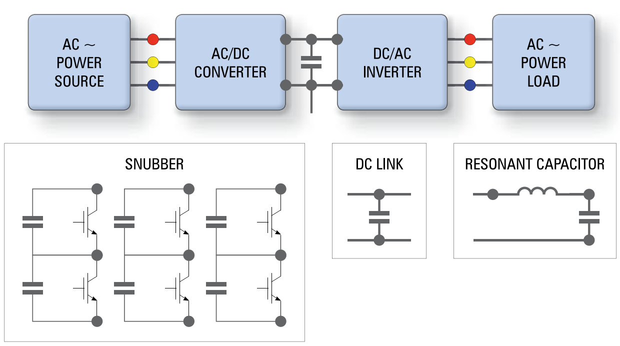
Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs)

KC-LINK™ for Fast Switching Semiconductor Applications DC Link, Snubber, Resonator Capacitor, 150°C (Commercial & Automotive Grade)

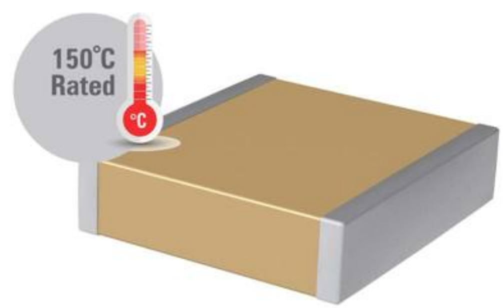
Overview

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 C0G/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.



KC-LINK C0G 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.



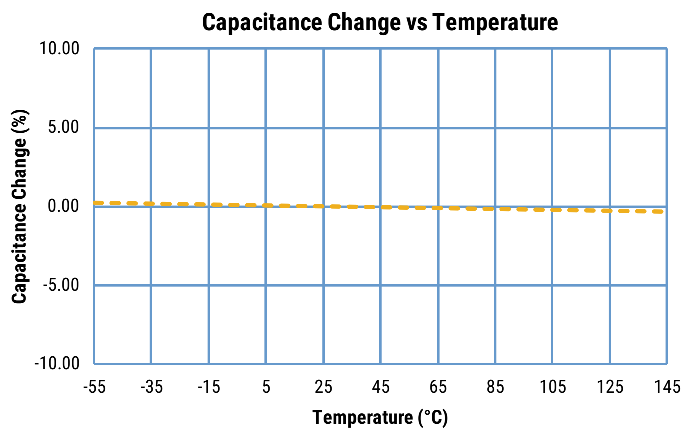
Benefits

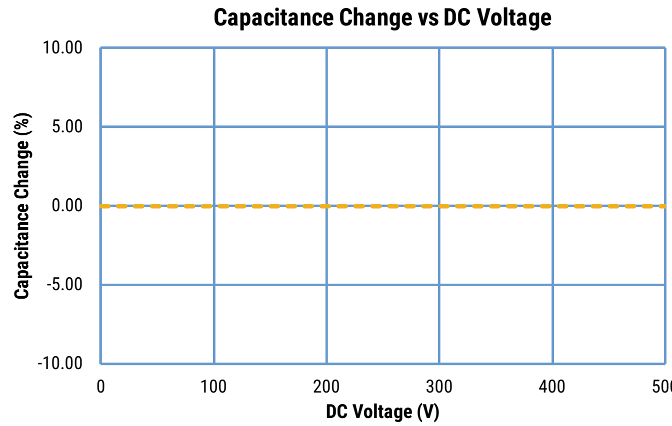
- EIA 1812, 2220, and 3640 case size
- AEC–Q200 automotive qualified
- Flexible termination option available
- Very high ripple current capability
- Extremely low equivalent series resistance (ESR)
- Extremely low equivalent series inductance (ESL)
- Operating temperature range of −55°C to +150°C
- High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

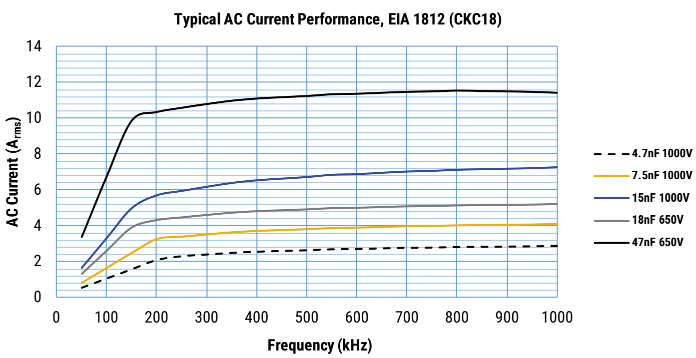
Applications

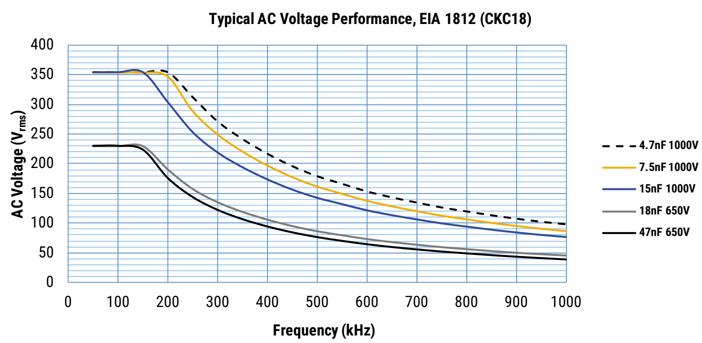
- Wide bandgap (WBG), silicon carbide (SiC) and gallium nitride (GaN) systems
- EV/HEV (drive systems, charging)
- Wireless charging
- Photovoltaic systems
- Power converters
- Inverters
- LLC resonant converters
- DC link
- Snubber

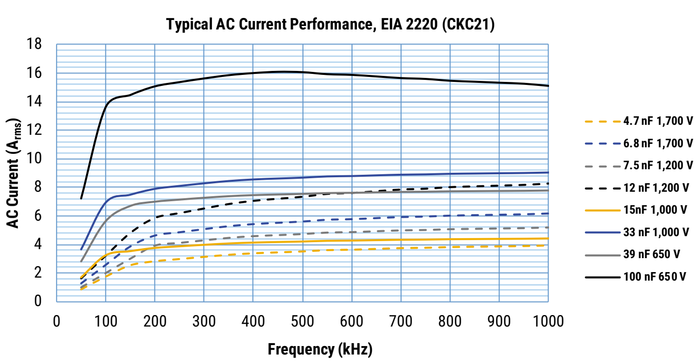
Typical Performance

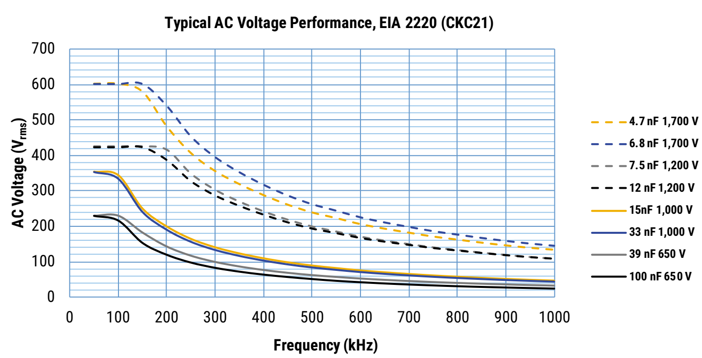


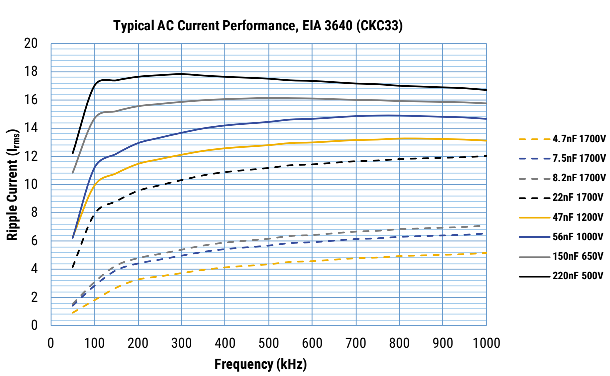


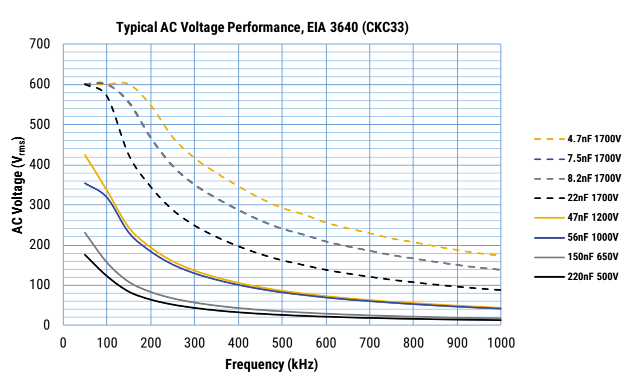












**Ripple current measurements conditions.- Ripple current measurement were took under ambient temperature. Ripple current measurements performed with a peak capacitor temperature of 150°C. Samples mounted to heat sink with no forced air cooling.*

Ordering Information

CKC	33	C	224	K	C	G	A	C	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 = C0G	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.

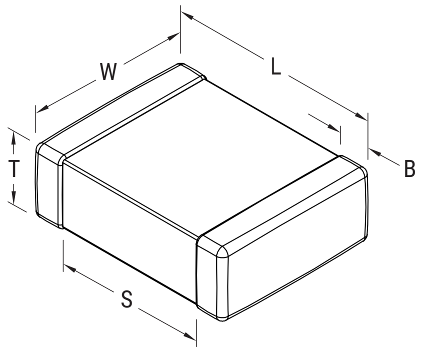
Packaging C-Spec Ordering Options Table

Packaging Type	Packaging/Grade Ordering Code (C-Spec)
Commercial Grade	
Bulk Bag[1]/Unmarked	Not required (Blank)
7" Reel/Unmarked	TU
13" Reel (Embossed Plastic Tape)/Unmarked	7210
Automotive Grade[2]	
7" Reel	AUTO
13" Reel (Embossed Plastic Tape)/Unmarked	AUTO7210

[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)	See Table 2 for Thickness	0.60 (0.024) ±0.35 (0.014)	N/A	Solder Reflow Only
21	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)		
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 Thickness	0.70 (0.028) ±0.35 (0.014)	N/A	Solder Reflow Only
21	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 1 – Capacitance Range/Selection Waterfall Standard Termination

Capacitance	Capacitance Code	Case Size/Series					CKC18C			CKC21C					CKC33C					
							1812			2220					3640					
		Voltage Code					C	W	D	C	W	D	E	J	C	W	D	E	J	G
		Rated Voltage (VDC)					500	650	1000	500	650	1000	1200	1700	500	650	1000	1200	1700	2000
		Capacitance Tolerance					Product Availability and Chip Thickness Codes See Packaging Specs for Chip Thickness Dimensions													
4,700 pF	472	F	G	J	K	M	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	M	GO	GO	GO	JE	JE	JE			MC	MC	MC	MC	MC	MC
18,000 pF	183	F	G	J	K	M	GH	GH		JE	JE	JE			MC	MC	MC	MC	MC	
22,000 pF	223	F	G	J	K	M	GH	GH		JK	JK	JK			MC	MC	MC	MC	MC	
27,000 pF	273	F	G	J	K	M	GK	GK		JL	JL	JL			MB	MB	MB	MB		
33,000 pF	333	F	G	J	K	M	GM	GM		JN	JN	JN			MB	MB	MB	MB		
39,000 pF	393	F	G	J	K	M	GO	GO		JE	JE				MC	MC	MC	MC		
47,000 pF	473	F	G	J	K	M	GO	GO		JE	JE				MC	MC	MC	MC		
56,000 pF	563	F	G	J	K	M				JK	JK				MC	MC	MC			
68,000 pF	683	F	G	J	K	M				JL	JL				MC	MC				
82,000 pF	823	F	G	J	K	M				JL	JL				MB	MB				
0.1 µF	104	F	G	J	K	M				JN	JN				MB	MB				
0.12 µF	124	F	G	J	K	M									MB	MB				
0.15 µF	154	F	G	J	K	M									MC	MC				
0.18 µF	184	F	G	J	K	M									MC					
0.22 µF	224	F	G	J	K	M									MC					
Capacitance	Capacitance Code	Rated Voltage (VDC)					500	650	1000	500	650	1000	1200	1700	500	650	1000	1200	1700	2000
		Voltage Code					C	W	D	C	W	D	E	J	C	W	D	E	J	G
		Case Size/Series					1812			2220					3640					
							CKC18C			CKC22C					CKC33C					

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

Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Plastic Quantity		Thickness Code	Case Size[1]	Thickness ± Range (mm)	Plastic Quantity	
			7" Reel	13" Reel				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 Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	Thickness Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel
			Plastic Quantity					Plastic Quantity	

Package quantity based on finished chip thickness specifications.

