | G | J | K | M | | | | ES | ES | EU | EU | | FM | FM | FM | FS | FS | LB | LB | LB | LC | LA | | |
| 470 pF | 471 | F | G | J | K | M | | | | ES | ES | EU | EU | | FM | FM | FM | FS | FS | LB | LB | LB | LC | LA | | |
| 510 pF | 511 | F | G | J | K | M | | | | ES | ES | EU | EU | | FM | FM | FM | FS | FS | LB | LB | LB | LC | LB | | |
| 560 pF | 561 | F | G | J | K | M | | | | ES | ES | EU | EU | | FM | FM | FM | FS | FS | LB | LB | LB | LC | LB | | |
| 620 pF | 621 | F | G | J | K | М | | | | EU | EU | EU | | | FM | FM | FM | FS | FS | LB | LB | LB | LA | LC | | |
| 680 pF | 681 | F | G | J | K | М | | | | EU | EU | EU | | | FM | FM | FM | FS | FS | LB | LB | LB | LA | LC | | |
| 750 pF | 751 | F | G | J | K | М | | | | EU | EU | EU | | | FM | FM | FM | FS | | LB | LB | LB | LB | | | |
| 820 pF | 821 | F | G | J | K | М | | | | EU | EU | EU | | | FM | FM | FM | FS | | LB | LB | LB | LB | | | |
| 910 pF | 911 | F | G | J | К | м | | | | EU | EU | EU | | | FM | FM | FM | FS | | LB | LB | LB | LB | | | |
| 1,000 pF | 102 | F | G | J | К | м | | | | EU | EU | EU | | | FM | FM | FM | FS | | LB | LB | LB | LB | | | |
| 1,100 pF | 112 | F | G | J | K | М | | | | | | | | | FK | FK | FK | FS | | LC | LC | LC | LC | | | |
| 1,200 pF | 122 | F | G | J | К | М | | | | | | | | | FK | FK | FK | FS | | LC | LC | LC | LC | | | |
| 1,300 pF | 132 | F | G | J | к | м | | | | | | | | | FS | FS | FS | | | LC | LC | LC | LC | | | |
| 1,500 pF | 152 | F | G | J | к | м | | | | | | | | | FS | FS | FS | | | LC | LC | LC | LC | | | |
| 1,600 pF | 162 | F | G | J | к | м | | | | | | | | | FS | FS | FS | | | LC | LC | LC | | | | |
| 1,800 pF | 182 | F | G | J | К | М | | | | | | | | | FS | FS | FS | | | LC | LC | LC | | | | |
| 2.000 pF | 202 | F | G | J | к | м | | | | | | | | | FS | FS | FS | | | LB | LB | LB | | | | |
| 2.200 pF | 222 | F | G | J | к | м | | | | | | | | | FS | FS | FS | | | LB | LB | LB | | | | |
| 2.400 pF | 242 | F | G | J | к | м | | | | | | | | | FS | FS | FS | | | LC | LC | LC | | | | |
| 2,700 pF | 272 | F | G | J | K | М | | | | | | | | | FS | FS | FS | | | LC | LC | LC | | | | |
| · · · | | | Rate | d Vo | Itage | | 0 | 0 | 8 | 0 | • | 8 | 8 | 8 | 0 | • | 8 | 8 | 8 | • | • | 8 | 8 | 8 | 8 | 8 |
| | Canacitanco | | | (VDC | ;) | | 50 | 63 | , 0, | 50 | 63 | ,0 1,0 | 1,5 | 2,0 | 50 | 63 | 10(| 15(| 20(| 50 | 63 | 10(| 15(| 20(| 25(| 30(|
| Capacitance | Code | | Volt | age | Code | | C | B | D | C | В | D | F | G | C | В | D | F | G | C | В | D | F | G | Z | H |
| | | c | ase | Size | /Seri | es | c | :0805 | δY | | C | 1206 | Y | | | C | 1210 | Y | | | | C | 1808 | Y | | |



Table 1B - Capacitance Range/Selection Waterfall (1812 - 2225 Case Sizes)

| | | С | as S | er | Si ie | ze/ s | | | C 1 | 81 | 2Y | | | | | C1 | 82 | 5Y | | | | | C2 | 222 | 0 Y | | | | | C2 | 22 | 5Y | | |
|------------------|-------------|---|----------|------------|--------------------|----------|----|----|------------|------|-----|---------|-----|----|-----|------|------|------------|-------------|-----------|-------|------|-----------|-----|---------------|-------|-----|-------------|----|-----|-----|-----|-----|-----|
| | Capacitance | v | olt | age | e C | ode | С | В | D | F | G | z | н | С | В | D | F | G | z | H | С | В | D | F | G | z | H | c | В | D | F | G | z | Н |
| Capacitance | Code | R | ate | d V | /olt | age | 00 | 30 | 000 | 500 | 000 | 500 | 000 | 00 | 30 | 000 | 500 | 000 | 500 | 000 | 00 | 30 | 000 | 500 | 000 | 500 | 000 | 00 | 30 | 000 | 500 | 000 | 500 | 000 |
| | | ┝ | an | (VL aci | ita | nco | Ľ, | | - | - | 7 | 7 | e | " | Dro | | | ہ اداند | ∾ nility | ຕ (and | 4 C h | in T | - hick | | ۲۹ ۲۰ - ۲۰ | 00 00 | m | 1 "' | | - | - | 7 | 7 | 3 |
| | | Ľ | To | ler | an | ce | | | | | | | | | Ś | ee T | able | 2 fo | or Ch | nip T | hic | ines | s Di | men | sior | 15 | | | | | | | | |
| 10 pF | 100 | F | G | J | J | KM | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 11 pF | 110 | F | G | j | J | KM | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 12 pF | 120 | F | G | j | J | KM | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 13 pF | 130 | F | G | | J | KM | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 15 pF | 150 | F | G | j | J | KM | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 16 pF | 160 | | G | | J I | KM | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 18 pF | 180 | | G | j | , I | KM | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 20 pF | 200 | | G | | ווי | KM | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 22 pF | 220 | | G | j | וו | KM | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 24 pF | 240 | | 6 | | ו נ י | | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | KF | KF | KF | KF | KF | KF | KF |
| 27 pF | 270 | | 6 | | ייי | KIM | GB | GB | GB | GB | GB | GB | GB | HG | HG | HG | HG | HG | HG | HG | JK | JK | JK | JK | JK | JK | JK | | KF | KF | KF | KF | KF | KF |
| 30 pr | 300 | | 6 | | ון ווו | | GB | GB | GB | GB | GB | GB | GB | ПС | но | HG | ПС | но | HG | по | | JK | JK | JK | JK | JK | JK | | | | | | KF | KF |
| 33 pr | 330 | | 6 | | ז נ ו נ | | GB | GB | GB | GB | GB | GB | GB | но | HG | HG | по | но | HG | по | | JK | JK | JK | JK | JK | JK | | | | KF | | | KF |
| 30 pF | 300 | | 6 | | ין נ ו ו | | GB | GB | GB | GB | GB | GB | GB | | по | | | | | по | | JK | | JK | JK | JK | | | | | | | | |
| 39 µr | 390 | | 0 | | , r , , | | CP | CP | CP | CP | CP | CP | CP | | | | | | | | | JK | | | | | JK | | | | | | | |
| 43 pr 47 pF | 430 | | | | ין נ ו ו | | GB | | | | | | | | | | | | | по | | JK | | JK | | | | | | | | | | |
| 47 µr 51 pc | 470 E10 | | | | ייי | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 51 pr | 510 | | | | ייי | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 50 pr | 500 | | | | ייי | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 62 pF | 620 | | 0 | | ין נ ו ו | | CP | CP | CP | CP | CP | CP | CP | | | | | ПС | | | | JK | JK | JK | JK | JK | JK | | | | | | | |
| 00 pr 75 pE | 750 | | | | ין ווו | | GB | GB | GD | GD | GD | GB | CP | | | | | | | | | JK | | | | | | | | | | | | |
| 75 µr | 750 | | | ' ' | יי | | | CP | | | | | CP | | | | | | | | | JK | | | | | | | | | | | | |
| 02 µr | 020 | | | | ין נ ו נ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 91 pr 100 pE | 101 | | 6 | | , r 1 1 | | GD | CD | CD | CD | CD | CD | CD | | | | | | | | | | | | | | | | | | | | | |
| 110 pF | 101 | | C | | , r 1 1 | | GD | GD | GD | GD | GD | GD | GD | | | | ПС | нс | | ПС | | | | | | | | | | | | | | |
| 120 pF | 101 | | C | | , , , , , , , , | | GD | CD | CD | | | | CD | | | | | | | по | | | | | | | | | | | | | | |
| 120 pF | 121 | | | | , , , , , , , , | | | GD | CD | | | | GD | | | | | | | по | | | | | | | | | | | | | | |
| 150 pF | 151 | | | | ין ע ו ו | | GV | GV | GV | GU | GV | GV | GV | | | | по | | | по | | | | | | | | | | | | | | |
| 150 pF | 151 | | | | ין י ו ו | | GK | GK | GK | GK | GK | GK | GK | | | | | | | по | | | | | | | | | | | | | | |
| 100 pF | 101 | E | 6 | | , i I I | | GK | GK | GK | GK | GK | GK | GK | | | | | | | | | JK | | JK | | | | K | KE | KE | KE | KE | KE | |
| 200 pE | 201 | | | | ין ע ו ו | | GR | CR | CR | CR | CR | | GM | | | | | | | | | | | | | | | | | | | | | |
| 200 pF | 201 | | | | ין ע ו ו | | GB | GB | GD | CP | GD | CD | GM | | | | | | | | | | | | | | | | | | | | | |
| 220 pF | 221 | | | | ייי | | CP | CR | CP | CP | CP | CLI CLI | GM | | | | | | | | | | | | | | | | | | | | | |
| 240 pF | 241 | | 6 | | ייי ויי | K M | GB | GB | GB | GB | GB | CH | GM | HE | HE | HE | HE | HE | HE | HG | | IK | IK | IK | IK | | IK | KE | KE | KE | KE | KE | KE | KE |
| 270 pF 300 pF | 301 | F | G | | , , , , | K M | GB | GB | GB | GB | GB | СH | GO | HE | HE | HE | HE | HE | HE | HG | IF | JE | JR | JE | IF | IK | IK | KE | KE | KE | KE | KE | KE | KE |
| 330 pF | 331 | F | 6 | | , r , i | K M | GB | GB | GB | GB | GB | СН | 60 | HE | HE | HE | HE | HE | HE | HG | IF | IF | IF | IF | IF | | | KE | KE | KE | KE | KE | KE | KE |
| 360 pF | 361 | F | 6 | | , r 1 | K M | GB | GB | GB | GB | CD | CK | 60 | HE | HE | HE | HE | HE | HE | HG | IF | IF | IF | IF | IF | | | KE | KE | KE | KE | KE | KE | KE |
| 300 pF | 301 | F | | | | K M | GB | GB | GB | GB | GD | CK | 60 | HE | HE | HE | HE | HE | HE | нс | IF | IE | IF | IE | IF | | | KE | KE | KE | KE | KE | KE | KE |
| 390 pF | /31 | F | 6 | | , , , , , , , | K M | GB | GB | GB | GB | CD | CK | 00 | HE | HE | HE | HE | HE | HE | ні | IF | IF | IF | IF | IF | | | | KE | KE | KE | KE | KE | KE |
| 400 pi | | R | ate | ed V | /olt | age | 0 | 00 | 9 | 9 | 2 | 2 | 2 | 0 | 0 | 9 | 9 | 2 | 2 | 2 | 0 | 0 | 9 | 9 | 2 | 2 | 2 | 0 | 0 | 9 | 0 | 2 | 2 | 9 |
| | 0 | Ľ | 1 | (VD | DC) | | 50 | 63 | 100 | 150 | 200 | 250 | 300 | 50 | 63 | 100 | 150 | 200 | 250 | 300 | 50 | 63 | 100 | 150 | 200 | 250 | 300 | 50 | 63 | 100 | 150 | 200 | 250 | 300 |
| Capacitance | Code | v | olt | age | e C | ode | С | В | D | F | G | z | н | С | В | D | F | G | z | н | С | В | D | F | G | z | н | C | В | D | F | G | z | н |
| | | (| Cas S | se Ser | Siz ies | ze/ | | | C | 1812 | 2Y | | | | | C | 1825 | jγ | | | | | C | 222 | DY | | | | | C | 222 | 5Y | | |