Table 3 – Performance & Reliability: Test Methods and Conditions

<table>
<tr><th>Test</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Visual and Mechanical</td><td>KEMET Internal</td><td>No defects that may affect performance (10X)</td><td>Dimensions according KEMET Spec Sheet</td></tr>
<tr><td>Capacitance (Cap)</td><td>KEMET Internal</td><td>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</td><td>Within Tolerance</td></tr>
<tr><td>Dissipation Factor (DF)</td><td>KEMET Internal</td><td>1 kHz ±50 Hz and 1.0 ±0.2 V_{rms}</td><td>Dissipation factor (DF) maximum limit at 25°C = 0.1%</td></tr>
<tr><td>Insulation Resistance (IR)</td><td>KEMET Internal</td><td>500 VDC applied for 120±5 seconds at 25°C</td><td>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</td></tr>
<tr><td>Temperature Coefficient of Capacitance (TCC)</td><td>KEMET Internal</td><td>Frequency: 1 kHz ±50 Hz
Capacitance change with reference to +25°C and 0 VDC applied.
* See part number specification sheet for voltage
<table>
<tr><th>Step</th><th>Temperature (°C)</th></tr>
<tr><td>1</td><td>+25°C</td></tr>
<tr><td>2</td><td>−55°C</td></tr>
<tr><td>3</td><td>+25°C (Reference)</td></tr>
<tr><td>4</td><td>+150°C</td></tr>
</table></td><td>±30 PPM / °C</td></tr>
<tr><td>Dielectric Withstanding Voltage (DWV)</td><td>KEMET Internal</td><td>
<table>
<tr><th>Rated DC Voltage</th><th>DWV Voltage (% of Rated)</th></tr>
<tr><td>500 V</td><td>150%</td></tr>
<tr><td>650 V</td><td>130%</td></tr>
<tr><td>≥ 1,000 V</td><td>120%</td></tr>
</table>
(5 ±1 seconds and charge/discharge not exceeding 50 mA)</td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit

Withstand test voltage without insulation breakdown or damage.</td></tr>
<tr><td>Aging Rate (Maximum % Capacitance Loss/Decade Hour)</td><td>KEMET Internal</td><td>Maximum % capacitance loss/decade hour</td><td>0% Loss/Decade Hour</td></tr>
<tr><td>Terminal Strength</td><td>Kemet Internal</td><td>Shear stress test per specific case size, Time: 60±1 seconds
<table>
<tr><th>Case Size</th><th>Force</th></tr>
<tr><td>3640</td><td>18N</td></tr>
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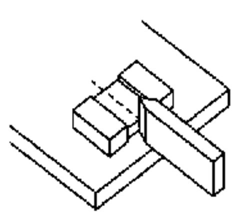
</td><td>No evidence of mechanical damage</td></tr>
</table>

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

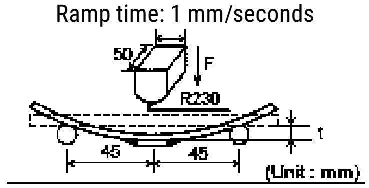
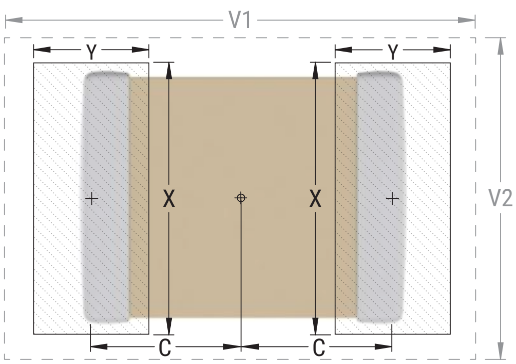
Test	Reference	Test Condition	Limits
Board Flex	AEC-Q200-005	Standard Termination system 3.0 mm Test time: 60±5 seconds Ramp time: 1 mm/seconds  	No evidence of mechanical damage
Solderability	J-STD-002	Magnification 50X. Conditions: a) Method B, 4 hours at 155°C, dry heat at 235°C b) Method B at 215°C 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 Method 108	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 IR: 10% of Initial Limit DF Limits Maximum: 0.5%
Storage Life		1,000 hours at 150°C, Unpowered	
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				
			C	Y	X	V1	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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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			○		

[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

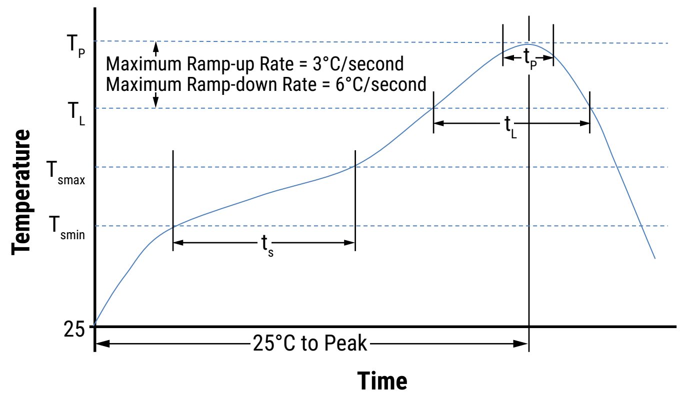
Soldering Process

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.

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.

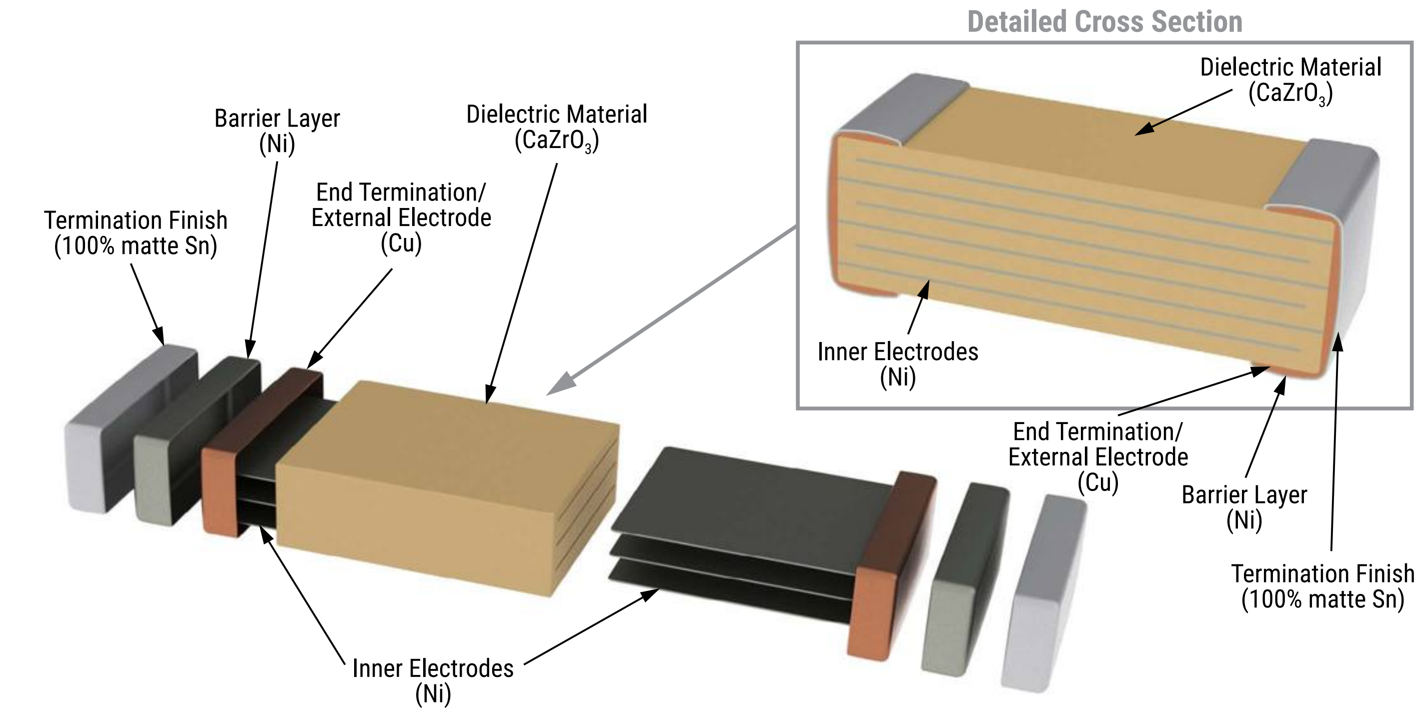


Storage & Handling

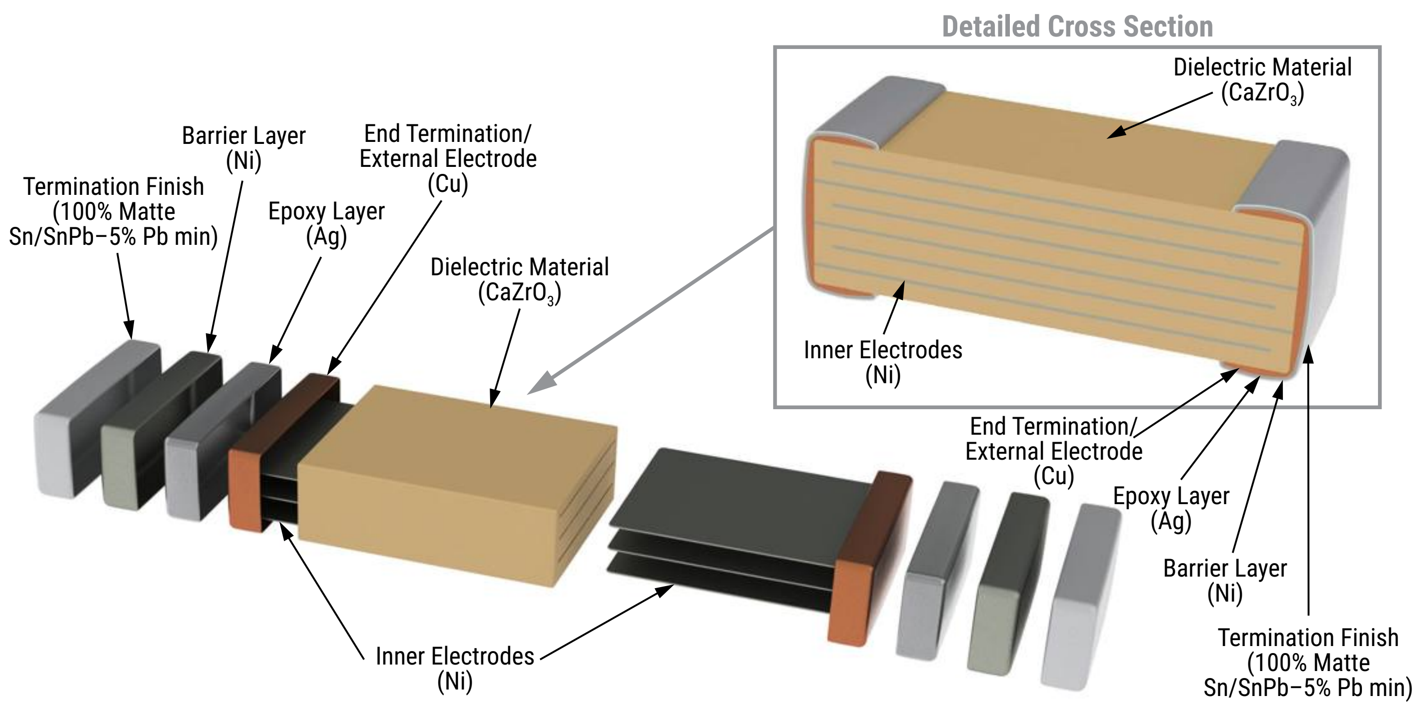
Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will 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

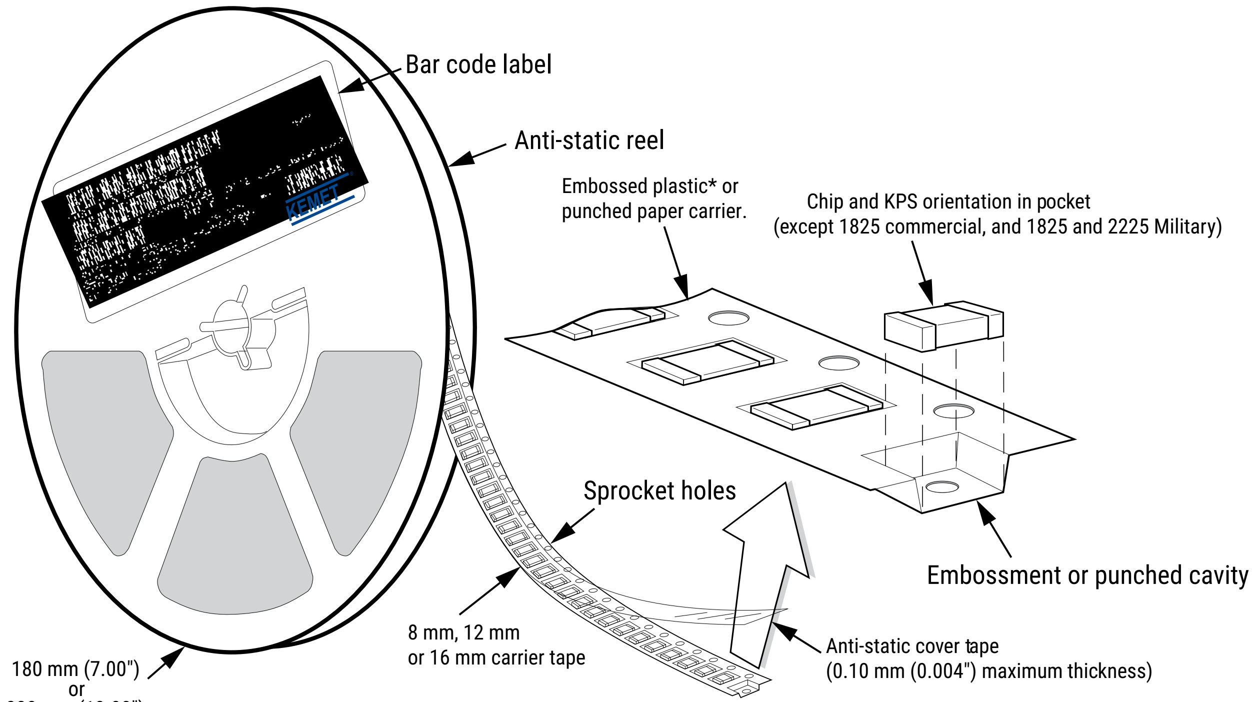


Flex Termination



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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic	
		7" Reel	13" Reel
		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