Table 1B – Capacitance Range/Selection Waterfall (1812 – 2225 Case Sizes) cont.

| | | C | a: S | se Se | S rie | iz(es | e/ | | | С | 18 ⁻ | 12Y | | | | | | C 1 | 82 | 5Y | | | | | C2 | 222 | 0Y | | | | | C2 | 222 | 5Y | | |
|-------------|---------------------|-----|----------|---------------------|------------|------------|---------|-----|-----|------|-----------------|------|----------|-------|------|-----|-----|---------------|--------------|---------------|-----------------|---------------|---------------|--------------|---------------|-------------|--------------|------|------|------|-----|------|------|------|------|------|
| | Capacitance | Ī | /ol | tag | e (| Cod | le | С | В | D | F | G | | z | н | С | В | D | F | G | z | н | c | В | D | F | G | z | н | c | В | D | F | G | z | н |
| Capacitance | Code | R | ate | ed | Vo | tag | je | 8 | 90 | 8 | 0 | 8 | | 3 | 00 | 00 | 30 | 0 | 00 | 00 | 00 | 8 | 8 | 30 | 00 | 00 | 00 | 00 | 8 | 8 | 30 | 8 | 00 | 8 | 00 | 8 |
| | | L | | (V | DC |) | | ũ | Ö | 9 | 15 | 20 | | ñ | 30 | ũ | é | 2 | 15 | 20 | 25 | е В | ē | ö | 9 | 15 | 20 | 25 | 30 | ũ | ö | 9 | 15 | 20 | 25 | 30 |
| | | C | ap To | le | ita rar | and ace | e | | | | | | | | | | Pro | oduc See 1 | t Av able | ailal 2 fo | bility or Cl | y an hip 1 | d Ch Thicl | ip T (nes | hick ss Di | ness men | : Co sior | des | | | | | | | | |
| 470 pF | 471 | F | (| ; | J | ĸ | М | GB | GB | GB | GE | 3 GD |) (| K | | HE | HE | HE | HE | HE | HE | HJ | JE | JE | JE | JE | JE | JK | JL | KF | KF | KF | KF | KE | KE | KF |
| 510 pF | 511 | F | 6 | | J | ĸ | М | GB | GB | GB | G | GF | IG | M | | HE | HE | HE | HE | HG | HE | HJ | JK | JK | JK | JK | JK | JK | JL | KF | KF | KF | KF | KE | KE | KF |
| 560 nF | 561 | F | 6 | | J | ĸ | м | GB | GB | GB | G | GF | I G | M | | HE | HF | HE | HF | HG | HE | HJ | ЛК | JK | JK | JK | JK | JK | JI | KF | KF | KF | KF | KF | KF | KF |
| 620 pF | 621 | F | 6 | | J | ĸ | м | GB | GB | GB | G | GF | | 0 | | HE | HF | HE | HE | HG | HG | нк | JF | JF | JF | JK | JK | JK | JI | KF | KF | KF | KF | KF | KF | кн |
| 680 pF | 681 | F | 6 | | | ĸ | м | GB | GB | GB | G | GF | | 0 | | HE | HE | HE | HE | HG | HG | нк | JE | JE | JE | JK | JK | JK | .11 | KF | KF | KF | KF | KE | KF | кн |
| 750 pF | 751 | Ē | 6 | | | ĸ | м | GB | GB | GB | G |) GK | | | | HE | HE | HE | HG | HG | HG | | JE | JE | JE | JK | JK | JK | JN | KF | KF | KF | KF | KE | KF | K.I |
| 820 nF | 821 | F | | | i | ĸ | м | GR | GB | GB | G | | | | | HE | HE | HE | нс | нс | нс | | IF | IF | IF | IK | IK | IK | | KE | KE | KE | KF | KE | KF | KI |
| 010 pF | 011 | L'E | | | ï | ĸ | м | GR | GR | GB | CL | | 1 | | | HE | HE | HE | нс | нс | нс | | | IK | IK | | IK | | | KE | KE | KE | KE | KE | KE | K I |
| 1 000 pF | 102 | | | | 1 | ĸ | M | GR | GB | GB | CL | | | | | HE | HE | HE | нс | нс | нс | | | | IK | | IK | | | KE | KE | KE | | KE | KE | KI |
| 1,000 pr | 102 | | | | 1 | ĸ | M | GR | GB | GB | CL | | | | | HE | HE | HE | нс | нс | н | | | | | | IK | | | KE | KE | KE | | KE | KE | KJ |
| 1,100 pl | 112 | F | 0 | 2 | 1 | K | M | GR | GB | GB | GL | | , , | | | HE | HE | HE | HG | HG | н | | | IK | IK | IK | IK | | | KE | KE | KE | KE | KE | KE | |
| 1,200 pl | 122 | 12 | | | 1 | ĸ | M | CP | CP | CP | CL | | <u>í</u> | | | | | | | | | | | | | | IE | | | | | | | | | |
| 1,500 pF | 152 | | | 2 | J | r v | | | | | | | <u>'</u> | | | | | | | | | | | | JK | | JE | JL | | | | | | | | |
| 1,500 pr | 152 | 12 | | | 1 | N V | | | CD | | G | | ' | | | | | TE | | ILC. | пк | | | JK | JK | | JE | | | | | KE | | | | |
| 1,000 pr | 102 | 12 | | | 1 | N V | | | CD | | GN | | | | | | | | | | | | | JK | JK | | JE | | | | | | | KE | | |
| 1,800 pF | 182 | | | , r | J | N | | GU | GD | GD | GN | 1 | | | | но | HG | HG | HG | HG | | | JK | JK | JK | JK | JE | JN | | I KE | KE | KE | | KE | KH | |
| 2,000 µF | 202 | | | | J | Ň | | бП | GH | | | | | | | ПО | | HG | HE | нJ | | | JK | JK | JK | JE | JK | | | KE | KE | KE | KF | KF | KJ | |
| 2,200 pF | 222 | | | | J | ĸ | NI N | GH | GH | GH | 60 | | | | | HG | HG | HG | HE | HJ | | | JK | JK | JK | JE | JK | | | KE | KE | KE | KF | KF | KJ | |
| 2,400 pF | 242 | Ľ | | | J | ĸ | M | GK | GK | GK | 60 | 2 | | | | HG | HG | HG | HE | HK | | | JK | JK | JK | JE | JL | | | KE | KE | KE | KE | KH | | |
| 2,700 pF | 272 | | | j | J | K | M | GK | GK | GK | GC | , I | | | | HG | HG | HG | HE | HK | | | JK | JK | JK | JE | JL | | | KE | KE | KE | KE | KH | | |
| 3,000 pF | 302 | | 0 | j | J | K | M | GK | GK | GK | | | 4 | - | _ | HG | HG | HG | HG | HK | | | JK | JK | JK | JK | JN | | | KE | KE | KE | KE | KJ | | |
| 3,300 pF | 332 | 15 | 0 | j | J | K | м | GK | GK | GK | | | | | | HG | HG | HG | HG | нк | | | JK | JK | JK | JK | JN | | | KE | KE | KE | KE | KJ | | |
| 3,600 pF | 362 | F | 0 | j | J | K | Μ | GM | GM | GM | | | | | | HG | HG | HG | HJ | | | | JK | JK | JK | JK | JN | | | KF | KF | KF | KF | KJ | | |
| 3,900 pF | 392 | F | 0 |) i | J | K | Μ | GM | GM | GM | | | | | | HG | HG | HG | HJ | | | | JK | JK | JK | JK | JN | | | KF | KF | KF | KF | KJ | | |
| 4,300 pF | 432 | F | 0 | 3 | J | K | М | GO | GO | GO | | | | | | HG | HG | HG | HJ | | | | JK | JK | JK | JL | | | | KF | KF | KF | кн | | | |
| 4,700 pF | 472 | F | 0 | 3 | J | K | М | GO | GO | GO | | | | | | HG | HG | HG | HJ | | | | JK | JK | JK | JL | | | | KF | KF | KF | KH | | | |
| 5,100 pF | 512 | F | 0 | 3 | J | K | М | GO | GO | GO | | | | | | HG | HG | HG | НК | | | | JK | JK | JK | JN | | | | KF | KF | KF | КН | | | |
| 5,600 pF | 562 | F | 0 | 3 | J | K | М | GO | GO | GO | | | | | | HG | HG | HG | НК | | | | JK | JK | JK | JN | | | | KF | KF | KF | KH | | | |
| 6,200 pF | 622 | F | 0 | 3 | J | K | М | | | | | | | | | НJ | HJ | HJ | | | | | JK | JK | JK | JN | | | | KF | KF | KF | KJ | | | |
| 6,800 pF | 682 | F | 0 | 3 | J | K | М | | | | | | | | | НJ | HJ | HJ | | | | | JK | JK | JK | JN | | | | KF | KF | KF | KJ | | | |
| 7,500 pF | 752 | F | 0 | 3 | J | Κ | М | | | | | | | | | HJ | HJ | HJ | | | | | JL | JL | JL | | | | | KF | KF | KF | | | | |
| 8,200 pF | 822 | F | 0 | 3 | J | K | М | | | | | | | | | HJ | HJ | HJ | | | | | JL | JL | JL | | | | | KF | KF | KF | | | | |
| 9,100 pF | 912 | F | 0 | 3 | J | Κ | М | | | | | | | | | ΗK | ΗK | HK | | | | | JL | JL | JL | | | | | KH | KH | KH | | | | |
| 10,000 pF | 103 | F | 0 | 3 | J | Κ | М | | | | | | | | | ΗK | ΗK | HK | | | | | JL | JL | JL | | | | | KH | KH | KH | | | | |
| 12,000 pF | 123 | F | 0 | 3 | J | Κ | М | | | | | | | | | | | | | | | | JN | JN | JN | | | | | KH | KH | KH | | | | |
| 15,000 pF | 153 | F | 0 | 3 | J | Κ | М | | | | | | | | | | | | | | | | | | | | | | | KJ | KJ | KJ | | | | |
| | | R | ate | ed ' (V) | Vol DC | lta) | je | 500 | 630 | 1000 | 1500 | 2000 | | 22000 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 | 500 | 630 | 1000 | 1500 | 2000 | 2500 | 3000 |
| Capacitance | Capacitance Code | V | /ol | tag | e (| Cod | le | C | B | D | F | G | | z | Н | C | В | D | F | G | z | Н | C | В | D | F | G | z | н | C | В | D | F | G | z | н |
| | ovac | | Ca | ase Size/ Series | | | | | | 0 | :181 | 2Y | | | | | | C | 182 | 5Y | | | | | C | 2220 | ŊΥ | | | | | C | 222 | 5Y | | |



Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic | Quantity |
|-----------|-------------------|-------------|---------|----------------------|---------|----------|
| Code | Size ¹ | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| DG | 805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| ES | 1206 | 1.00 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EU | 1206 | 1.60 ± 0.25 | 0 | 0 | 2,000 | 8,000 |
| FZ | 1210 | 1.25 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FK | 1210 | 2.10 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1,000 | 4,000 |
| LA | 1808 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| LB | 1808 | 1.60 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| LC | 1808 | 2.00 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GD | 1812 | 1.25 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GH | 1812 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| GK | 1812 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| GM | 1812 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| GO | 1812 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| HE | 1825 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| HG | 1825 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| HJ | 1825 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| HK | 1825 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| JE | 2220 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| JK | 2220 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| JL | 2220 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| JN | 2220 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| KE | 2225 | 1.40 ± 0.15 | 0 | 0 | 1,000 | 4,000 |
| KF | 2225 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| KH | 2225 | 2.00 ± 0.20 | 0 | 0 | 500 | 2,000 |
| KJ | 2225 | 2.50 ± 0.20 | 0 | 0 | 500 | 2,000 |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| Code | Size ¹ | Range (mm) | Paper Q | uantity ¹ | Plastic | Quantity |

Package quantity based on finished chip thickness specifications.

¹ If ordering using the 2 mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".



Table 2B – Bulk Packaging Quantities

| Deelver | ing Tune | Loose P | ackaging |
|----------|------------------------|------------------------|------------------------|
| Раска | jing type | Bulk Bag | (default) |
| Packagi | ng C-Spec ¹ | N, | /A ² |
| Cas | e Size | Packaging Quantities (| pieces/unit packaging) |
| EIA (in) | Metric (mm) | Minimum | Maximum |
| 0402 | 1005 | | |
| 0603 | 1608 | | |
| 0805 | 2012 | | 50,000 |
| 1206 | 3216 | | |
| 1210 | 3225 | 1 | |
| 1808 | 4520 | | |
| 1812 | 4532 | | |
| 1825 | 4564 | | 20,000 |
| 2220 | 5650 | | |
| 2225 | 5664 | | |

¹ The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial Grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive Grade products.

² A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size | Metric Size | | Dens Maxi Land Pi | sity Lev mum (I rotrusio | vel A: Most) on (mm |) | | Dens Media Land Pi | sity Lev an (Nor rotrusio | vel B: minal) on (mm |) | | Dens Minir Land Pr | sity Lev num (L rotrusio | vel C: .east) on (mm |) |
|-------------|----------------|------|-------------------------|--------------------------------|---------------------------|------|------|--------------------------|---------------------------------|----------------------------|------|------|--------------------------|--------------------------------|----------------------------|------|
| Coue | Coue | С | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0805 | 2012 | 0.99 | 1.44 | 1.66 | 4.47 | 2.71 | 0.89 | 1.24 | 1.56 | 3.57 | 2.11 | 0.79 | 1.04 | 1.46 | 2.42 | 1.81 |
| 1206 | 3216 | 1.59 | 1.62 | 2.06 | 5.85 | 3.06 | 1.49 | 1.42 | 1.96 | 4.95 | 2.46 | 1.39 | 1.22 | 1.86 | 4.25 | 2.16 |
| 1210 | 3225 | 1.59 | 1.62 | 3.01 | 5.90 | 4.01 | 1.49 | 1.42 | 2.91 | 4.95 | 3.41 | 1.39 | 1.22 | 2.81 | 4.25 | 3.11 |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 |
| 1812 | 4532 | 2.10 | 1.80 | 3.60 | 7.00 | 4.60 | 2.00 | 1.60 | 3.50 | 6.10 | 4.00 | 1.90 | 1.40 | 3.40 | 5.40 | 3.70 |
| 1825 | 4564 | 2.15 | 1.80 | 6.90 | 7.10 | 7.90 | 2.05 | 1.60 | 6.80 | 6.20 | 7.30 | 1.95 | 1.40 | 6.70 | 5.50 | 7.00 |
| 2220 | 5650 | 2.85 | 2.10 | 5.50 | 8.80 | 6.50 | 2.75 | 1.90 | 5.40 | 7.90 | 5.90 | 2.65 | 1.70 | 5.30 | 7.20 | 5.60 |
| 2225 | 5664 | 2.85 | 2.10 | 6.90 | 8.80 | 7.90 | 2.75 | 1.90 | 6.80 | 7.90 | 7.30 | 2.65 | 1.70 | 6.70 | 7.20 | 7.00 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Terminati | ion Finish |
|--|-----------------------|-----------------------|
| Tomeredure | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate (T_L to T_P) | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T _L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _P) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |

Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.





Table 4 – Performance & Reliability: Test Methods and Conditions

| Stress | Reference | Test Condition | Limits |
|--|----------------|--|--|
| Visual and Mechanical | KEMET Internal | No defects that may affect performance (10X) | Dimensions according KEMET Spec Sheet |
| Capacitance (Cap) | KEMET Internal | C ≤ 1,000 pF Frequency: 1 MHz ±100 kHz Voltage*:1.0 V _{rms} ±0.2 V C > 1,000 pF Frequency: 1 kHz ±50 Hz Voltage: 1.0 V _{rms} ±0.2 V * See part number specification sheet for voltage | Within Tolerance |
| Dissipation Factor (DF) | KEMET Internal | C ≤ 1,000 pF Frequency: 1 MHz ±100 kHz Voltage*: 1.0 V _{rms} ±0.2 V C > 1,000 pF Frequency: 1 kHz ±50 Hz Voltage: 1.0 V _{rms} ±0.2 V * See part number specification sheet for voltage | Within Specification Dissipation factor (DF) maximum limit at 25°C = 0.1% |
| Insulation Resistance (IR) | KEMET Internal | 500 VDC applied for 120 ±5 seconds at 25°C | Within Specification To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ limit. Select the lower of the two limits: 1,000 megohm microfarads or 100 GΩ. |
| Temperature Coefficient of Capacitance (TCC) | KEMET Internal | Capacitance change with reference to +25°C and 0 VDC applied. * See part number specification sheet for voltage Step Temperature (°C) 1 +25°C 2 -55°C 3 +25°C (Reference Temperature) 4 +125°C | Within Specification: ±30 ppm / °C |



Table 4 – Performance & Reliability: Test Methods and Conditions cont.

| Stress | Reference | Test Condition | Limits |
|--|-------------------------|--|--|
| | | See Dielectric Withstanding Voltage (DWV) Table (5 ±1 seconds and charge/discharge not exceeding 50 mA) | |
| | | EIA Case Size 500 V 630 V ≥ 1,000 V | |
| | | 0603 130% of rated voltage | Conversional Limit |
| Dielectric | | 0805 < 620pF 150% of rated voltage ≥ 620pF 130% of rated voltage | DF: Initial Limit |
| Withstanding | KEMET Internal | 1206 < 5.1nF 150% of rated voltage ≥ 5.1nF 130% of rated voltage | IR: Initial Limit |
| Voltage (DWV) | | 1210 < 7.5nF 150% of rated voltage 2.7.5nF 130% of rated voltage 150% 120% | Withstand test voltage without |
| | | 1808 of rated voltage voltage voltage voltage voltage | insulation breakdown of damage. |
| | | 1812 ≤ 12nF 130% of rated voltage ≥ 12nF 130% of rated voltage | |
| | | 1825 ≥ 22nF 130% of rated voltage | |
| | | 2220 ≥ 27nF 130% of rated voltage | |
| | | 2225 ≥ 33nF 130% of rated voltage | |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | KEMET Internal | Maximum % capacitance loss/decade hour | 0% Loss/Decade Hour |
| | | Shear stress test per specific case size, | |
| Terminal Strength | KEMET Internal | Case Size Force 0603 5N 0805 9N ≥ 1206 18N | No evidence of mechanical damage |
| Board Flex | AEC-Q200-005 | Standard Termination System 2.0 mm Flexible Termination System 3.0 mm Test Time: 60± 5 seconds Ramp Time: 1 mm/second | No evidence of mechanical damage |
| Solderability | J-STD-002 | Condition: 4 hours ±15 minutes at 155°C dry bake apply all methods Test 245 ±5°C (SnPb & Pb-Free) | Visual Inspection. 95% coverage on termination. No leaching |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to +125°C) 2 - 3 cycles per hour Soak Time: 1 or 5 minute | Measurement at 24 hours ±4 hours after test conclusion. Cap: Initial Limit DF: Initial Limit IR: Initial Limit |



Table 4 – Performance & Reliability: Test Methods and Conditions cont.

| Stress | Reference | Test Condition | Limits | |
|---------------------------|---------------------------|---|---|--|
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and 200 VDC maximum Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. | Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5% | |
| Moisture Resistance | MIL-STD-202 Method 106 | Number of Cycles Required: 10, 24 hours per cycle. Steps 7a and 7b not required | Cap: Initial Limit DF: Initial Limit IR: Initial Limit | |
| Thermal Shock | MIL-STD-202 Method 107 | Number of Cycles Required: 5, (-55°C to 125°C) Dwell time 15 minutes. | Cap: Initial Limit DF: Initial Limit IR: Initial Limit | |
| High Temperature Life | MIL-STD-202 | 1,000 hours at 125°C with 1.2 X rated voltage applied. | Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift | |
| Storage Life Method 108 | | 1,000 hours at 150°C, Unpowered | IR: 10% of Initial Limit DF Limits Maximum: 0.5% | |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations. Test from 10 – 2,000 Hz | Cap: Initial Limit DF: Initial Limit IR: Initial Limit | |
| Mechanical Shock | MIL-STD-202 Method 213 | 1,500 g's 0.5 millisecond Half-sine, Velocity Change: 15.4 feet/second (Condition F) | Cap: Initial Limit DF: Initial Limit IR: Initial Limit | |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents. | Visual Inspection 10X Readable marking, no decoloration or stains. No physical damage. | |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature–reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction



Capacitor Marking (Optional)

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punched Paper | | |
|----------------------|------|--------------------------|------------|--------------------------|----------|--|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| | (W)* | Pitch (P ₁)* | | Pitch (P ₁)* | | |
| 01005 - 0402 | 8 | | | 2 | 2 | |
| 0603 | 8 | | | 2/4 | 2/4 | |
| 0805 | 8 | 4 | 4 | 4 | 4 | |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 | |
| 1805 - 1808 | 12 | 4 | 4 | | | |
| ≥ 1812 | 12 | 8 | 8 | | | |
| KPS 1210 | 12 | 8 | 8 | | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | | |
| Array 0612 | 8 | 4 | 4 | | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 6 and 7 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size. 2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | | |
|--|--|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|-------------------|---------------------------|
| Tape Size | D ₀ | D ₁ Minimum Note 1 | E ₁ | P ₀ | P ₂ | R Reference Note 2 | S ₁ Minimum Note 3 | T Maximum | T ₁ Maximum |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 16 mm | | (0.059) | | | | (1.181) | | | |
| | Variable Dimensions — Millimeters (Inches) | | | | | | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B | , & K ₀ |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | |
| 12 mm | Single (4 mm) and double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | Note 5 | |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of the embossment location and the hole location shall be applied independently of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6.)