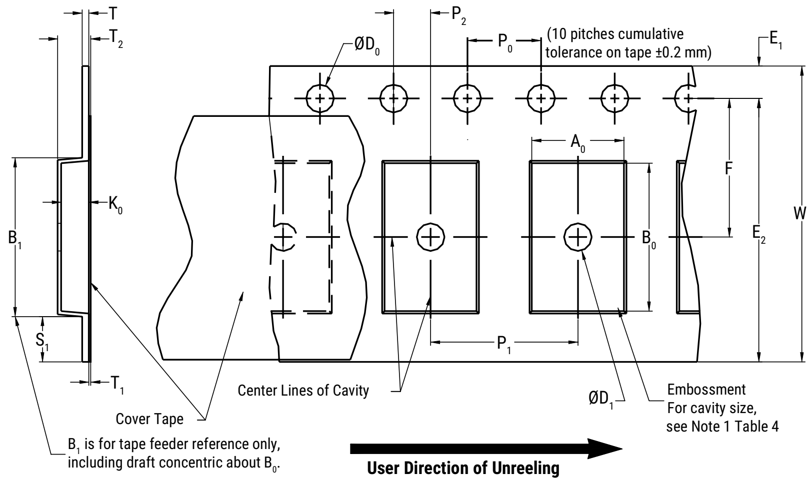


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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)
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	
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)	Note 5	
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)		

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_0, B_0 and K_0 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

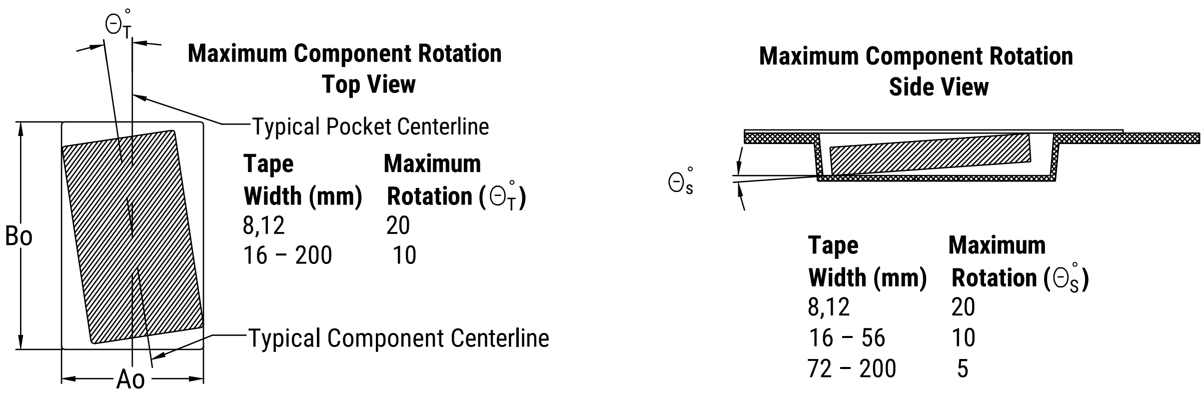


Figure 3 – Maximum Lateral Movement

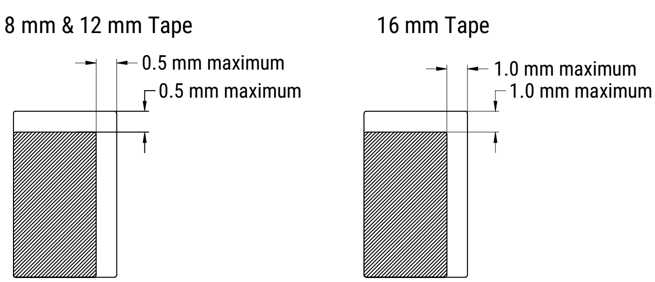


Figure 4 – Bending Radius

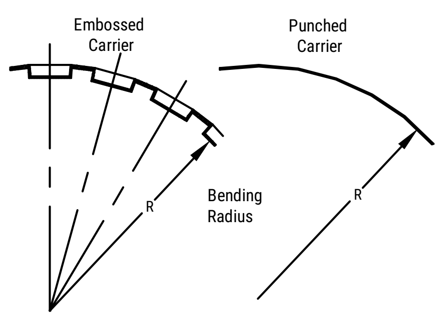
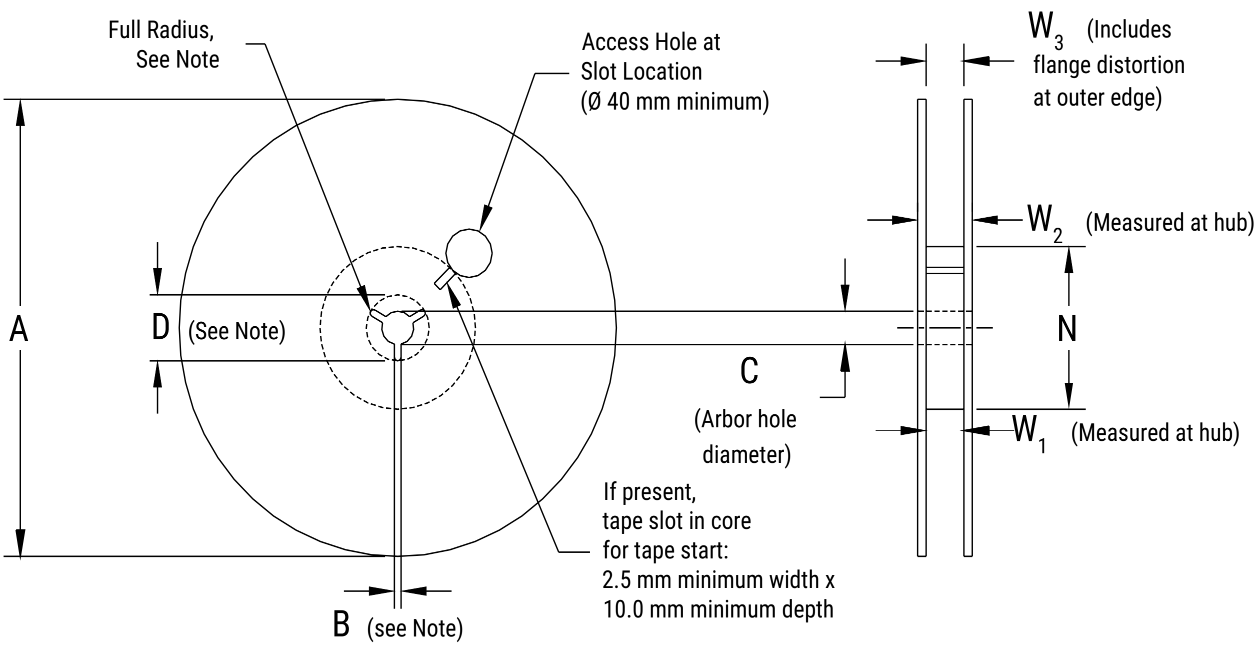


Figure 5 – Reel Dimensions



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	C	D Minimum
12 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)
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
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
24 mm		25 +1.0/−0.0 (0.984 +0.039/−0.0)	27.4 ±1.0 (1.078 ±0.039)	

Figure 6 – Tape Leader & Trailer Dimensions

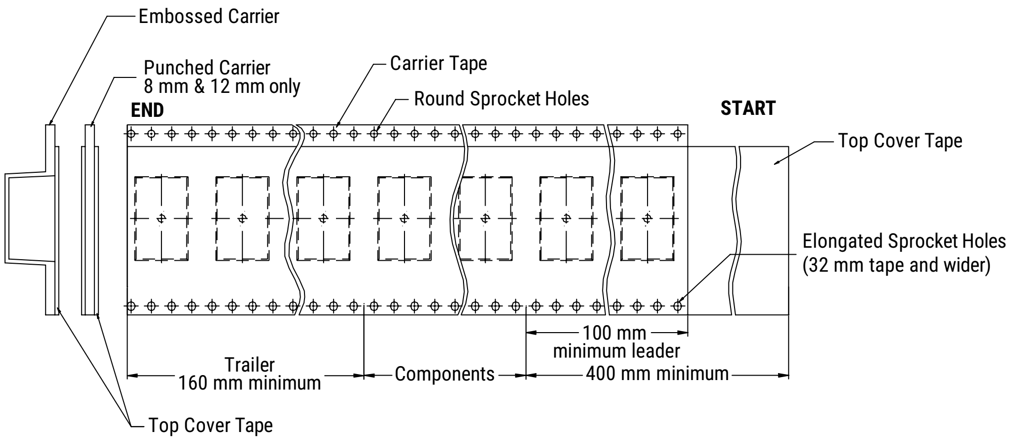
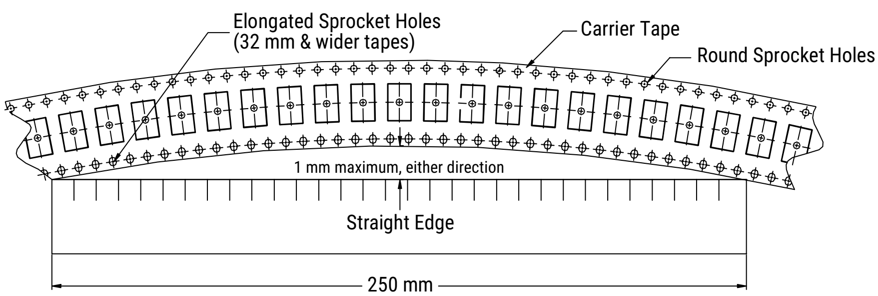


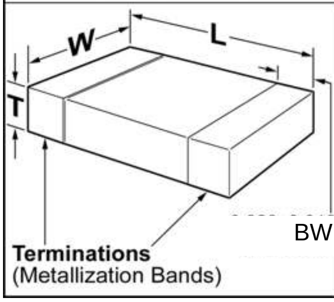
Figure 7 – Maximum Camber



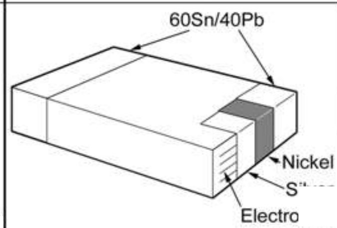
CERAMIC CHIP/MIL-PRF-55681

CAPACITOR OUTLINE DRAWINGS

CHIP DIMENSIONS

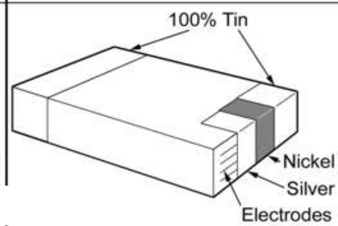


SOLDER COATED



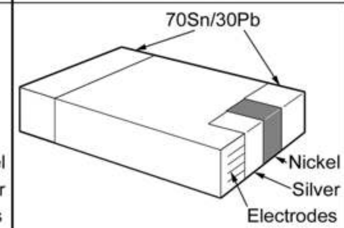
Military Designation - **S**
KEMET Designation - **H**

TIN PLATED



Military Designation - **Y**
KEMET Designation - **C**

SOLDER PLATED



Military Designation - **Z**, **U**, or **W**
KEMET Designation - **L**

DIMENSIONS—MILLIMETERS AND (INCHES)

STYLE	KEMET SIZE CODE	L	W	T MIN.	T 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	4.57 +.51 –.38 (.180 +.020 –.015)	6.35 +.51 –.38 (.250 +.020 –.015)	.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	Width
CDR01	0.51MM (.020)	0.38MM (.015)
CDR02-06	0.64MM (.025)	0.38MM (.015)
CDR31-35	0.60MM (.023)	0.30MM (.012)

MIL-PRF-55681 PART NUMBER ORDERING INFORMATION

CDR01 B P 101 B K Z M

STYLE & SIZE CODE
STYLE
C— Ceramic
D— Dielectric, Fixed Chip
R— Established Reliability

RATED TEMPERATURE
–55°C to +125°C

DIELECTRICS
P—± 30 PPM/°C—WITH OR WITHOUT VOLTAGE
X—± 15%—without voltage
+ 15%, –25%—with voltage

CAPACITANCE
Expressed in picofarads (pF).
First 2 digits represent significant figures and the last digit specifies the number of zeros to follow.
(Use 9 for 1.0 through 9.9pF. Example: 2.2pF = 229)

FAILURE RATE LEVEL (%/1000 hrs.)
M — 1.0 R — 0.01
P — 0.1 S — 0.001

TERMINATION FINISH
S — Solder Coated, Final
U — Base Metalization—Barrier Metal—Solder Coated
Z – Base metallization - barrier metal-tinned (tin/lead alloy, with a min. of 4% lead)
W — Base Metalization—Barrier Metal—Tinned Tin or (Tin/Lead Alloy)
Y — Base Metalization Barrier Metal—Tinned (100% Tin)

CAPACITANCE TOLERANCE

B	C	D	F	J	K	M
±.1 pF	±.25 pF	±.5 pF	±1%	±5%	±10%	±20%

RATED VOLTAGE
A — 50; B — 100

KEMET/MIL-PRF-55681 PART NUMBER EQUIVALENTS

C 0805 P 101 K 1 G M L

CERAMIC

SIZE CODE
See Table Above

SPECIFICATION
P-MIL-PRF-55681 = CDR01-CDR06
N-MIL-PRF-55681 = CDR31-CDR35

CAPACITANCE CODE
Expressed in picofarads (pF).
First two digits represent significant figures.
Third digit specifies number of zeros. (Use 9 for 1.0 thru 9.9 pF. Example: 2.2 pF –229)

CAPACITANCE TOLERANCE

B	C	D	F	J	K	M
±.1 pF	±.25 pF	±.5 pF	±1%	±5%	±10%	±20%

END METALIZATION
L — 70Sn/30Pb Plated (Military codes Z,W,U)
C— 100% Tin Plated (Military code Y)
H – Sn60 Coated (Military code S)

FAILURE RATE (%/1,000 hrs.)
M — 1.0 R — 0.01
P — 0.1 S — 0.001

VOLTAGE TEMPERATURE CHARACTERISTIC
Designated by Capacitance Change Over Temperature Range
G — BP (C0G/NP0) (±30 PPM/°C)
X — BX (±15% Without Voltage +15% -25% With Voltage)

VOLTAGE
1 — 100V, 5 — 50V

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

RATINGS & PART NUMBER REFERENCE

Charac-teristics	Cap pF	Avail. Tol.	KEMET Part Number	MIL-PRF-55681 Part Number
100 Volt - C0805 Size (Military CDR01)				
BP	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)
	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 BX	120	J,K	C0805P121(3)1(2)(4)L	CDR01B(1)121B(3)Z(4)
	150	J,K	C0805P151(3)1(2)(4)L	CDR01B(1)151B(3)Z(4)
	180	J,K	C0805P181(3)1(2)(4)L	CDR01B(1)181B(3)Z(4)
BX	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	K	C0805P391K1X(4)L	CDR01BX391BKZ(4)
	470	K,M	C0805P471(3)1X(4)L	CDR01BX471B(3)Z(4)
	560	K	C0805P561K1X(4)L	CDR01BX561BKZ(4)
	680	K,M	C0805P681(3)1X(4)L	CDR01BX681B(3)Z(4)
	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	K	C0805P272K1X(4)L	CDR01BX272BKZ(4)
	3,300	K,M	C0805P332(3)1X(4)L	CDR01BX332B(3)Z(4)
50 Volt - C0805 Size (Military CDR01)				
BX	3,900	K	C0805P392K5X(4)L	CDR01BX392AKZ(4)
	4,700	K,M	C0805P472(3)5X(4)L	CDR01BX472A(3)Z(4)
100 Volt - C1805 Size (Military CDR02)				
BP	220	J,K	C1805P221(3)1G(4)L	CDR02BP221B(3)Z(4)
	270	J	C1805P271J1G(4)L	CDR02BP271BJZ(4)
BX	3,900	K	C1805P392K1X(4)L	CDR02BX392BKZ(4)
	4,700	K,M	C1805P472(3)1X(4)L	CDR02BX472B(3)Z(4)
	5,600	K	C1805P562K1X(4)L	CDR02BX562BKZ(4)
	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 CDR02)				
BX	12,000	K	C1805P123K5X(4)L	CDR02BX123AKZ(4)
	15,000	K,M	C1805P153(3)5X(4)L	CDR02BX153A(3)Z(4)
	18,000	K	C1805P183K5X(4)L	CDR02BX183AKZ(4)
	22,000	K,M	C1805P223(3)5X(4)L	CDR02BX223A(3)Z(4)
100 Volt - C1808 Size (Military CDR03)				
BP	330	J,K	C1808P331(3)1G(4)L	CDR03BP331B(3)Z(4)
	390	J	C1808P391J1G(4)L	CDR03BP391BJZ(4)
	470	J,K	C1808P471(3)1G(4)L	CDR03BP471B(3)Z(4)

Charac-teristics	Cap pF	Avail. Tol.	KEMET Part Number	MIL-PRF-55681 Part Number
100 Volt - C1808 Size (Military CDR03) cont.				
BP	560	J	C1808P561J1G(4)L	CDR03BP561BJZ(4)
	680	J,K	C1808P681(3)1G(4)L	CDR03BP681B(3)Z(4)
	820	J	C1808P821J1G(4)L	CDR03BP821BJZ(4)
	1,000	J,K	C1808P102(3)1G(4)L	CDR03BP102B(3)Z(4)
BX	12,000	K	C1808P123K1X(4)L	CDR03BX123BKZ(4)
	15,000	K,M	C1808P153(3)1X(4)L	CDR03BX153B(3)Z(4)
	18,000	K	C1808P183K1X(4)L	CDR03BX183BKZ(4)
	22,000	K,M	C1808P223(3)1X(4)L	CDR03BX223B(3)Z(4)
	27,000	K	C1808P273K1X(4)L	CDR03BX273BKZ(4)
	33,000	K,M	C1808P333(3)1X(4)L	CDR03BX333B(3)Z(4)
50 Volt - C1808 Size (Military CDR03)				
BX	39,000	K	C1808P393K5X(4)L	CDR03BX393AKZ(4)
	47,000	K,M	C1808P473(3)5X(4)L	CDR03BX473A(3)Z(4)
	56,000	K	C1808P563K5X(4)L	CDR03BX563AKZ(4)
	68,000	K,M	C1808P683(3)5X(4)L	CDR03BX683A(3)Z(4)
100 Volt - C1812 Size (Military CDR04)				
BP	1,200	J	C1812P122J1G(4)L	CDR04BP122BJZ(4)
	1,500	J,K	C1812P152(3)1G(4)L	CDR04BP152B(3)Z(4)
	1,800	J	C1812P182J1G(4)L	CDR04BP182BJZ(4)
	2,200	J,K	C1812P222(3)1G(4)L	CDR04BP222B(3)Z(4)
	2,700	J	C1812P272J1G(4)L	CDR04BP272BJZ(4)
	3,300	J,K	C1812P332(3)1G(4)L	CDR04BP332B(3)Z(4)
BX	39,000	K	C1812P393K1X(4)L	CDR04BX393BKZ(4)
	47,000	K,M	C1812P473(3)1X(4)L	CDR04BX473B(3)Z(4)
	56,000	K	C1812P563K1X(4)L	CDR04BX563BKZ(4)
50 Volt - C1812 Size (Military CDR04)				
BX	82,000	K	C1812P823K5X(4)L	CDR04BX823AKZ(4)
	100,000	K,M	C1812P104(3)5X(4)L	CDR04BX104A(3)Z(4)
	120,000	K	C1812P124K5X(4)L	CDR04BX124AKZ(4)
	150,000	K,M	C1812P154(3)5X(4)L	CDR04BX154A(3)Z(4)
	180,000	K	C1812P184K5X(4)L	CDR04BX184AKZ(4)
100 Volt - C1825 Size (Military CDR05)				
BP	3,900	J,K	C1825P392(3)1G(4)L	CDR05BP392B(3)Z(4)
	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)
BX	68,000	K,M	C1825P683(3)1X(4)L	CDR05BX683B(3)Z(4)
	82,000	K	C1825P823K1X(4)L	CDR05BX823BKZ(4)
	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 CDR05)				
BX	220,000	K,M	C1825P224(3)5X(4)L	CDR05BX224A(3)Z(4)
	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 CDR06)				
BP	6,800	J,K	C2225P682(3)1G(4)L	CDR06BP682B(3)Z(4)
	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 CDR06)				
BX	390,000	K	C2225P394K5X(4)L	CDR06BX394AKZ(4)
	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.

KEMET CHARGED.

RATINGS & PART NUMBER REFERENCE

Cap pF	Avail. Tol.	KEMET Part Number	MIL-PRF-55681 Part Number
100 Volt - BP - C0805 Size (Military CDR31)			
1.0	B,C	C0805N109(3)1G(4)L	CDR31BP1R0B(3)Z(4)
1.1	B,C	C0805N119(3)1G(4)L	CDR31BP1R1B(3)Z(4)
1.2	B,C	C0805C129(3)1G(4)L	CDR31BP1R2B(3)Z(4)
1.3	B,C	C0805N139(3)1G(4)L	CDR31BP1R3B(3)Z(4)
1.5	B,C	C0805N159(3)1G(4)L	CDR31BP1R5B(3)Z(4)
1.6	B,C	C0805N169(3)1G(4)L	CDR31BP1R6B(3)Z(4)
1.8	B,C	C0805N189(3)1G(4)L	CDR31BP1R8B(3)Z(4)
2.0	B,C	C0805N209(3)1G(4)L	CDR31BP2R0B(3)Z(4)
2.2	B,C	C0805N229(3)1G(4)L	CDR31BP2R2B(3)Z(4)
2.4	B,C	C0805N249(3)1G(4)L	CDR31BP2R4B(3)Z(4)
2.7	B,C,D	C0805N279(3)1G(4)L	CDR31BP2R7B(3)Z(4)
3.0	B,C,D	C0805N309(3)1G(4)L	CDR31BP3R0B(3)Z(4)
3.3	B,C,D	C0805N339(3)1G(4)L	CDR31BP3R3B(3)Z(4)
3.6	B,C,D	C0805N369(3)1G(4)L	CDR31BP3R6B(3)Z(4)
3.9	B,C,D	C0805N399(3)1G(4)L	CDR31BP3R9B(3)Z(4)
4.3	B,C,D	C0805N439(3)1G(4)L	CDR31BP4R3B(3)Z(4)
4.7	B,C,D	C0805N479(3)1G(4)L	CDR31BP4R7B(3)Z(4)
5.1	B,C,D	C0805N519(3)1G(4)L	CDR31BP5R1B(3)Z(4)
5.6	B,C,D	C0805N569(3)1G(4)L	CDR31BP5R6B(3)Z(4)
6.2	B,C,D	C0805N629(3)1G(4)L	CDR31BP6R2B(3)Z(4)
6.8	B,C,D	C0805N689(3)1G(4)L	CDR31BP6R8B(3)Z(4)
7.5	B,C,D	C0805N759(3)1G(4)L	CDR31BP7R5B(3)Z(4)
8.2	B,C,D	C0805N829(3)1G(4)L	CDR31BP8R2B(3)Z(4)
9.1	B,C,D	C0805N919(3)1G(4)L	CDR31BP9R1B(3)Z(4)
10	F,J,K	C0805N100(3)1G(4)L	CDR31BP100B(3)Z(4)
11	F,J,K	C0805N110(3)1G(4)L	CDR31BP110B(3)Z(4)
12	F,J,K	C0805N120(3)1G(4)L	CDR31BP120B(3)Z(4)
13	F,J,K	C0805N130(3)1G(4)L	CDR31BP130B(3)Z(4)
15	F,J,K	C0805N150(3)1G(4)L	CDR31BP150B(3)Z(4)
16	F,J,K	C0805N160(3)1G(4)L	CDR31BP160B(3)Z(4)
18	F,J,K	C0805N180(3)1G(4)L	CDR31BP180B(3)Z(4)
20	F,J,K	C0805N200(3)1G(4)L	CDR31BP200B(3)Z(4)
22	F,J,K	C0805N220(3)1G(4)L	CDR31BP220B(3)Z(4)
24	F,J,K	C0805N240(3)1G(4)L	CDR31BP240B(3)Z(4)
27	F,J,K	C0805N270(3)1G(4)L	CDR31BP270B(3)Z(4)
30	F,J,K	C0805N300(3)1G(4)L	CDR31BP300B(3)Z(4)
33	F,J,K	C0805N330(3)1G(4)L	CDR31BP330B(3)Z(4)
36	F,J,K	C0805N360(3)1G(4)L	CDR31BP360B(3)Z(4)
39	F,J,K	C0805N390(3)1G(4)L	CDR31BP390B(3)Z(4)
43	F,J,K	C0805N430(3)1G(4)L	CDR31BP430B(3)Z(4)
47	F,J,K	C0805N470(3)1G(4)L	CDR31BP470B(3)Z(4)
51	F,J,K	C0805N510(3)1G(4)L	CDR31BP510B(3)Z(4)
56	F,J,K	C0805N560(3)1G(4)L	CDR31BP560B(3)Z(4)
62	F,J,K	C0805N620(3)1G(4)L	CDR31BP620B(3)Z(4)
68	F,J,K	C0805N680(3)1G(4)L	CDR31BP680B(3)Z(4)
75	F,J,K	C0805N750(3)1G(4)L	CDR31BP750B(3)Z(4)
82	F,J,K	C0805N820(3)1G(4)L	CDR31BP820B(3)Z(4)