3. If S₁ < 1.0 mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)

(e) for KPS product, A_a and B_a are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | |
|--|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|
| Tape Size | D _o | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) maximum | 0.75 (0.030) | 25 (0.984) |
| | Variable Dimensions — Millimeters (Inches) | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3.)

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6.)



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ± 10 mm/minute.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius



Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs) Floating Electrode (FF-CAP), High Voltage with Flexible Termination COG Dielectric, 500 – 3,000 VDC (Commercial & Automotive Grade)



Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 8 – Reel Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | |
|--|--|---------------------------------------|--|--|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | |
| 8 mm | 178 ±0.20 | | | | | | |
| 12 mm | (7.008 ±0.008) Or | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | |
| 16 mm | (13.000 ±0.008) | | | | | | |
| | Variable Dimensions – Millimeters (Inches) | | | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | |
| 12 mm | 50 (1.969) | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape width without interference | | | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Solder Fluxes and Cleaning

The use of water-soluble fluxes provides advantages of excellent solderability due to high activation. However, these fluxes contain organic acids that can induce arcing under high DC or AC voltages. Notable problem areas are underneath the MLCC where flux can be trapped between the ceramic material and PCB. It is therefore critical that PCBs are properly cleaned to remove all flux residue to maintain reliability.

Coating for High Voltage MLCCs

For MLCC ratings \geq 1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

| Dielectric | CTE (ppm/°C) |
|----------------------------|--------------|
| Class II BaTiO₃ | 10.7 |
| Class I CaZrO ₃ | 9.8 |

Slits in PCB

It is recommended to apply a slit in the PCB under the MLCC to improve washing of flux residue that may get trapped underneath. In some cases, it is not possible to slit entirely through the PCB due to underlying metal planes. It is also acceptable to apply a recessed slit under the MLCC which will also promote cleaning.

- Recommended for case sizes ≥1206
- The width (w) of the slit should be 1mm
- Length of the slit should be as short as possible to prevent damaging the MLCC due to mechanical stress of the PCB.
- Slits also reduce the risk of solder balls under MLCC which decreased the creepage distance.



Solder Resist

If a slit cannot be applied as above, it is recommended to not use solder resist directly under the MLCC. The use of solder resist material reduces the distance between MLCC ceramic material and PCB thus making it difficult to clean.

Solder Balls

Improper reflow techniques and/or improper washing can induce solder balls under or adjacent to the MLCC. Solder balls reduce the creepage distance between the MLCC terminations and increase the risk of arcing or damage to the ceramic material. To reduce the risk of solder balls:

- Follow KEMET's solder recommendations as outlined in the datasheet.
- If performing a cleaning procedure, properly clean the PCB per KEMET's cleaning recommendations.
- Add slit to the PCB as shown above.





Flexible Termination System (FT-CAP), High Voltage, X7R Dielectric, 500 – 1,000 VDC, VW 80808 Specification



Overview

The KEMET VW80808 Automotive Grade Flexible Termination (FT-CAP) High Voltage multilayer ceramic capacitors in X7R dielectric are suited for a variety of applications requiring proven, reliable performance in harsh-environment conditions. Whether automotive under hood or in-cabin, these devices emphasize the vital and robust nature of capacitors required for mission and safety of critical automotive subsystems and are compliant with AEC-Q200 and VW80808 specifications.



Benefits

- VW 80808 Specification Compliant
- AEC-Q200 automotive qualified.
- Superior flex performance (5 mm)
- DC voltage ratings of 500V, 630V, & 1KV
- Capacitance offerings ranging from 10 pF to 100 nF
- Non-polar device, minimizing installation concerns
- · Lead (Pb)-Free, RoHS and REACH compliant

These devices use flexible termination technology that inhibits the transfer of board stress to the rigid ceramic body, therefore mitigating flex cracks, which can result in low IR or short circuit failures. Although this technology does not eliminate the potential for mechanical damage that may propagate during extreme environmental and handling conditions, it does provide superior flex performance over standard termination systems. Combined with the stability of an X7R dielectric and designed to accommodate all capacitance requirements, these flex-robust devices are RoHS-compliant, offer up to 5mm of flex-bend capability and exhibit a predictable change in capacitance with respect to time and voltage.



Applications

- Direct Battery/Power Circuits
- Filtering (power plane/bus)
- High Voltage Heater
- Inverter, DC/DC
- BMS
- Power Factor Correction


Application Note

X7R dielectric is not recommended for AC line filtering or pulse applications. These capacitors and/or the assembled circuit board containing these capacitors may require a protective surface coating to prevent external surface arcing.

Ordering Information

| С | 1210 | X | 104 | K | С | R | Α | С | 3316 |
|---------|------------------------------|-----------------------------|--|---------------------------------|---------------------------------|------------|-------------------------|------------------------------------|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ¹ | Packaging/Grade (C-Spec) |
| | 0603 0805 1206 1210 | X = Flexible Termination | Two significant digits and number of zeros | J = ±5% K = ±10% M = ±20% | C = 500 B = 630 D = 1,000 | R = X7R | A = N/A | C = 100% Matte Sn | 3316 = 7" Reel Unmarked (VW80808 & AEC-Q200) 3317 = 13" Reel Unmarked (VW80808 & AEC-Q200) |

¹ Additional termination finish options may be available. Contact KEMET for details.

Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|------------------|---------------------|-------------------------------|-------------------------------|-----------------|-------------------------------|----------------------------|-----------------------|
| 0603 | 1608 | 1.60 (0.063) ±0.17 (0.007) | 0.80 (0.032) ±0.15 (0.006) | | 0.45 (0.018) ±0.15 (0.006) | 0.58 (0.023) | Calderwaye |
| 0805 | 2012 | 2.00 (0.079) ±0.30 (0.012) | 1.25 (0.049) ±0.30 (0.012) | See Table 2 for | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | or or |
| 1206 | 3216 | 3.30 (0.130) ±0.40 (0.016) | 1.60 (0.063) ±0.35 (0.013) | Thickness | 0.60 (0.024) ±0.25 (0.010) | N1/A | Soluer reliow |
| 1210 | 3225 | 3.30 (0.130) ±0.40 (0.016) | 2.60 (0.102) ±0.30 (0.012) | | 0.60 (0.024) ±0.25 (0.010) | N/A | Solder reflow only |



Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions.

Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±15% |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| ² Dielectric Withstanding Voltage (DWV) | 150% of rated voltage for voltage rating of < 1,000 V 120% of rated voltage for voltage rating of ≥ 1,000 V (5 ±1 seconds and charge/discharge not exceeding 50 mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | 2.5% |
| ⁴ Insulation Resistance (IR) Minimum Limit at 25°C | See Insulation Resistance Limit Table (500 VDC applied for 120 ±5 seconds at 25°C) |

¹ Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours.

²DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

³ Capacitance and dissipation factor (DF) measured under the following conditions:

1 kHz ±50 Hz and 1.0 ±0.2 V_{rms} if capacitance \leq 10 μ F

120 Hz ±10 Hz and 0.5 ±0.1 $V_{\rm rms}$ if capacitance > 10 μF

⁴ To obtain IR limit, divide $M\Omega$ - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

Post Environmental Limits

| High | High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | | | | | |
|---------------|---|-------------|--------------------------------------|----------------------|--------------------------|--|--|--|--|--|--|--|
| EIA Case Size | Rated DC Voltage | Capacitance | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | | | | | | | |
| X7R | All | All | 3.0 | ±20% | 10% of Initial Limit | | | | | | | |



Insulation Resistance Limit Table

| EIA Case Size | Rated DC Voltage | 1,000 megohm microfarads or 100 GΩ | 500 megohm microfarads or 10 GΩ | 100 megohm microfarads or 10 GΩ |
|---------------|------------------|---------------------------------------|------------------------------------|------------------------------------|
| 0603 | All | N/A | N/A | All |
| 0805 | All | < 0.0039 µF | N/A | ≥ 0.0039 µF |
| 1206 | All | < 0.012 µF | N/A | ≥ 0.012 µF |
| 1210 | All | < 0.033 µF | N/A | ≥ 0.033 µF |

Table 1 – Capacitance Range/Selection Waterfall (0603 – 1210 Case Sizes)

| Conocitoroo | Com | Case Size/ Series | C06 | 03X | С | 0805 | X | C1206X | | | C1210X | | |
|---|--|---------------------------------|----------------|-----|---|---|--|--|--|--|---|---|---|
| (pF) | Code | Rated Voltage (VDC) | 500 | 630 | 500 | 630 | 1,000 | 500 | 630 | 1,000 | 500 | 630 | 1,000 |
| | | Voltage Code | С | В | c | В | D | C | В | D | c | В | D |
| 10 - 20 pF* 24 - 68pF 75 pF 82 pF 91 pF 100 - 150 pF** 110 pF 120 pF 130 pF 220 pF 270 pF 270 pF 330 pF 470 pF 560 pF 680 pF 820 pF 1,000 pF 1,200 pF 1,200 pF 2,200 pF 2,200 pF 2,200 pF 3,300 pF 3,300 pF 3,900 pF 4,700 pF 5,600 pF 6,800 pF | 100 - 200* 240 - 680* 750 820 910 101 - 151** 111 121 131 151 181 221 271 331 391 471 561 681 821 102 122 152 182 222 272 332 392 472 562 682 | J = ±5% K = ±10% M = ±20% | CG CG CG | CG | DG DG DG DG DG DG DG DG DG DG DG DG DG D | DG DG DG DG DG DG DG DG DG DG DG DG DG D | DG DG DG DG DG DG DG DG DG DG DG DG DG | ES ES EF EF EF EF EV EV EV EV EV EV EV EV EV EV EV EV EV | ES ES EF EF EF EU EU EU EU EU EU EU EU EU EU EU EU EU | ES ES EF EF EF EU EU EU EU EU EU EU EU EU EU EU EU EU | FM FM FM FM FM FM FM FM FM FM FM FM FM F | FM FM FM FM FM FM FM FM FM FM FM FM FM F | FM FM FM FM FM FM FM FM FM FM FM FM FM F |
| | | Voltage Code | С | в | С | В | D | С | В | D | С | В | D |
| Capacitance (pF) | Cap Code | Rated Voltage (VDC) | 500 | 630 | 500 | 630 | 1,000 | 500 | 630 | 1,000 | 500 | 630 | 1,000 |
| | | Case Size/Series | C06 | 03X | | C0805) | (| | C1206) | (| | C1210) | (|



Table 1 – Capacitance Range/Selection Waterfall (0603 – 1210 Case Sizes) cont.