Cap pF	Avail. Tol.	KEMET Part Number	MIL-PRF-55681 Part Number
100 Volt - BP - C0805 Size (Military CDR31)			
91	F,J,K	C0805N910(3)1G(4)L	CDR31BP910B(3)Z(4)
100	F,J,K	C0805N101(3)1G(4)L	CDR31BP101B(3)Z(4)
110	F,J,K	C0805N111(3)1G(4)L	CDR31BP111B(3)Z(4)
120	F,J,K	C0805N121(3)1G(4)L	CDR31BP121B(3)Z(4)
130	F,J,K	C0805N131(3)1G(4)L	CDR31BP131B(3)Z(4)
150	F,J,K	C0805N151(3)1G(4)L	CDR31BP151B(3)Z(4)
160	F,J,K	C0805N161(3)1G(4)L	CDR31BP161B(3)Z(4)
180	F,J,K	C0805N181(3)1G(4)L	CDR31BP181B(3)Z(4)
200	F,J,K	C0805N201(3)1G(4)L	CDR31BP201B(3)Z(4)
220	F,J,K	C0805N221(3)1G(4)L	CDR31BP221B(3)Z(4)
240	F,J,K	C0805N241(3)1G(4)L	CDR31BP241B(3)Z(4)
270	F,J,K	C0805N271(3)1G(4)L	CDR31BP271B(3)Z(4)
300	F,J,K	C0805N301(3)1G(4)L	CDR31BP301B(3)Z(4)
330	F,J,K	C0805N331(3)1G(4)L	CDR31BP331B(3)Z(4)
360	F,J,K	C0805N361(3)1G(4)L	CDR31BP361B(3)Z(4)
390	F,J,K	C0805N391(3)1G(4)L	CDR31BP391B(3)Z(4)
430	F,J,K	C0805N431(3)1G(4)L	CDR31BP431B(3)Z(4)
470	F,J,K	C0805N471(3)1G(4)L	CDR31BP471B(3)Z(4)
50 Volt - BP - C0805 Size (Military CDR31)			
510	F,J,K	C0805N511(3)5G(4)L	CDR31BP511A(3)Z(4)
560	F,J,K	C0805N561(3)5G(4)L	CDR31BP561A(3)Z(4)
620	F,J,K	C0805N621(3)5G(4)L	CDR31BP621A(3)Z(4)
680	F,J,K	C0805N681(3)5G(4)L	CDR31BP681A(3)Z(4)
100 Volt - BX - C0805 Size (Military CDR31)			
470	K,M	C0805N471(3)1X(4)L	CDR31BX471B(3)Z(4)
560	K,M	C0805N561(3)1X(4)L	CDR31BX561B(3)Z(4)
680	K,M	C0805N681(3)1X(4)L	CDR31BX681B(3)Z(4)
820	K,M	C0805N821(3)1X(4)L	CDR31BX821B(3)Z(4)
1,000	K,M	C0805N102(3)1X(4)L	CDR31BX102B(3)Z(4)
1,200	K,M	C0805N122(3)1X(4)L	CDR31BX122B(3)Z(4)
1,500	K,M	C0805N152(3)1X(4)L	CDR31BX152B(3)Z(4)
1,800	K,M	C0805N182(3)1X(4)L	CDR31BX182B(3)Z(4)
2,200	K,M	C0805N222(3)1X(4)L	CDR31BX222B(3)Z(4)
2,700	K,M	C0805N272(3)1X(4)L	CDR31BX272B(3)Z(4)
3,300	K,M	C0805N332(3)1X(4)L	CDR31BX332B(3)Z(4)
3,900	K,M	C0805N392(3)1X(4)L	CDR31BX392B(3)Z(4)
4,700	K,M	C0805N472(3)1X(4)L	CDR31BX472B(3)Z(4)
50 Volt - BX - C0805 Size (Military CDR31)			
5,600	K,M	C0805N562(3)5X(4)L	CDR31BX562A(3)Z(4)
6,800	K,M	C0805N682(3)5X(4)L	CDR31BX682A(3)Z(4)
8,200	K,M	C0805N822(3)5X(4)L	CDR31BX822A(3)Z(4)
10,000	K,M	C0805N103(3)5X(4)L	CDR31BX103A(3)Z(4)
12,000	K,M	C0805N123(3)5X(4)L	CDR31BX123A(3)Z(4)
15,000	K,M	C0805N153(3)5X(4)L	CDR31BX153A(3)Z(4)
18,000	K,M	C0805N183(3)5X(4)L	CDR31BX183A(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 Iwhen 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.

RATINGS & PART NUMBER REFERENCE

Cap pF	Avail. Tol.	KEMET Part Number	MIL-PRF-55681 Part Number
100 Volt - BP - C1206 Size (Military CDR32)			
1.0	B,C	C1206N109(3)1G(4)L	CDR32BP1R0B(3)Z(4)
1.1	B,C	C1206N119(3)1G(4)L	CDR32BP1R1B(3)Z(4)
1.2	B,C	C1206C129(3)1G(4)L	CDR32BP1R2B(3)Z(4)
1.3	B,C	C1206N139(3)1G(4)L	CDR32BP1R3B(3)Z(4)
1.5	B,C	C1206N159(3)1G(4)L	CDR32BP1R5B(3)Z(4)
1.6	B,C	C1206N169(3)1G(4)L	CDR32BP1R6B(3)Z(4))
1.8	B,C	C1206N189(3)1G(4)L	CDR32BP1R8B(3)Z(4)
2.0	B,C	C1206N209(3)1G(4)L	CDR32BP2R0B(3)Z(4)
2.2	B,C	C1206N229(3)1G(4)L	CDR32BP2R2B(3)Z(4)
2.4	B,C	C1206N249(3)1G(4)L	CDR32BP2R4B(3)Z(4)
2.7	B,C,D	C1206N279(3)1G(4)L	CDR32BP2R7B(3)Z(4)
3.0	B,C,D	C1206N309(3)1G(4)L	CDR32BP3R0B(3)Z(4)
3.3	B,C,D	C1206N339(3)1G(4)L	CDR32BP3R3B(3)Z(4)
3.6	B,C,D	C1206N369(3)1G(4)L	CDR32BP3R6B(3)Z(4)
3.9	B,C,D	C1206N399(3)1G(4)L	CDR32BP3R9B(3)Z(4)
4.3	B,C,D	C1206N439(3)1G(4)L	CDR32BP4R3B(3)Z(4)
4.7	B,C,D	C1206N479(3)1G(4)L	CDR32BP4R7B(3)Z(4)
5.1	B,C,D	C1206N519(3)1G(4)L	CDR32BP5R1B(3)Z(4)
5.6	B,C,D	C1206N569(3)1G(4)L	CDR32BP5R6B(3)Z(4)
6.2	B,C,D	C1206N629(3)1G(4)L	CDR32BP6R2B(3)Z(4)
6.8	B,C,D	C1206N689(3)1G(4)L	CDR32BP6R8B(3)Z(4)
7.5	B,C,D	C1206N759(3)1G(4)L	CDR32BP7R5B(3)Z(4)
8.2	B,C,D	C1206N829(3)1G(4)L	CDR32BP8R2B(3)Z(4)
9.1	B,C,D	C1206N919(3)1G(4)L	CDR32BP9R1B(3)Z(4)
10	F,J,K	C1206N100(3)1G(4)L	CDR32BP100B(3)Z(4)
11	F,J,K	C1206N110(3)1G(4)L	CDR32BP110B(3)Z(4)
12	F,J,K	C1206N120(3)1G(4)L	CDR32BP120B(3)Z(4)
13	F,J,K	C1206N130(3)1G(4)L	CDR32BP130B(3)Z(4)
15	F,J,K	C1206N150(3)1G(4)L	CDR32BP150B(3)Z(4)
16	F,J,K	C1206N160(3)1G(4)L	CDR32BP160B(3)Z(4)
18	F,J,K	C1206N180(3)1G(4)L	CDR32BP180B(3)Z(4)
20	F,J,K	C1206N200(3)1G(4)L	CDR32BP200B(3)Z(4)
22	F,J,K	C1206N220(3)1G(4)L	CDR32BP220B(3)Z(4)
24	F,J,K	C1206N240(3)1G(4)L	CDR32BP240B(3)Z(4)
27	F,J,K	C1206N270(3)1G(4)L	CDR32BP270B(3)Z(4)
30	F,J,K	C1206N300(3)1G(4)L	CDR32BP300B(3)Z(4)
33	F,J,K	C1206N330(3)1G(4)L	CDR32BP330B(3)Z(4)
36	F,J,K	C1206N360(3)1G(4)L	CDR32BP360B(3)Z(4)
39	F,J,K	C1206N390(3)1G(4)L	CDR32BP390B(3)Z(4)
43	F,J,K	C1206N430(3)1G(4)L	CDR32BP430B(3)Z(4)
47	F,J,K	C1206N470(3)1G(4)L	CDR32BP470B(3)Z(4)
51	F,J,K	C1206N510(3)1G(4)L	CDR32BP510B(3)Z(4)
56	F,J,K	C1206N560(3)1G(4)L	CDR32BP560B(3)Z(4)
62	F,J,K	C1206N620(3)1G(4)L	CDR32BP620B(3)Z(4)
68	F,J,K	C1206N680(3)1G(4)L	CDR32BP680B(3)Z(4)
75	F,J,K	C1206N750(3)1G(4)L	CDR32BP750B(3)Z(4)
82	F,J,K	C1206N820(3)1G(4)L	CDR32BP820B(3)Z(4)
91	F,J,K	C1206N910(3)1G(4)L	CDR32BP910B(3)Z(4)
100	F,J,K	C1206N101(3)1G(4)L	CDR32BP101B(3)Z(4)

Cap pF	Avail. Tol.	KEMET Part Number	MIL-PRF-55681 Part Number
100 Volt - BP - C1206 Size (Military CDR32)			
110	F,J,K	C1206N111(3)1G(4)L	CDR32BP111B(3)Z(4)
120	F,J,K	C1206N121(3)1G(4)L	CDR32BP121B(3)Z(4)
130	F,J,K	C1206N131(3)1G(4)L	CDR32BP131B(3)Z(4)
150	F,J,K	C1206N151(3)1G(4)L	CDR32BP151B(3)Z(4)
160	F,J,K	C1206N161(3)1G(4)L	CDR32BP161B(3)Z(4)
180	F,J,K	C1206N181(3)1G(4)L	CDR32BP181B(3)Z(4)
200	F,J,K	C1206N201(3)1G(4)L	CDR32BP201B(3)Z(4)
220	F,J,K	C1206N221(3)1G(4)L	CDR32BP221B(3)Z(4)
240	F,J,K	C1206N241(3)1G(4)L	CDR32BP241B(3)Z(4)
270	F,J,K	C1206N271(3)1G(4)L	CDR32BP271B(3)Z(4)
300	F,J,K	C1206N301(3)1G(4)L	CDR32BP301B(3)Z(4)
330	F,J,K	C1206N331(3)1G(4)L	CDR32BP331B(3)Z(4)
360	F,J,K	C1206N361(3)1G(4)L	CDR32BP361B(3)Z(4)
390	F,J,K	C1206N391(3)1G(4)L	CDR32BP391B(3)Z(4)
430	F,J,K	C1206N431(3)1G(4)L	CDR32BP431B(3)Z(4)
470	F,J,K	C1206N471(3)1G(4)L	CDR32BP471B(3)Z(4)
510	F,J,K	C1206N511(3)1G(4)L	CDR32BP511B(3)Z(4)
560	F,J,K	C1206N561(3)1G(4)L	CDR32BP561B(3)Z(4)
620	F,J,K	C1206N621(3)1G(4)L	CDR32BP621B(3)Z(4)
680	F,J,K	C1206N681(3)1G(4)L	CDR32BP681B(3)Z(4)
750	F,J,K	C1206N751(3)1G(4)L	CDR32BP751B(3)Z(4)
820	F,J,K	C1206N821(3)1G(4)L	CDR32BP821B(3)Z(4)
910	F,J,K	C1206N911(3)1G(4)L	CDR32BP911B(3)Z(4)
1,000	F,J,K	C1206N102(3)1G(4)L	CDR32BP102B(3)Z(4)
50 Volt - BP - C1206 Size (Military CDR32)			
1,100	F,J,K	C1206N112(3)5G(4)L	CDR32BP112A(3)Z(4)
1,200	F,J,K	C1206N122(3)5G(4)L	CDR32BP122A(3)Z(4)
1,300	F,J,K	C1206N132(3)5G(4)L	CDR32BP132A(3)Z(4)
1,500	F,J,K	C1206N152(3)5G(4)L	CDR32BP152A(3)Z(4)
1,600	F,J,K	C1206N162(3)5G(4)L	CDR32BP162A(3)Z(4)
1,800	F,J,K	C1206N182(3)5G(4)L	CDR32BP182A(3)Z(4)
2,000	F,J,K	C1206N202(3)5G(4)L	CDR32BP202A(3)Z(4)
2,200	F,J,K	C1206N222(3)5G(4)L	CDR32BP222A(3)Z(4)
100 Volt - BX - C1206 Size (Military CDR32)			
4,700	K,M	C1206N472(3)1X(4)L	CDR32BX472B(3)Z(4)
5,600	K,M	C1206N562(3)1X(4)L	CDR32BX562B(3)Z(4)
6,800	K,M	C1206N682(3)1X(4)L	CDR32BX682B(3)Z(4)
8,200	K,M	C1206N822(3)1X(4)L	CDR32BX822B(3)Z(4)
10,000	K,M	C1206N103(3)1X(4)L	CDR32BX103B(3)Z(4)
12,000	K,M	C1206N123(3)1X(4)L	CDR32BX123B(3)Z(4)
15,000	K,M	C1206N153(3)1X(4)L	CDR32BX153B(3)Z(4)
50 Volt - BX - C1206 Size (Military CDR32)			
18,000	K,M	C1206N183(3)5X(4)L	CDR32BX183A(3)Z(4)
22,000	K,M	C1206N223(3)5X(4)L	CDR32BX223A(3)Z(4)
27,000	K,M	C1206N273(3)5X(4)L	CDR32BX273A(3)Z(4)
33,000	K,M	C1206N333(3)5X(4)L	CDR32BX333A(3)Z(4)
39,000	K,M	C1206N393(3)5X(4)L	CDR32BX393A(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 Iwhen 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.