| Conscitones | Cap Code | Case Size/ Series | C0603X | | C | C0805X | | C | 1206 | X | C1210X | | |
|-----------------------|-------------|------------------------|--------|-----|----------|--------|-------|----------|----------|----------|----------|----------|----------|
| (pF) | | Rated Voltage (VDC) | 500 | 630 | 500 | 630 | 1,000 | 500 | 630 | 1,000 | 500 | 630 | 1,000 |
| | | Voltage Code | С | В | С | В | D | С | В | D | С | В | D |
| 8,200 pF 10,000 pF | 822 103 | | | | DG DG | | | EU EU | EU EU | EU EU | FK FK | FK FK | FK FK |
| 12,000 pF | 123 | | | | DG | | | EJ | EJ | | FK | FK | FK |
| 15,000 pF | 153 | | | | | | | EJ | EJ | | FL | FL | FL |
| 18,000 pF | 183 | | | | | | | EJ | EJ | | FM | FM | FM |
| 22,000 pF | 223 | 1 - +5% | | | | | | EJ | EJ | | FM | FM | FM |
| 27,000 pF | 273 | $K = \pm 10\%$ | | | | | | EJ | | | FK | FK | FK |
| 33,000 pF | 333 | M = ±20% | | | | | | EJ | | | FS | FS | FS |
| 39,000 pF | 393 | | | | | | | | | | FS | FS | FS |
| 47,000 pF | 4/3 | | | | | | | | | | FK | FK | |
| 56,000 pF | 563 | | | | | | | | | | FK | FK | |
| 68,000 pF | 003 | | | | | | | | | | F5 E0 | Fo | |
| 0 10 µF | 023 | | | | | | | | | | FK | | |
| 0.10 µ1 | | | | | | _ | _ | | _ | _ | | _ | _ |
| | | Voltage Code | C | В | C | В | D | C | В | D | C | В | D |
| Capacitance (pF) | Cap Code | Rated Voltage (VDC) | 500 | 630 | 500 | 630 | 1,000 | 500 | 630 | 1,000 | 500 | 630 | 1,000 |
| | | Case Size/Series | C06 | 03X | | C0805) | (| | C1206) | (| | C1210X | (|

Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic Quantity | | |
|-----------|------|-------------|---------|-----------------------|------------------|----------|--|
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| CG | 0603 | 0.80 ± 0.10 | 4,000 | 15,000 | 0 | 0 | |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | |
| ES | 1206 | 1.00 ± 0.20 | 0 | 0 | 2,500 | 10,000 | |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 | |
| EU | 1206 | 1.60 ± 0.25 | 0 | 0 | 2,000 | 8,000 | |
| EJ | 1206 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| FL | 1210 | 1.40 ± 0.15 | 0 | 0 | 2,000 | 8,000 | |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| FK | 1210 | 2.10 ± 0.20 | 0 | 0 | 1,500 | 7,000 | |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1,000 | 4,000 | |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| Code | Size | Range (mm) | Paper Q | luantity ¹ | Plastic | Quantity | |



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size Code | Metric Size | Metric Size Code | | | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | |
|---------------------|----------------|------------------------|------|------|------|------|--|------|------|------|------|---|------|------|------|------|
| coue coue | | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0603 | 1608 | 0.85 | 1.25 | 1.10 | 4.00 | 2.10 | 0.75 | 1.05 | 1.00 | 3.10 | 1.50 | 0.65 | 0.85 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 0.99 | 1.44 | 1.66 | 4.47 | 2.71 | 0.89 | 1.24 | 1.56 | 3.57 | 2.11 | 0.79 | 1.04 | 1.46 | 2.42 | 1.81 |
| 1206 | 3216 | 1.59 | 1.62 | 2.06 | 5.85 | 3.06 | 1.49 | 1.42 | 1.96 | 4.95 | 2.46 | 1.39 | 1.22 | 1.86 | 4.25 | 2.16 |
| 1210 | 3225 | 1.59 | 1.62 | 3.01 | 5.90 | 4.01 | 1.49 | 1.42 | 2.91 | 4.95 | 3.41 | 1.39 | 1.22 | 2.81 | 4.25 | 3.11 |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 |
| 1812 | 4532 | 2.10 | 1.80 | 3.60 | 7.00 | 4.60 | 2.00 | 1.60 | 3.50 | 6.10 | 4.00 | 1.90 | 1.40 | 3.40 | 5.40 | 3.70 |
| 1825 | 4564 | 2.15 | 1.80 | 6.90 | 7.10 | 7.90 | 2.05 | 1.60 | 6.80 | 6.20 | 7.30 | 1.95 | 1.40 | 6.70 | 5.50 | 7.00 |
| 2220 | 5650 | 2.85 | 2.10 | 5.50 | 8.80 | 6.50 | 2.75 | 1.90 | 5.40 | 7.90 | 5.90 | 2.65 | 1.70 | 5.30 | 7.20 | 5.60 |
| 2225 | 5664 | 2.85 | 2.10 | 6.90 | 8.80 | 7.90 | 2.75 | 1.90 | 6.80 | 7.90 | 7.30 | 2.65 | 1.70 | 6.70 | 7.20 | 7.00 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Termination FInish | | | | |
|--|-----------------------|--|--|--|--|
| | 100% Matte Sn | | | | |
| Preheat/Soak | | | | | |
| Temperature Minimum (T _{smin}) | 150°C | | | | |
| Temperature Maximum (T _{smax}) | 200°C | | | | |
| Time (t_s) from T _{smin} to T _{smax} | 60 – 120 seconds | | | | |
| Ramp-Up Rate $(T_L to T_P)$ | 3°C/second maximum | | | | |
| Liquidous Temperature (T_L) | 217°C | | | | |
| Time Above Liquidous (t_L) | 60 – 150 seconds | | | | |
| Peak Temperature (T _P) | 260°C | | | | |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 30 seconds maximum | | | | |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | | | | |
| Time 25°C to Peak Temperature | 8 minutes maximum | | | | |



Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction





Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a "K" to identify KEMET, followed by two characters (per EIA–198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the "K" character only.

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.
- X7R dielectric products in capacitance values outlined below.

| EIA Case Size | Metric Size Code | Capacitance |
|---------------|------------------|-------------|
| 0603 | 1608 | ≤ 170 pF |
| 0805 | 2012 | ≤ 150 pF |
| 1206 | 3216 | ≤ 910 pF |
| 1210 | 3225 | ≤ 2,000 pF |
| 1808 | 4520 | ≤ 3,900 pF |
| 1812 | 4532 | ≤ 6,700 pF |
| 1825 | 4564 | ≤ 0.018 µF |
| 2220 | 5650 | ≤ 0.027 µF |
| 2225 | 5664 | ≤ 0.033 µF |

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 μ F. Orientation of marking is vendor optional.





Capacitor Marking (Optional) cont.

| Capacitance (pF) For Various Alpha/Numeral Identifiers | | | | | | | | | | | | | | |
|--|------------------|---------|----|-----|-------|--------|---------|-----------|------------|-------------|--|--|--|--|
| Alaba | | Numeral | | | | | | | | | | | | |
| Alpna | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | | |
| Character | Capacitance (pF) | | | | | | | | | | | | | |
| A | 0.10 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 | | | | |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 | | | | |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 | | | | |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 | | | | |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 | | | | |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 | | | | |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 | | | | |
| Н | 0.20 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 | | | | |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 | | | | |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 | | | | |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 | | | | |
| М | 0.30 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 | | | | |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 | | | | |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 | | | | |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 | | | | |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 | | | | |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 | | | | |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 | | | | |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 | | | | |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 | | | | |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 | | | | |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 | | | | |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 | | | | |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 | | | | |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 | | | | |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 | | | | |
| d | 0.40 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 | | | | |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 | | | | |
| f | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 | | | | |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 | | | | |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 | | | | |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 | | | | |
| у | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 | | | | |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 4 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | | Embosse | ed Plastic | Punched Paper | |
|----------------------|------|---------|--------------------------|---------------|--------------------|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| | (W)* | Pitch | Pitch (P ₁)* | | (P ₁)* |
| 01005 - 0402 | 8 | | | 2 | 2 |
| 0603 | 8 | | | 2/4 | 2/4 |
| 0805 | 8 | 4 | 4 | 4 | 4 |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 |
| 1805 - 1808 | 12 | 4 | 4 | | |
| ≥ 1812 | 12 | 8 | 8 | | |
| KPS 1210 | 12 | 8 | 8 | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | |
| Array 0612 | 8 | 4 | 4 | | |

*Refer to Figures 1 and 2 for W and P₁ carrier tape reference locations. *Refer to Tables 5 and 6 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size. 2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 5 - Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | | | |
|--|---------------------------------------|----------------------------------|------------------------------|------------------------------|------------------------------|---------------------------|------------------------|--------------------------------|--------------------|
| Tana Cina | D | D ₁ Minimum | F | D | P | R Reference | S ₁ Minimum | Т | T ₁ |
| Tape Size | D ₀ | Note 1 | E ₁ | P ₀ | P ₂ | Note 2 | Note 3 | Maximum | Maximum |
| 8 mm | | 1.0 (0.039) | | | | 25.0 (0.984) | | | |
| 12 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 30 | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 16 mm | | (0.059) | | | | (1.181) | | | |
| 24 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.5 (0.059) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.10 (0.078 ±0.003) | 30 (1.181) | 5 (0.196) | 0.250 (0.009) | 0.350 (0.013) |
| | | , | Variable Dime | ensions – Mil | limeters (Incl | nes) | | | |
| Tape Size | Pitch | B ₁ Maximum Note 4 | E ₂ Minimum | F | P ₁ | T ₂ Maximum | W Maximum | A ₀ ,B ₀ | , & K ₀ |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 2.5 (0.098) | 8.3 (0.327) | | |
| 12 mm | Single (4 mm) and Double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ±0.05 (0.217 ±0.002) | 8.0 ±0.10 (0.315 ±0.004) | 4.6 (0.181) | 12.3 (0.484) | No | to 5 |
| 16 mm | Triple (12 mm) | 12.1 (0.476) | 14.25 (0.561) | 7.5 ±0.05 (0.138 ±0.002) | 12.0 ±0.10 (0.157 ±0.004) | 4.6 (0.181) | 16.3 (0.642) | NU | |
| 24 mm | 16 mm | 11.5 (0.452) | 22.25 (0.875) | 11.5 ±0.10 (0.452 ±0.003) | 16.0 ±0.10 (0.629 ±0.004) | 3 (0.118) | 24.3 (0.956) | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6).

3. If S₁ < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Standard 481 paragraph 4.3 section b).

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3).

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4).

(e) for KPS product, A_0 and B_0 are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 6 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | | |
|--|--|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|--|
| Tape Size | D _o | E ₁ | P ₀ | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 | |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) Maximum | 0.75 (0.030) | 25 (0.984) | |
| | Variable Dimensions — Millimeters (Inches) | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ | |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 | |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | NOLE I | |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3).

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4).

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6).



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 Newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 Newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 7 – Reel Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | | | | |
|--|-----------------|---------------------------------------|--|----------------------------|--|--|--|
| Tape Size | А | B Minimum | С | D Minimum | | | |
| 8 mm | 178 +0 20 | | | | | | |
| 12 mm | (7.008 ±0.008) | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) | | | |
| 16 mm | or 330 +0.20 | () | (,, | () | | | |
| 24 mm | (13.000 ±0.008) | 1.2 (0.047) | 13.0 ±0.2 (0.521 ±0.008) | 21 (0.826) | | | |
| | Variable | Dimensions — Millimeter | rs (Inches) | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ | | | |
| 8 mm | | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | | | | |
| 12 mm | 50 | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | Shall accommodate tape | | | |
| 16 mm | (1.969) | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | width without interference | | | |
| 24 mm | | 25 +1.0/-0.0 (0.984 +0.039/-0.0) | 27.4 ±1.0 (1.078 ±0.039) | - | | | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber





Application Guide

Solder Fluxes and Cleaning

The use of water-soluble fluxes provides advantages of excellent solderability due to high activation. However, these fluxes contain organic acids that can induce arcing under high DC or AC voltages. Notable problem areas are underneath the MLCC where flux can be trapped between the ceramic material and PCB. It is therefore critical that PCBs are properly cleaned to remove all flux residue to maintain reliability.