KEMET CHARGED.

RATINGS & PART NUMBER REFERENCE

Cap pF	Avail. Tol.	KEMET Part Number	MIL-PRF-55681 Part Number
100 Volt - BP - C1210 Size (Military CDR33)			
1,000	F,J,K	C1210N102(3)1G(4)L	CDR33BP102B(3)Z(4)
1,100	F,J,K	C1210N112(3)1G(4)L	CDR33BP112B(3)Z(4)
1,200	F,J,K	C1210N122(3)1G(4)L	CDR33BP122B(3)Z(4)
1,300	F,J,K	C1210N132(3)1G(4)L	CDR33BP132B(3)Z(4)
1,500	F,J,K	C1210N152(3)1G(4)L	CDR33BP152B(3)Z(4)
1,600	F,J,K	C1210N162(3)1G(4)L	CDR33BP162B(3)Z(4)
1,800	F,J,K	C1210N182(3)1G(4)L	CDR33BP182B(3)Z(4)
2,000	F,J,K	C1210N202(3)1G(4)L	CDR33BP202B(3)Z(4)
2,200	F,J,K	C1210N222(3)1G(4)L	CDR33BP222B(3)Z(4)
50 Volt - BP - C1210 Size (Military CDR33)			
2,400	F,J,K	C1210N242(3)5G(4)L	CDR33BP242A(3)Z(4)
2,700	F,J,K	C1210N272(3)5G(4)L	CDR33BP272A(3)Z(4)
3,000	F,J,K	C1210N302(3)5G(4)L	CDR33BP302A(3)Z(4)
3,300	F,J,K	C1210N332(3)5G(4)L	CDR33BP332A(3)Z(4)
100 Volt - BX - C1210 Size (Military CDR33)			
15,000	K,M	C1210N153(3)1X(4)L	CDR33BX153B(3)Z(4)
18,000	K,M	C1210N183(3)1X(4)L	CDR33BX183B(3)Z(4)
22,000	K,M	C1210N223(3)1X(4)L	CDR33BX223B(3)Z(4)
27,000	K,M	C1210N273(3)1X(4)L	CDR33BX273B(3)Z(4)
50 Volt - BX - C1210 Size (Military CDR33)			
39,000	K,M	C1210N393(3)5X(4)L	CDR33BX393A(3)Z(4)
47,000	K,M	C1210N473(3)5X(4)L	CDR33BX473A(3)Z(4)
56,000	K,M	C1210N563(3)5X(4)L	CDR33BX563A(3)Z(4)
68,000	K,M	C1210N683(3)5X(4)L	CDR33BX683A(3)Z(4)
82,000	K,M	C1210N823(3)5X(4)L	CDR33BX823A(3)Z(4)
100,000	K,M	C1210N104(3)5X(4)L	CDR33BX104A(3)Z(4)
100 Volt - BP - C1812 Size (Military CDR34)			
2,200	F,J,K	C1812N222(3)1G(4)L	CDR34BP222B(3)Z(4)
2,400	F,J,K	C1812N242(3)1G(4)L	CDR34BP242B(3)Z(4)
2,700	F,J,K	C1812N272(3)1G(4)L	CDR34BP272B(3)Z(4)
3,000	F,J,K	C1812N322(3)1G(4)L	CDR34BP302B(3)Z(4)
3,300	F,J,K	C1812N332(3)1G(4)L	CDR34BP332B(3)Z(4)
3,600	F,J,K	C1812N362(3)1G(4)L	CDR34BP362B(3)Z(4)
3,900	F,J,K	C1812N392(3)1G(4)L	CDR34BP392B(3)Z(4)
4,300	F,J,K	C1812N432(3)1G(4)L	CDR34BP432B(3)Z(4)
4,700	F,J,K	C1812N472(3)1G(4)L	CDR34BP472B(3)Z(4)
50 Volt - BP - C1812 Size (Military CDR34)			
5,100	F,J,K	C1812N512(3)5G(4)L	CDR34BP512A(3)Z(4)
5,600	F,J,K	C1812N562(3)5G(4)L	CDR34BP562A(3)Z(4)
6,200	F,J,K	C1812N622(3)5G(4)L	CDR34BP622A(3)Z(4)
6,800	F,J,K	C1812N682(3)5G(4)L	CDR34BP682A(3)Z(4)
7,500	F,J,K	C1812N752(3)5G(4)L	CDR34BP752A(3)Z(4)
8,200	F,J,K	C1812N822(3)5G(4)L	CDR34BP822A(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)

Cap pF	Avail. Tol.	KEMET Part Number	MIL-PRF-55681 Part Number
100 Volt - BX - C1812 Size (Military CDR34)			
27,000	K,M	C1812N273(3)1X(4)L	CDR34BX273B(3)Z(4)
33,000	K,M	C1812N333(3)1X(4)L	CDR34BX333B(3)Z(4)
39,000	K,M	C1812N393(3)1X(4)L	CDR34BX393B(3)Z(4)
47,000	K,M	C1812N473(3)1X(4)L	CDR34BX473B(3)Z(4)
56,000	K,M	C1812N563(3)1X(4)L	CDR34BX563B(3)Z(4)
50 Volt - BX - C1812 Size (Military CDR34)			
100,000	K,M	C1812N104(3)5X(4)L	CDR34BX104A(3)Z(4)
120,000	K,M	C1812N124(3)5X(4)L	CDR34BX124A(3)Z(4)
150,000	K,M	C1812N154(3)5X(4)L	CDR34BX154A(3)Z(4)
180,000	K,M	C1812N184(3)5X(4)L	CDR34BX184A(3)Z(4)
100 Volt - BP - C1825 Size (Military CDR35)			
4,700	F,J,K	C1825N472(3)1G(4)L	CDR35BP472B(3)Z(4)
5,100	F,J,K	C1825N512(3)1G(4)L	CDR35BP512B(3)Z(4)
5,600	F,J,K	C1825N562(3)1G(4)L	CDR35BP562B(3)Z(4)
6,200	F,J,K	C1825N622(3)1G(4)L	CDR35BP622B(3)Z(4)
6,800	F,J,K	C1825N682(3)1G(4)L	CDR35BP682B(3)Z(4)
7,500	F,J,K	C1825N752(3)1G(4)L	CDR35BP752B(3)Z(4)
8,200	F,J,K	C1825N822(3)1G(4)L	CDR35BP822B(3)Z(4)
9,100	F,J,K	C1825N912(3)1G(4)L	CDR35BP912B(3)Z(4)
10,000	F,J,K	C1825N103(3)1G(4)L	CDR35BP103B(3)Z(4)
50 Volt - BP - C1825 Size (Military CDR35)			
11,000	F,J,K	C1825N113(3)5G(4)L	CDR35BP113A(3)Z(4)
12,000	F,J,K	C1825N123(3)5G(4)L	CDR35BP123A(3)Z(4)
13,000	F,J,K	C1825N133(3)5G(4)L	CDR35BP133A(3)Z(4)
15,000	F,J,K	C1825N153(3)5G(4)L	CDR35BP153A(3)Z(4)
16,000	F,J,K	C1825N163(3)5G(4)L	CDR35BP163A(3)Z(4)
18,000	F,J,K	C1825N183(3)5G(4)L	CDR35BP183A(3)Z(4)
20,000	F,J,K	C1825N203(3)5G(4)L	CDR35BP203A(3)Z(4)
22,000	F,J,K	C1825N223(3)5G(4)L	CDR35BP223A(3)Z(4)
100 Volt - BX - C1825 Size (Military CDR35)			
56,000	K,M	C1825N563(3)1X(4)L	CDR35BX563B(3)Z(4)
68,000	K,M	C1825N683(3)1X(4)L	CDR35BX683B(3)Z(4)
82,000	K,M	C1825N823(3)1X(4)L	CDR35BX823B(3)Z(4)
100,000	K,M	C1825N104(3)1X(4)L	CDR35BX104B(3)Z(4)
120,000	K,M	C1825N124(3)1X(4)L	CDR35BX124B(3)Z(4)
150,000	K,M	C1825N154(3)1X(4)L	CDR35BX154B(3)Z(4)
50 Volt - BX - C1825 Size (Military CDR35)			
180,000	K,M	C1825N184(3)5X(4)L	CDR35BX184A(3)Z(4)
220,000	K,M	C1825N224(3)5X(4)L	CDR35BX224A(3)Z(4)
270,000	K,M	C1825N274(3)5X(4)L	CDR35BX274A(3)Z(4)
330,000	K,M	C1825N334(3)5X(4)L	CDR35BX334A(3)Z(4)
390,000	K,M	C1825N394(3)5X(4)L	CDR35BX394A(3)Z(4)
470,000	K,M	C1825N474(3)5X(4)L	CDR35BX474A(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.

MIL-PRF-55681 MAXIMUM INDIVIDUAL PACKAGING QUANTITIES

CHIP SIZE	REELED	BULK-STD BAG	BULK - ANTI-STATIC BAG	CHIP SIZE	REELED	BULK-STD BAG	BULK - ANTI-STATIC 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

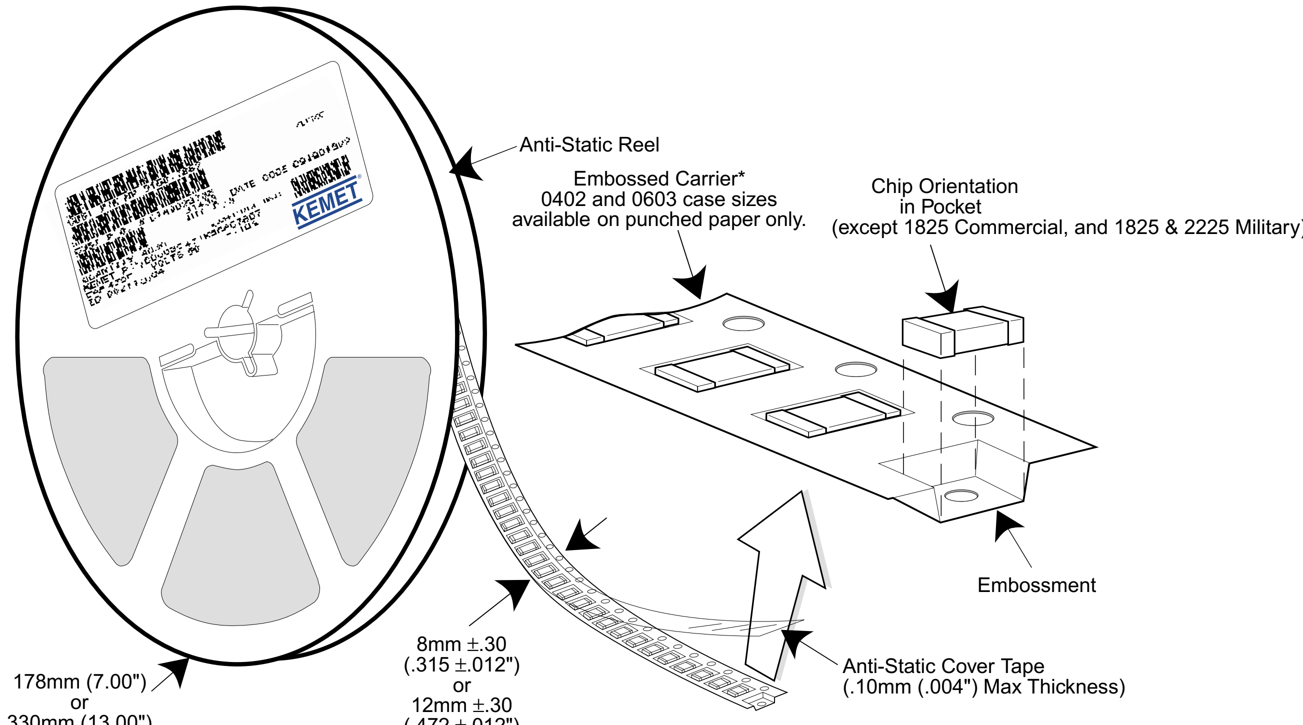
MIL-PRF-55681 chips available in 7" reels only.