Coating for High Voltage MLCCs

For MLCC ratings \geq 1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

| Dielectric | CTE (ppm/°C) |
|----------------------------|--------------|
| Class II BaTiO₃ | 10.7 |
| Class I CaZrO ₃ | 9.8 |

Slits in PCB

It is recommended to apply a slit in the PCB under the MLCC to improve washing of flux residue that may get trapped underneath. In some cases, it is not possible to slit entirely through the PCB due to underlying metal planes. It is also acceptable to apply a recessed slit under the MLCC which will also promote cleaning.

- Recommended for case sizes ≥1206
- The width (w) of the slit should be 1mm
- Length of the slit should be as short as possible to prevent damaging the MLCC due to mechanical stress of the PCB.
- Slits also reduce the risk of solder balls under MLCC which decreased the creepage distance.



Solder Resist

If a slit cannot be applied as above, it is recommended to not use solder resist directly under the MLCC. The use of solder resist material reduces the distance between MLCC ceramic material and PCB thus making it difficult to clean.

Solder Balls

Improper reflow techniques and/or improper washing can induce solder balls under or adjacent to the MLCC. Solder balls reduce the creepage distance between the MLCC terminations and increase the risk of arcing or damage to the ceramic material. To reduce the risk of solder balls:

- Follow KEMET's solder recommendations as outlined in the datasheet.
- If performing a cleaning procedure, properly clean the PCB per KEMET's cleaning recommendations.
- Add slit to the PCB as shown above.



Flexible Termination System (FT-CAP), X7R Dielectric, 6.3 – 250 VDC, VW 80808 Specification



Overview

The KEMET VW80808 Automotive Grade Flexible Termination (FT-CAP) multilayer ceramic capacitors in X7R dielectric are suited for a variety of applications requiring proven, reliable performance in harsh-environment conditions. Whether automotive under hood or in-cabin, these devices emphasize the vital and robust nature of capacitors required for mission and safety of critical automotive subsystems and are compliant with AEC-Q200 and VW80808 specifications.



Benefits

- VW 80808 Specification Compliant
- AEC-Q200 automotive qualified.
- Superior flex performance (5 mm)
- DC voltage ratings up to 250 V
- Capacitance offerings ranging from 180 pF 10 μF
- Non-polar device, minimizing installation concerns
- Lead (Pb)-Free, RoHS and REACH compliant

These devices use flexible termination technology that inhibits the transfer of board stress to the rigid ceramic body, therefore mitigating flex cracks, which can result in low IR or short circuit failures. Although this technology does not eliminate the potential for mechanical damage that may propagate during extreme environmental and handling conditions, it does provide superior flex performance over standard termination systems. Combined with the stability of an X7R dielectric and designed to accommodate all capacitance requirements, these flex-robust devices are RoHS-compliant, offer up to 5 mm of flex-bend capability and exhibit a predictable change in capacitance with respect to time and voltage.



Applications

- High current applications (automobile battery line)
- Circuits (direct battery/power connection)
- Control units, sensors, and actuators in motor vehicles
- Filtering (power plane/bus)
- Electronic and Electrical subsystems



Ordering Information

| С | 1210 | X | 106 | K | 8 | R | Α | С | 3316 |
|---------|------------------------------|-----------------------------|--|---------------------------------|--|------------|-------------------------|------------------------------------|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish ¹ | Packaging/Grade (C-Spec) |
| | 0603 0805 1206 1210 | X = Flexible Termination | Two significant digits and number of zeros | J = ±5% K = ±10% M = ±20% | 9 = 6.3 8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 2 = 200 A = 250 | R = X7R | A = N/A | C = 100% Matte Sn | 3316 = 7" Reel Unmarked (VW80808 & AEC-Q200) 3317 = 13" Reel Unmarked (VW80808 & AEC-Q200) |

¹ Additional reeling or packaging options may be available. Contact KEMET for details.

Dimensions – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|-------------------|---------------------|-------------------------------|-------------------------------|-----------------|-------------------------------|----------------------------|------------------------------------|
| ¹ 0603 | 1608 | 1.60 (0.063) ±0.17 (0.007) | 0.80 (0.032) ±0.15 (0.006) | | 0.45 (0.018) ±0.15 (0.006) | 0.58 (0.023) | Osldssuus |
| ² 0805 | 2012 | 2.00 (0.079) ±0.30 (0.012) | 1.25 (0.049) ±0.30 (0.012) | See Table 2 for | 0.50 (0.02) ±0.25 (0.010) | 0.75 (0.030) | Solder wave or solder reflow |
| 1206 | 3216 | 3.30 (0.130) ±0.40 (0.016) | 1.60 (0.063) ±0.35 (0.013) | Thickness | 0.60 (0.024) ±0.25 (0.010) | N1/A | |
| 1210 | 3225 | 3.30 (0.130) ±0.40 (0.016) | 2.60 (0.102) ±0.30 (0.012) | | 0.60 (0.024) ±0.25 (0.010) | IN/A | Solder reflow only |

¹ For capacitance values \geq 0.56 μ F add 0.03 (0.001) to length tolerance dimension.

² For capacitance values \geq 2.7 μ F add 0.05 (0.002) to length tolerance dimension.



Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | -55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±15% |
| ¹ Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| ² Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA) |
| ³ Dissipation Factor (DF) Maximum Limit at 25°C | 5% (6.3 V and 10 V), 3.5% (16 V and 25 V) and 2.5% (50 V to 250 V) |
| ^₄ Insulation Resistance (IR) Minimum Limit at 25°C | See Insulation Resistance Limit table (Rated voltage applied for 120 ±5 seconds at 25°C) |

¹ Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours.

²DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

³ Capacitance and dissipation factor (DF) measured under the following conditions:

1 kHz ±50 Hz and 1.0 ±0.2 V_{rms} if capacitance \leq 10 μ F

120 Hz ±10 Hz and 0.5 ±0.1 $V_{\rm rms}$ if capacitance > 10 μF

⁴ To obtain IR limit, divide M Ω - μ F value by the capacitance and compare to G Ω limit. Select the lower of the two limits.

Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."



Post Environmental Limits

| High Temperature Life, Biased Humidity, Moisture Resistance | | | | | | | |
|---|---------------------|-------------|--------------------------------------|----------------------|--------------------------|--|--|
| EIA Case Size | Rated DC Voltage | Capacitance | Dissipation Factor (Maximum %) | Capacitance Shift | Insulation Resistance | | |
| | > 25 | | 3.0 | ±20% | 10% of Initial | | |
| X7R | 16/25 | All | 5.0 | | | | |
| | < 16 | | 7.5 | | 2 | | |

Insulation Resistance Limit Table

| EIA Case Size | Rated DC Voltage | 1,000 megohm microfarads or 100 GΩ | 500 megohm microfarads or 10 GΩ | 100 megohm microfarads or 10 GΩ |
|---------------|------------------|---------------------------------------|------------------------------------|------------------------------------|
| 0602 | < 200 V | < 0.047 µF | ≥ 0.047 µF | N/A |
| 0005 | ≥ 200 V | < 1.0nF | N/A | ≥ 1.0nF |
| 0005 | < 200 V | < 0.15 µF | ≥ 0.15 µF | N/A |
| 0805 | ≥ 200 V | < 0.0039µF | N/A | ≥ 0.0039µF |
| 1206 | < 200 V | < 0.47 µF | ≥ 0.47 µF | N/A |
| | ≥ 200 V | < 0.012µF | N/A | ≥ 0.012µF |
| 1010 | < 200 V | < 0.39 µF | ≥ 0.39 µF | N/A |
| 1210 | ≥ 200 V | < 0.047µF | N/A | ≥ 0.047µF |



Table 1 – Capacitance Range/Selection Waterfall (0603 – 1210 Case Sizes)

| Conceitonce | Con | Case Size/ Series | | | C | :06 | 03 | X | | | | | C | :08 | 05 | X | | | | | C | C12 | 06) | X | | | | | (| C12 | 210) | ĸ | | |
|--|---|---|---|--------|----|--------|----|-----|----------------------------|----------------------------|---|---|---|---|---|---|---|--|---|---|---------------------------------------|-----|---------------------------------------|---|-----|-----|---------------------------------------|---------------------------------------|---------------------------------------|--|---|--|---------------------------------------|--|
| (pF) | Code | Rated Voltage (VDC) | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 |
| | | Voltage Code | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A |
| 180pF 220pF 330pF 390pF 470pF 560pF 680pF 820pF 1.0 nF 1.2 nF 1.5 nF 1.8 nF 2.2 nF 2.7 nF 3.3 nF 3.9 nF 4.7 nF 5.6 nF 6.8 nF 8.2 nF 10 nF 12 nF 15 nF 18 nF 22 nF 27 nF 33 nF 39 nF 47 nF 56 nF 68 nF 82 nF 10 nF 12 nF 15 nF 18 nF 22 nF 27 nF 33 nF 39 nF 47 nF 56 nF 68 nF 82 nF 10 nF 12 nF 15 nF 18 nF 22 nF 27 nF 33 nF 39 nF 47 nF 56 nF 68 nF 82 nF 10 nF 10 nF 12 nF 15 nF 18 nF 22 nF 27 nF 33 nF 39 nF 47 nF 56 nF 68 nF 82 nF 10 nF 10 nF 120 nF 130 nF 10 nF 120 nF 150 nF 180 nF 270 nF 30 nF 39 nF 47 nF 56 nF 68 nF 82 nF 100 nF 120 nF 150 nF 180 nF 270 nF 30 nF | 181 221 271 331 391 471 561 681 821 102 122 152 182 272 332 392 472 562 822 103 123 153 183 223 273 333 393 473 563 683 823 104 124 154 184 224 274 334 394 474 564 824 | Capacitance Tolerances: J = ±5% K = ±10% M = ±20% | 555555555555555555555555555555555555555 | | | | | | CG CG CG CG CG | CG CG CG CG CG | DR DR DR DR DR DR DR DR DR DR DR DR DR D | DR DR DR DR DR DR DR DR DR DR DR DR DR D | DR DR DR DR DR DR DR DR DR DR DR DR DR D | DR DR DR DR DR DR DR DR DR DR DR DR DR D | DR DR DR DR DR DR DR DR DR DR DR DR DR D | DR DR DR DR DR DR DR DR DR DR DR DR DR D | DR DR DR DR DR DR DR DR DR DR DR DR DR D | DG DG DG DG DG DG DG DG DG DG DG DG DG D | E Q Q E Q Q E Q Q E Q Q E Q Q E Q Q E Q Q E Q Q E Q Q E Q Q E Q Q E Q Q E Q Q E Q Q E Q Q E Q Q E Q E Q E Q E Q E Q E Q E Q E Q E Q E Q E C C E C C C C | EQQEQQEQQEQQEQQEQQEQQEQQEQQEQQEQQEQQEQQ | E E E E E E E E E E E E E E E E E E E | | E E E E E E E E E E E E E E E E E E E | EQ EQ EQ EQ EQ EQ EQ EQ EQ EQ EQ EQ EQ E | | | F F F F F F F F F F F F F F F F F F F | F F F F F F F F F F F F F F F F F F F | F F F F F F F F F F F F F F F F F F F | FN FN FN FN FN FN FN FN FN FN FN FN FN F | FNN FNN FNN FNN FNN FNN FNN FNN FNN FNN | FN FN FN FN FN FN FN FN FN FN FN FN FN F | F F F F F F F F F F F F F F F F F F F | FM FS FS FS F FK FL F FF FS FS FS FK FK FK FK FK FK FK FK FK FK FK FK FK |
| 02011 | 024 | Voltage Code | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A |
| Capacitance | Cap | Rated Voltage | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | <u>1</u> 0 | 200 | 250 |
| (PF) | coae | Case Size/Series | | C0603X | | C0805X | | | | C1206X | | | | " | C1210X | | | | | | | | | | | | | | | | | | | |



Table 1 – Capacitance Range/Selection Waterfall (0603 – 1210 Case Sizes) cont.

| Conceitones | Con | Case Size/ Series | | | C | :06 | 03 | X | | | | | (| :08 | 05 | X | | | | | C | ;12 | 06 | X | | | | | (| 212 | 210 | X | | |
|---------------------|-------------|------------------------|-----|----|----|-----|-----|-----|-----|-----|-----|----|----|-----|------|-----|-----|-----|-----|----|----|-----|-----|-----|-----|-----|-----|----|----|-----|------|-----|-----|-----|
| (pF) | Cap Code | Rated Voltage (VDC) | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 |
| | | Voltage Code | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A |
| 1.0 µF | 105 | | | | | | | | | | DG | DG | DG | DG | | | | | ES | ES | ES | ES | ES | | | | FU | FU | FU | FU | FM | FM | | |
| 1.2 µF | 125 | | | | | | | | | | DS | DS | | | | | | | EH | EH | EH | EH | EH | | | | FZ | FZ | FZ | FZ | FZ | | | |
| 1.5 µF | 155 | | | | | | | | | | DG | DG | | | | | | | EH | EH | EH | EH | EH | | | | FZ | FZ | FZ | FZ | FZ | | | |
| 1.8 µF | 185 | 0 | | | | | | | | | | | | | | | | | EH | EH | EH | EH | EH | | | | FZ | FZ | FZ | FZ | FZ | | | |
| 2.2 µF | 225 | Capacitance | | | | | | | | | | | | | | | | | EH | EH | EH | EH | EH | | | | FZ | FZ | FZ | FZ | FZ | | | |
| 2.7 µF | 275 | TOTEL allices. | | | | | | | | | | | | | | | | | EH | EH | EH | | | | | | FZ | FZ | FZ | FU | FU | | | |
| 3.3 µF | 335 | .1 = +5% | | | | | | | | | | | | | | | | | EH | EH | EH | | | | | | FM | FM | FM | FM | FM | | | |
| 3.9 µF | 395 | K = ±10% | | | | | | | | | | | | | | | | | | | | | | | | | FK | FK | FK | FK | FK | | | |
| 4.7 μF | 475 | M = ±20% | | | | | | | | | | | | | | | | | | | | | | | | | FS | FS | FS | FS | FS | | | |
| 5.6 µF | 565 | | | | | | | | | | | | | | | | | | | | | | | | | | FU | FU | FU | | | | | |
| 6.8 µF | 685 | | | | | | | | | | | | | | | | | | | | | | | | | | FM | FM | FM | | | | | |
| 8.2 µF | 825 | | | | | | | | | | | | | | | | | | | | | | | | | | FK | FK | | | | | | |
| 10 µF | 106 | | | | | | | | | | | | | | | | | | | | | | | | | | FS | FS | | | | | | _ |
| | | Voltage Code | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A |
| Capacitance (pF) | Cap Code | Rated Voltage (VDC) | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 |
| | | Case Size/Series | | | | C06 | 03X | | | | | | | C08 | 805) | (| | | | | | C12 | 06X | [| | | | | | C12 | 210) | [| | |

Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness | Case | Thickness ± | Paper Q | uantity ¹ | Plastic (| Quantity | |
|-----------|------|-------------|---------|----------------------|-----------|------------|--|
| Code | Size | Range (mm) | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| CG | 0603 | 0.80 ± 0.10 | 4,000 | 15,000 | 0 | 0 | |
| CJ | 0603 | 0.80 ± 0.15 | 4,000 | 15,000 | 0 | 0 | |
| DR | 0805 | 0.78 ± 0.20 | 0 | 0 | 4,000 | 10,000 | |
| DD | 0805 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 | |
| DS | 0805 | 1.00 ± 0.20 | 0 | 0 | 2,500 | 10,000 | |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | |
| EQ | 1206 | 0.78 ± 0.20 | 0 | 0 | 4,000 | 10,000 | |
| ER | 1206 | 0.90 ± 0.20 | 0 | 0 | 4,000 | 10,000 | |
| ES | 1206 | 1.00 ± 0.20 | 0 | 0 | 2,500 | 10,000 | |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 | |
| EM | 1206 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 | |
| EH | 1206 | 1.60 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| EU | 1206 | 1.60 ± 0.25 | 0 | 0 | 2,000 | 8,000 | |
| EJ | 1206 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| FN | 1210 | 0.78 ± 0.20 | 0 | 0 | 4,000 | 10,000 | |
| FQ | 1210 | 0.90 ± 0.20 | 0 | 0 | 4,000 | 10,000 | |
| FX | 1210 | 0.95 ± 0.20 | 0 | 0 | 4,000 | 10,000 | |
| FA | 1210 | 1.10 ± 0.15 | 0 | 0 | 2,500 | 10,000 | |
| FZ | 1210 | 1.25 ± 0.20 | 0 | 0 | 2,500 | 10,000 | |
| FL | 1210 | 1.40 ± 0.15 | 0 | 0 | 2,000 | 8,000 | |
| FU | 1210 | 1.55 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| FK | 1210 | 2.10 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1,000 | 4,000 | |
| FK | 1210 | 2.10 ± 0.20 | 0 | 0 | 2,000 | 8,000 | |
| FS | 1210 | 2.50 ± 0.30 | 0 | 0 | 1,000 | 4,000 | |
| Thickness | Case | Thickness ± | 7" Reel | 13" Reel | 7" Reel | 13" Reel | |
| Code | Size | Range (mm) | Paper Q | uantity ¹ | Plastic | c Quantity | |



Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351

| EIA Size | Metric Size | | Dens Maxi Land Pi | sity Lev mum (I rotrusio | vel A: Most) on (mm |) | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | | | | |
|-------------|----------------|------|-------------------------|--------------------------------|---------------------------|------|--|------|------|------|------|------|---|------|------|------|--|--|--|--|
| Coue | Coue | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | | | | |
| 0603 | 1608 | 0.85 | 1.25 | 1.10 | 4.00 | 2.10 | 0.75 | 1.05 | 1.00 | 3.10 | 1.50 | 0.65 | 0.85 | 0.90 | 2.40 | 1.20 | | | | |
| 0805 | 2012 | 0.99 | 1.44 | 1.66 | 4.47 | 2.71 | 0.89 | 1.24 | 1.56 | 3.57 | 2.11 | 0.79 | 1.04 | 1.46 | 2.42 | 1.81 | | | | |
| 1206 | 3216 | 1.59 | 1.62 | 2.06 | 5.85 | 3.06 | 1.49 | 1.42 | 1.96 | 4.95 | 2.46 | 1.39 | 1.22 | 1.86 | 4.25 | 2.16 | | | | |
| 1210 | 3225 | 1.59 | 1.62 | 3.01 | 5.90 | 4.01 | 1.49 | 1.42 | 2.91 | 4.95 | 3.41 | 1.39 | 1.22 | 2.81 | 4.25 | 3.11 | | | | |
| 1808 | 4520 | 2.30 | 1.75 | 2.30 | 7.40 | 3.30 | 2.20 | 1.55 | 2.20 | 6.50 | 2.70 | 2.10 | 1.35 | 2.10 | 5.80 | 2.40 | | | | |
| 1812 | 4532 | 2.10 | 1.80 | 3.60 | 7.00 | 4.60 | 2.00 | 1.60 | 3.50 | 6.10 | 4.00 | 1.90 | 1.40 | 3.40 | 5.40 | 3.70 | | | | |
| 1825 | 4564 | 2.15 | 1.80 | 6.90 | 7.10 | 7.90 | 2.05 | 1.60 | 6.80 | 6.20 | 7.30 | 1.95 | 1.40 | 6.70 | 5.50 | 7.00 | | | | |
| 2220 | 5650 | 2.85 | 2.10 | 5.50 | 8.80 | 6.50 | 2.75 | 1.90 | 5.40 | 7.90 | 5.90 | 2.65 | 1.70 | 5.30 | 7.20 | 5.60 | | | | |
| 2225 | 5664 | 2.85 | 2.10 | 6.90 | 8.80 | 7.90 | 2.75 | 1.90 | 6.80 | 7.90 | 7.30 | 2.65 | 1.70 | 6.70 | 7.20 | 7.00 | | | | |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes. **Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

Image below based on Density Level B for an EIA 1210 case size.





Soldering Process

Recommended Soldering Technique:

- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- · All other EIA case sizes are limited to solder reflow only

Recommended Reflow Soldering Profile:

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

T,

emperature

| Profile Feature | Terminat | ion Finish |
|--|-----------------------|-----------------------|
| Fromereature | SnPb | 100% Matte Sn |
| Preheat/Soak | | |
| Temperature Minimum (T _{smin}) | 100°C | 150°C |
| Temperature Maximum (T _{Smax}) | 150°C | 200°C |
| Time (t_s) from T_{smin} to T_{smax} | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-Up Rate (T_L to T_p) | 3°C/second maximum | 3°C/second maximum |
| Liquidous Temperature (T _L) | 183°C | 217°C |
| Time Above Liquidous (t_L) | 60 – 150 seconds | 60 – 150 seconds |
| Peak Temperature (T _P) | 235°C | 260°C |
| Time Within 5°C of Maximum Peak Temperature (t _p) | 20 seconds maximum | 30 seconds maximum |
| Ramp-Down Rate $(T_p to T_l)$ | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to Peak Temperature | 6 minutes maximum | 8 minutes maximum |



Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature – reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.



Construction





Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a "K" to identify KEMET, followed by two characters (per EIA–198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the "K" character only.

Laser marking option is not available on:

- COG, ultra stable X8R and Y5V dielectric devices.
- EIA 0402 case size devices.
- EIA 0603 case size devices with flexible termination option.
- KPS commercial and automotive grade stacked devices.
- X7R dielectric products in capacitance values outlined below.

| EIA Case Size | Metric Size Code | Capacitance |
|---------------|------------------|-------------|
| 0603 | 1608 | ≤ 170 pF |
| 0805 | 2012 | ≤ 150 pF |
| 1206 | 3216 | ≤ 910 pF |
| 1210 | 3225 | ≤ 2,000 pF |
| 1808 | 4520 | ≤ 3,900 pF |
| 1812 | 4532 | ≤ 6,700 pF |
| 1825 | 4564 | ≤ 0.018 µF |
| 2220 | 5650 | ≤ 0.027 µF |
| 2225 | 5664 | ≤ 0.033 µF |

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 μ F. Orientation of marking is vendor optional.