Ceramic Surface Mount

KEMET CHARGED.

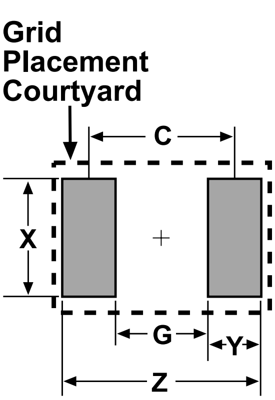
Tape & Reel Packaging

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.



* Punched paper carrier used for 0402 and 0603 case size.

SURFACE MOUNT LAND DIMENSIONS - CERAMIC CHIP CAPACITORS - MM



	Reflow Solder					Wave Solder				
Dimension	Z	G	X	Y(ref)	C(ref)	Z	G	X	Y(ref)	Smin
0402	2.14	0.28	0.74	0.93	1.21	Not Recommended				
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	Not Recommended				
1825	5.90	2.30	6.90	1.80	4.10					
2220	7.00	3.30	5.50	1.85	5.15					
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

Packaging

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 Newton to 1.0 Newton (10g to 100g)
12 mm	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

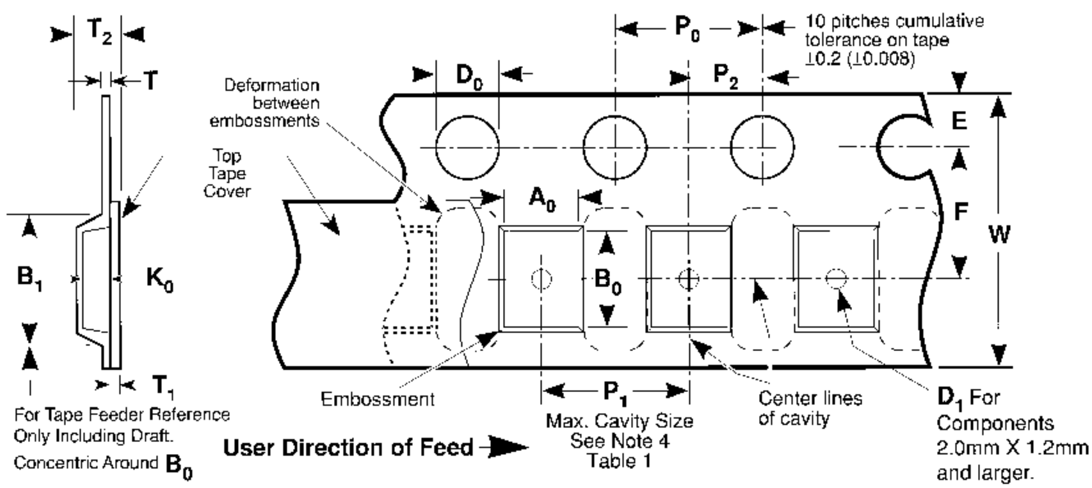


Table 1 — EMBOSSED TAPE DIMENSIONS (Metric will govern)

Constant Dimensions — Millimeters (Inches)

Tape Size	D_0	E	P_0	P_2	T Max	T_1 Max
8 mm and 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)	0.600 (0.024)	0.100 (0.004)

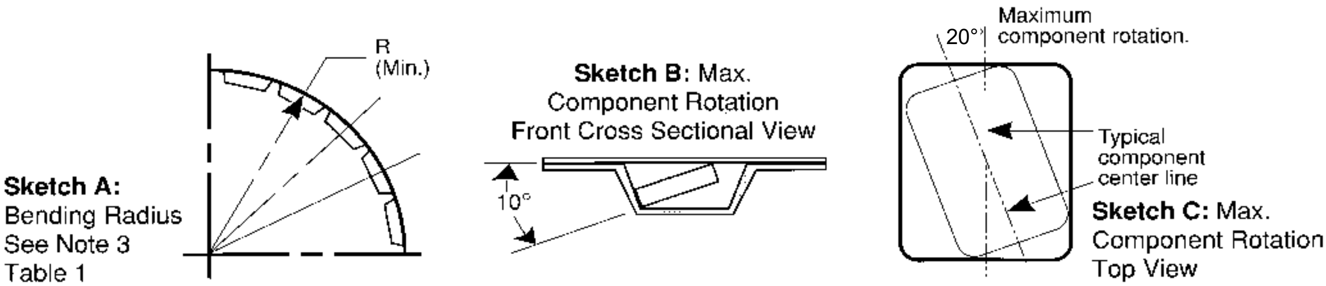
Variable Dimensions — Millimeters (Inches)

Tape Size	Pitch	B_1 Max. Note 1	D_1 Min. Note 2	F	P_1	R Min. Note 3	T_2 Max	W	$A_0B_0K_0$ Note 4
8 mm	Single (4 mm)	4.4 (0.173)	1.0 (0.039)	3.5 ±0.05 (0.138 ±0.002)	4.0 ±0.10 (0.157 ±0.004)	25.0 (0.984)	2.5 (0.098)	8.0 ±0.30 (.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)	

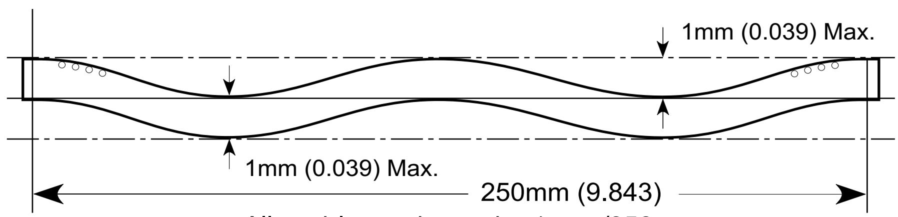
NOTES

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 A_0, B_0, and K_0 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.)

Embossed Carrier Tape Configuration (cont.)



Sketch D: Tape Camber (Top View)



Allowable camber to be 1 mm/250 mm.

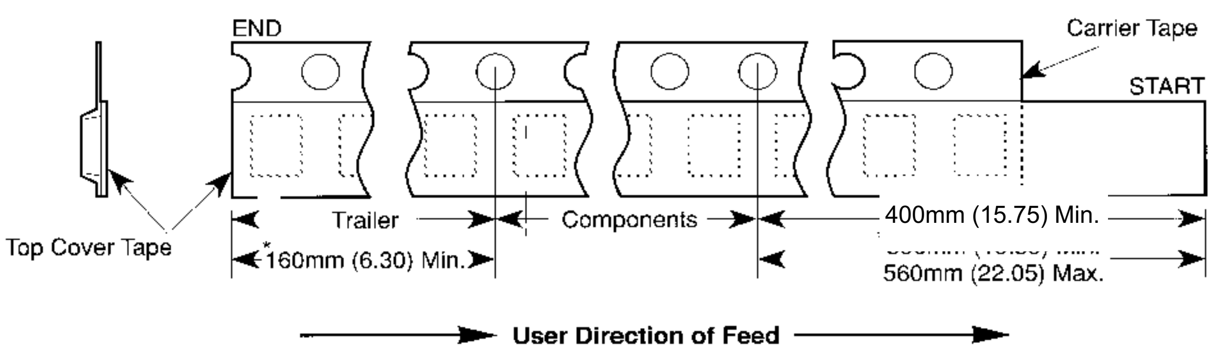


Figure 2: Tape Leader & Trailer Dimensions (Metric Dimensions Will Govern)

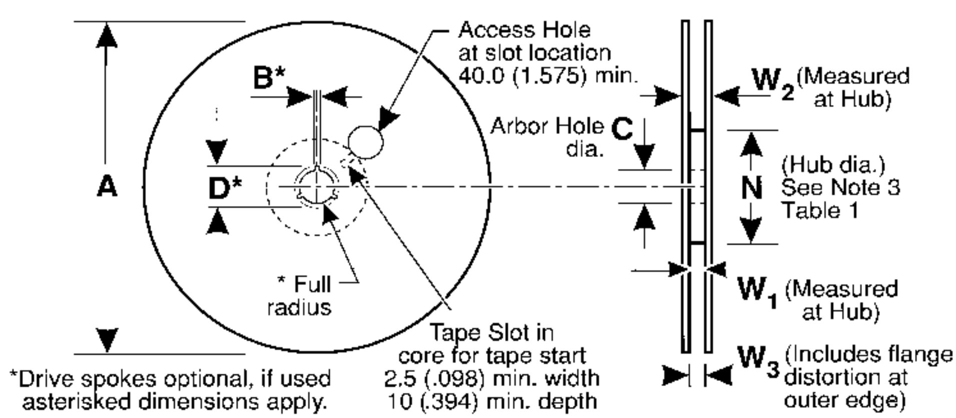


Figure 3: Reel Dimensions (Metric Dimensions will govern)

Table 2 – REEL DIMENSIONS (Metric will govern)

Tape Size	A Max	B* Min	C	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 Table 1	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)		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)

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

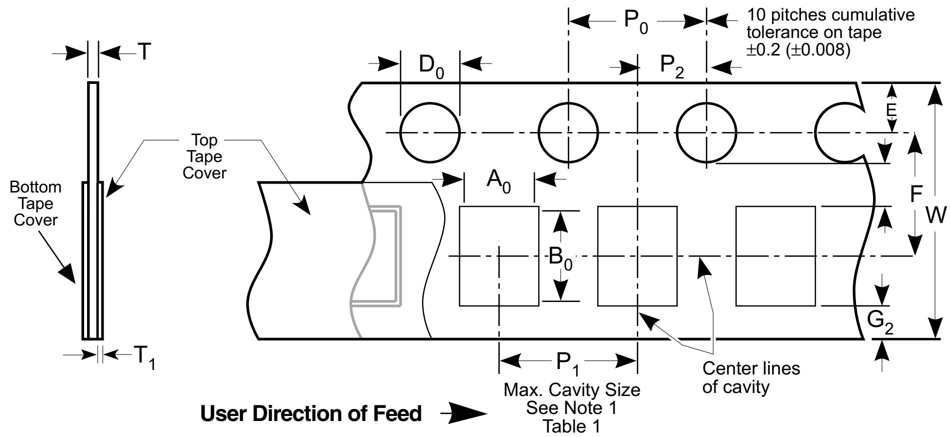


Table 1: 8 & 12mm Punched Tape
(Metric Dimensions Will Govern)

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 ± 0.002)	0.10 (.004) Max.	0.75 (.030) Min.	0.75 (.030) Min.	25 (.984) See Note 2 Table 1

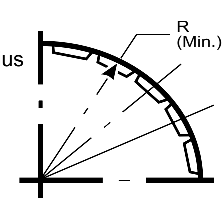
Table 1: 8 & 12mm Punched Tape
(Metric Dimensions Will Govern)

Variable Dimensions - Millimeters (Inches)

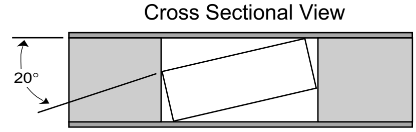
Tape Size	P_1	F	W	A_0B_0	T
8mm 1/2 Pitch	2.0 ± 0.10 (.079 ±.004) See Require-ments Section 3.3 (d)	3.5 ± 0.05 (.138 ± .002)	8.0 ± 0.3 (.315 ± 0.012)	See Note 1 Table 1	1.1mm (.043) Max. for Paper Base Tape and 1.6mm (.063) Max. for Non-Paper Base Compositions. See Note 3.
8mm	4.0 ± 0.10 (0.157 ± .004)				
12mm	4.0 ± 0.10 (0.157 ± .004)	5.5 ± 0.05 (.217 ± .002)	12.0 ± 0.3 (.472 ± .012)		
12mm Double Pitch	8.0 ± 0.10 (0.315 ± .004)				

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.

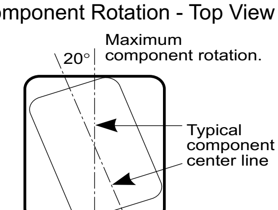
Sketch A:
Bending Radius
See Note 2
Table 1



Sketch B:
Max. Component
Rotation - Front
Cross Sectional View



Sketch C:
Component Rotation - Top View



KEMET CHARGED.