Capacitor Marking (Optional) cont.

| | C | apacita | ance (p | F) For \ | /arious | Alpha/ | Numera | al Identif | iers | |
|-----------|------|---------|---------|----------|---------|---------|---------|------------|------------|-------------|
| Alaha | | | | | | Numera | l I | | | |
| Alpna | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Character | | | | | Сара | citance | e (pF) | | | |
| A | 0.10 | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 |
| В | 0.11 | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 |
| С | 0.12 | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 |
| D | 0.13 | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 |
| E | 0.15 | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 |
| F | 0.16 | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 |
| G | 0.18 | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 |
| Н | 0.20 | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 |
| J | 0.22 | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 |
| К | 0.24 | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 |
| L | 0.27 | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 |
| М | 0.30 | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 |
| N | 0.33 | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 |
| Р | 0.36 | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 |
| Q | 0.39 | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 |
| R | 0.43 | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 |
| S | 0.47 | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 |
| Т | 0.51 | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 |
| U | 0.56 | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 |
| V | 0.62 | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 |
| W | 0.68 | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 |
| Х | 0.75 | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 |
| Y | 0.82 | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 |
| Z | 0.91 | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 |
| а | 0.25 | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 |
| b | 0.35 | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 |
| d | 0.40 | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 |
| е | 0.45 | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 |
| f | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 |
| у | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 |



Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.



Table 4 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| | Tape | Embosse | ed Plastic | Punche | d Paper |
|----------------------|------|---------|--------------------|---------|--------------------|
| EIA Case Size | Size | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| | (W)* | Pitch | (P ₁)* | Pitch | (P ₁)* |
| 01005 - 0402 | 8 | | | 2 | 2 |
| 0603 | 8 | | | 2/4 | 2/4 |
| 0805 | 8 | 4 | 4 | 4 | 4 |
| 1206 - 1210 | 8 | 4 | 4 | 4 | 4 |
| 1805 - 1808 | 12 | 4 | 4 | | |
| ≥ 1812 | 12 | 8 | 8 | | |
| KPS 1210 | 12 | 8 | 8 | | |
| KPS 1812 and 2220 | 16 | 12 | 12 | | |
| Array 0612 | 8 | 4 | 4 | | |

*Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations. *Refer to Tables 5 and 6 for tolerance specifications.

New 2 mm Pitch Reel Options*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options |
|--|------------------------------------|
| C-3190 | Automotive grade 7" reel unmarked |
| C-3191 | Automotive grade 13" reel unmarked |
| C-7081 | Commercial grade 7" reel unmarked |
| C-7082 | Commercial grade 13" reel unmarked |

* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.



Figure 1 – Embossed (Plastic) Carrier Tape Dimensions



Table 5 - Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| | | (| Constant Dim | ensions – Mil | limeters (Inc | hes) | | | |
|-----------|----------------------|------------------------|-----------------------|-----------------------------------|-----------------------------------|---------------|------------------------|--------------------------------|--------------------|
| Tana Ciza | n | D ₁ Minimum | F | Р | П | R Reference | S ₁ Minimum | Т | T ₁ |
| Tape Size | D ₀ | Note 1 | E ₁ | P ₀ | P ₂ | Note 2 | Note 3 | Maximum | Maximum |
| 8 mm | | 1.0 | | | | 25.0 | | | |
| | | (0.039) | 175.040 | 4.0.0.40 | 0.0.005 | (0.984) | | 0.600 | 0.400 |
| 12 mm | 1.5 +0.10/-0.0 | | 1./5 ±0.10 | 4.0 ±0.10 | 2.0 ±0.05 | | 0.600 | 0.600 | 0.100 |
| | (0.059 +0.004/-0.0) | 1.5 | (0.069 ±0.004) | (0.157 ±0.004) | (0.079 ±0.002) | 30 | (0.024) | (0.024) | (0.004) |
| 16 mm | | (0.059) | | | | (1.181) | | | |
| | | 1 Г | 175 10 10 | 4.0 + 0.10 | 0.0.10.10 | 20 | F | 0.050 | 0.050 |
| 24 mm | $1.5 \pm 0.10 - 0.0$ | 1.5 | 1.75 ± 0.10 | 4.0 ± 0.10 (0.157 ± 0.004) | 2.0 ± 0.10 (0.079 ± 0.002) | 30 (1 101) | 5 (0.106) | 0.250 | 0.350 |
| | (0.03910.0047 0.0) | (0.039) | (0.009 ±0.004) | (0.137 ±0.004) | (0.078 ±0.003) | (1.101) | (0.190) | (0.009) | (0.013) |
| | | | Variable Dime | ensions — Mil | limeters (Incl | nes) | | | |
| Tana Cina | Ditah | B ₁ Maximum | E, | F | D | Τ, | W | A D | 0.1/ |
| Tape Size | Plich | Note 4 | Minimum | F | P ₁ | Maximum | Maximum | А ₀ ,В ₀ | ο α κ _ο |
| 0 mm | Single (4 mm) | 4.35 | 6.25 | 3.5 ±0.05 | 4.0 ±0.10 | 2.5 | 8.3 | | |
| 0 11111 | Siligie (4 min) | (0.171) | (0.246) | (0.138 ±0.002) | (0.157 ±0.004) | (0.098) | (0.327) | | |
| 10 mm | Single (4 mm) | 8.2 | 10.25 | 5.5 ±0.05 | 8.0 ±0.10 | 4.6 | 12.3 | | |
| 12 11111 | and Double (8 mm) | (0.323) | (0.404) | (0.217 ±0.002) | (0.315 ±0.004) | (0.181) | (0.484) | Not | to E |
| 16 mm | Triple (12 mm) | 12.1 | 14.25 | 7.5 ±0.05 | 12.0 ±0.10 | 4.6 | 16.3 | NU | le 5 |
| 10 11111 | | (0.476) | (0.561) | (0.138 ±0.002) | (0.157 ±0.004) | (0.181) | (0.642) | | |
| 24 mm | 16 mm | 11.5 | 22.25 | 11.5 ±0.10 | 16.0 ±0.10 | 3 | 24.3 | | |
| Z4 11111 | 10 11111 | (0.452) | (0.075) | (0 452 10 002) | (0 (00 1 0 00 4) | (0 110) | | | |

1. The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.

2. The tape with or without components shall pass around R without damage (see Figure 6).

3. If S₁ < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Standard 481 paragraph 4.3 section b).

4. B, dimension is a reference dimension for tape feeder clearance only.

5. The cavity defined by A_{μ} , B_{μ} and K_{μ} shall surround the component with sufficient clearance that:

(a) the component does not protrude above the top surface of the carrier tape.

(b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3).

(d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4).

(e) for KPS product, A_a and B_a are measured on a plane 0.3 mm above the bottom of the pocket.

(f) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.



Figure 2 – Punched (Paper) Carrier Tape Dimensions



Table 6 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| | | Constant [| Dimensions — M | lillimeters (Inch | es) | | |
|-----------|---------------------------------------|------------------------------|-----------------------------|-----------------------------|----------------------------|-----------------|-------------------------------|
| Tape Size | D _o | E ₁ | Po | P ₂ | T ₁ Maximum | G Minimum | R Reference Note 2 |
| 8 mm | 1.5 +0.10 -0.0 (0.059 +0.004 -0.0) | 1.75 ±0.10 (0.069 ±0.004) | 4.0 ±0.10 (0.157 ±0.004) | 2.0 ±0.05 (0.079 ±0.002) | 0.10 (0.004) Maximum | 0.75 (0.030) | 25 (0.984) |
| | | Variable D | imensions — M | illimeters (Inch | es) | | |
| Tape Size | Pitch | E2 Minimum | F | P ₁ | T Maximum | W Maximum | A ₀ B ₀ |
| 8 mm | Half (2 mm) | 6.25 | 3.5 ±0.05 | 2.0 ±0.05 (0.079 ±0.002) | 1.1 | 8.3 (0.327) | Noto 1 |
| 8 mm | Single (4 mm) | (0.246) | (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | (0.098) | 8.3 (0.327) | Note I |

1. The cavity defined by A_{α} , B_{α} and T shall surround the component with sufficient clearance that:

a) the component does not protrude beyond either surface of the carrier tape.

b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.

c) rotation of the component is limited to 20° maximum (see Figure 3).

d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4).

e) see addendum in EIA Standard 481 for standards relating to more precise taping requirements.

2. The tape with or without components shall pass around R without damage (see Figure 6).



Packaging Information Performance Notes

- 1. Cover Tape Break Force: 1.0 kg minimum.
- 2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

| Tape Width | Peel Strength |
|--------------|----------------------------------|
| 8 mm | 0.1 to 1.0 Newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 Newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of $300 \pm 10 \text{ mm/minute}$.

3. Labeling: Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624*.

Figure 3 – Maximum Component Rotation



Figure 4 – Maximum Lateral Movement



Figure 5 – Bending Radius





Figure 6 – Reel Dimensions



Note: Drive spokes optional; if used, dimensions B and D shall apply.

Table 7 – Reel Dimensions

Metric will govern

| Constant Dimensions – Millimeters (Inches) | | | | |
|--|---|---------------------------------------|--|---|
| Tape Size | А | B Minimum | С | D Minimum |
| 8 mm | 178 ±0.20 (7.008 ±0.008) or 330 ±0.20 (13.000 ±0.008) | 1.5 (0.059) | 13.0 +0.5/-0.2 (0.521 +0.02/-0.008) | 20.2 (0.795) |
| 12 mm | | | | |
| 16 mm | | | | (0 |
| 24 mm | | 1.2 (0.047) | 13.0 ±0.2 (0.521 ±0.008) | 21 (0.826) |
| Variable Dimensions – Millimeters (Inches) | | | | |
| Tape Size | N Minimum | W ₁ | W ₂ Maximum | W ₃ |
| 8 mm | 50 (1.969) | 8.4 +1.5/-0.0 (0.331 +0.059/-0.0) | 14.4 (0.567) | Shall accommodate tape width without interference |
| 12 mm | | 12.4 +2.0/-0.0 (0.488 +0.078/-0.0) | 18.4 (0.724) | |
| 16 mm | | 16.4 +2.0/-0.0 (0.646 +0.078/-0.0) | 22.4 (0.882) | |
| 24 mm | | 25 +1.0/-0.0 (0.984 +0.039/-0.0) | 27.4 ±1.0 (1.078 ±0.039) | |



Figure 7 – Tape Leader & Trailer Dimensions



Figure 8 – Maximum Camber



Алматы (7273)495-231 Ангарск (3955)60-70-56 Архангельск (8182)63-90-72 Астрахань (8512)99-46-04 Бариаул (3852)73-04-60 Белгород (4722)40-23-64 Благовещенск (4162)22-76-07 Брянск (4832)59-03-52 Владивосток (423)249-28-31 Владикаеказ (8672)28-90-48 Владимир (4922)49-43-18 Волгоград (844)278-03-48 Волоград (841278-03-48 Воронеж (473)204-51-73 Екатеринбург (343)384-55-89

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Тольятти (8482)63-91-07 Томск (3822)98-41-53 Тула (4872)33-79-87 Тюмень (3452)66-21-18 Улан-Иза (3012)59-97-51 Уфа (347)229-48-12 Хабаровск (4212)92-98-04 Чебоксары (8352)28-53-07 Челябинск (351)202-03-61 Череповец (8202)49-02-64 Чита (3022)38-34-83 Якутск (4112)23-90-97 Яроспавть (4852)69-52-93