Bulk Cassette Packaging (Ceramic Chips only)

(Meets Dimensional Requirements IEC-286-6 and EIAJ 7201)

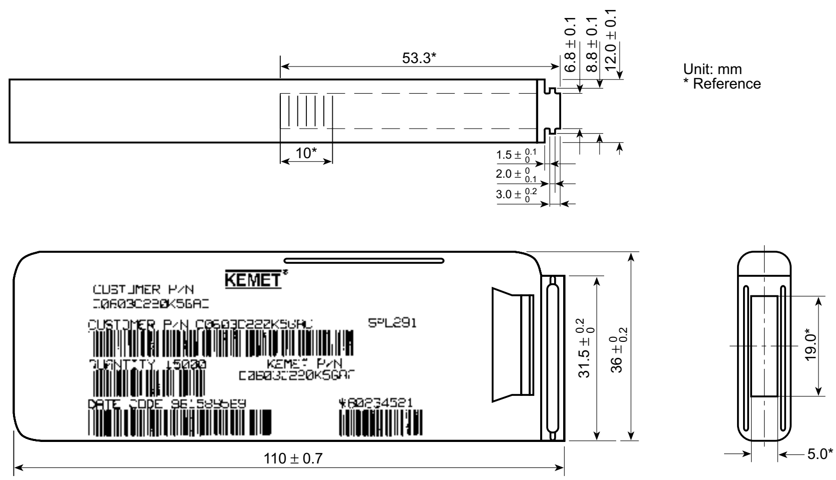


Table 2 – Capacitance Values Available In Bulk Cassette Packaging

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	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	0402	1.0 ± 0.05	0.5 ± 0.05	0.5 ± .05	0.2 to 0.4	0.3	50,000
1608	0603	1.6 ± 0.07	0.8 ± 0.07	0.8 ± .07	0.2 to 0.5	0.7	15,000
2012	0805	2.0 ± 0.10	1.25 ± 0.10	0.6 ± .10	0.5 to 0.75	0.75	10,000

Terminations: KEMET nickel barrier layer with a tin overplate.

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

Alpha Character \ Numeral	Capacitance (pF) For Various Numeral Identifiers: 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
B	0.11	1.1	11	110	1100	11,000	110,000	1,100,000	11,000,000
C	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
H	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
K	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
T	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
a	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
e	0.45	4.5	45	450	4500	45,000	450,000	4,500,000	45,000,000
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
y	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 $\overline{\text{K}}$ 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 $\overline{\text{K}}$ only.

	$\overline{\text{K}}$A3	

Example shown is 1,000 pF capacitor.

Packaging

Surface Mount Multilayer Ceramic Chip Capacitors
DSCC Approved 03028 (BR/BX Dielectrics)

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.

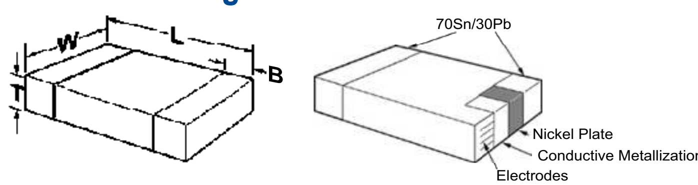
Benefits

- 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
- 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^	W WIDTH^	B BANDWIDTH	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	C	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
	BX	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 +200ºC 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 @ 25ºC	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 100GΩ 100 megohm microfarads (minimum) or 10GΩ

To obtain the IR limit, divide MΩ-µF value by the capacitance and compare to GΩ 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 @ 25ºC	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 100GΩ 100 megohm microfarads (minimum) or 10GΩ

To obtain the IR limit, divide MΩ-µF value by the capacitance and compare to GΩ 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

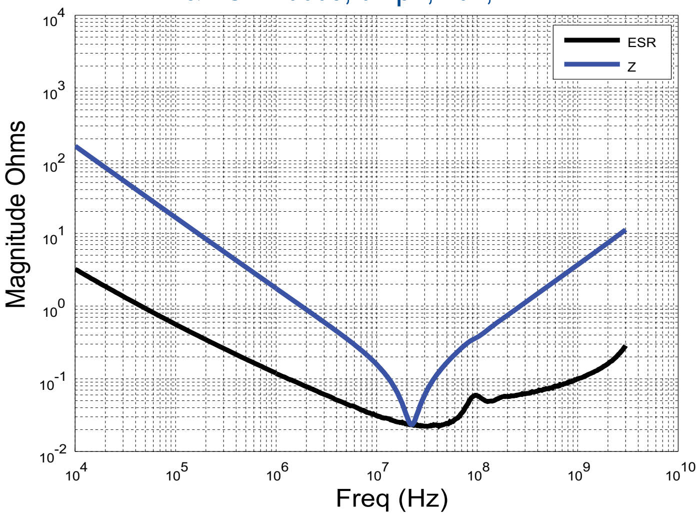
Qualification/Certification

Qualification Inspection per MIL-PRF-55681

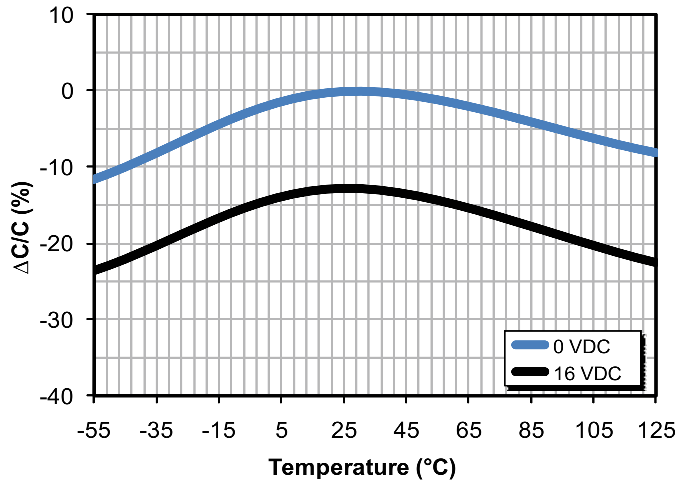
Inspection	Test method paragraph
Group I	
Voltage conditioning	4.8.3
DWV	4.8.9
IR (elevated temperature)	4.8.6
Capacitance	4.8.4
Dissipation factor	4.8.5
IR	4.8.6
DWV	4.8.9
Visual and mechanical examination	4.8.2
Group II	
Solderability	4.8.10
Group III	
Voltage-temperature limits	4.8.11
Thermal shock 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

Electrical Characteristics

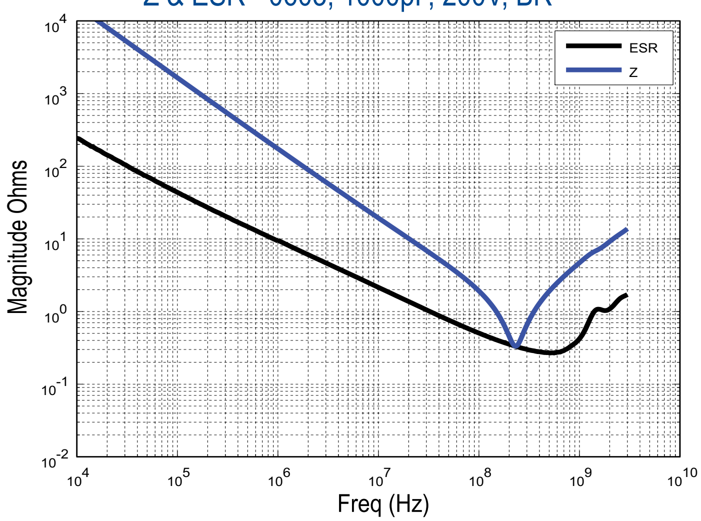
Z & ESR - 0603, 0.1µF, 16V, BX



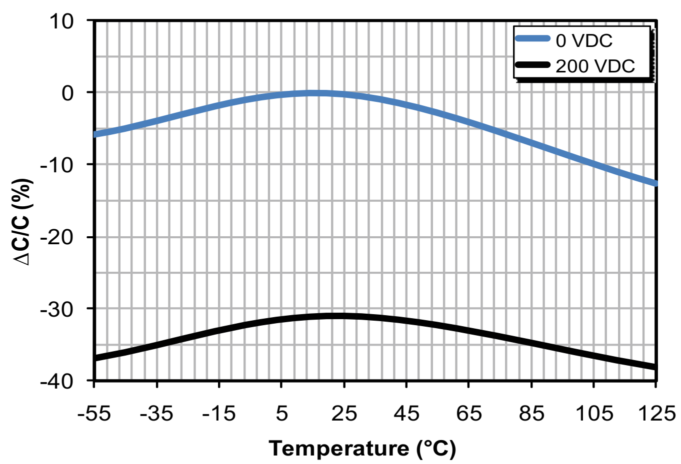
TCVC - 0603, 0.1µF, 16V, BX



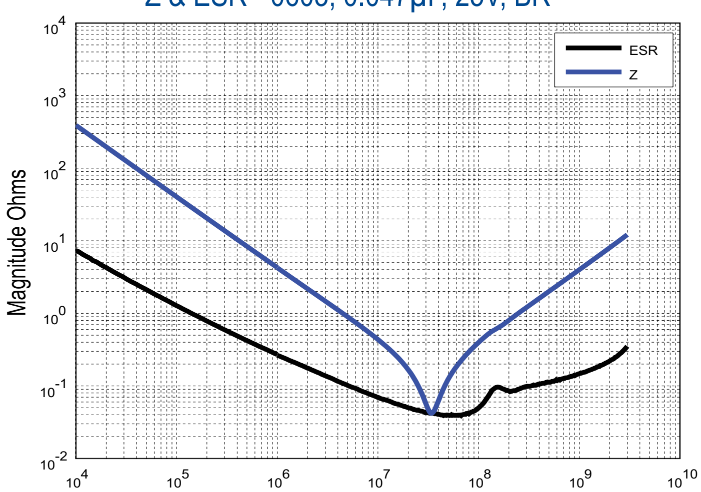
Z & ESR - 0603, 1000pF, 200V, BR



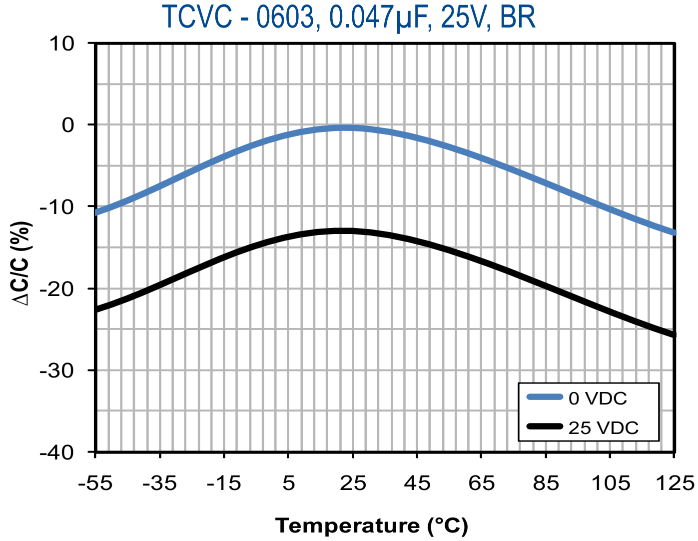
TCVC - 0603, 1000pF, 200V, BR



Z & ESR - 0603, 0.047µF, 25V, BR



TCVC - 0603, 0.047µF, 25V, BR



Capacitance pF	Cap Code	DSCC DRAWING NO. 03028														
		DIELECTRIC	BR							BX						
		Voltage	6.3V	10V	16V	25V	50V	100V	200V	6.3V	10V	16V	25V	50V	100V	200V
		Voltage Code	W	X	Y	Z	A	B	C	W	X	Y	Z	A	B	C
		Cap Tolerance	EIA 0603 CASE SIZE													
100	101	J K M	•	•	•	•	•	•	•	•	•	•	•	•	•	
120	121	J K M	•	•	•	•	•	•	•	•	•	•	•	•	•	
150	151	J K M	•	•	•	•	•	•	•	•	•	•	•	•	•	
180	181	J K M	•	•	•	•	•	•	•	•	•	•	•	•	•	
220	221	J K M	•	•	•	•	•	•	•	•	•	•	•	•	•	
270	271	J K M	•	•	•	•	•	•	•	•	•	•	•	•	•	
330	331	J K M	•	•	•	•	•	•	•	•	•	•	•	•	•	
390	391	J K M	•	•	•	•	•	•	•	•	•	•	•	•	•	
470	471	J K M	•	•	•	•	•	•	•	•	•	•	•	•	•	
560	561	J K M	•	•	•	•	•	•	•	•	•	•	•	•	•	
680	681	J K M	•	•	•	•	•	•	•	•	•	•	•	•	•	
820	821	J K M	•	•	•	•	•	•	•	•	•	•	•	•	•	
1,000	102	J K M	•	•	•	•	•	•	•	•	•	•	•	•	•	
1,200	122	J K M	•	•	•	•	•	•		•	•	•	•	•		
1,500	152	J K M	•	•	•	•	•	•		•	•	•	•	•		
1,800	182	J K M	•	•	•	•	•	•		•	•	•	•	•		
2,200	222	J K M	•	•	•	•	•	•		•	•	•	•	•		
2,700	272	J K M	•	•	•	•	•	•		•	•	•	•	•		
3,300	332	J K M	•	•	•	•	•	•		•	•	•	•	•		
3,900	392	J K M	•	•	•	•	•	•		•	•	•	•	•		
4,700	472	J K M	•	•	•	•	•	•		•	•	•	•	•		
5,600	562	J K M	•	•	•	•	•			•	•	•	•			
6,800	682	J K M	•	•	•	•	•			•	•	•	•			
8,200	822	J K M	•	•	•	•	•			•	•	•	•			
10,000	103	J K M	•	•	•	•	•			•	•	•	•			
12,000	123	J K M	•	•	•	•	•			•	•	•	•			
15,000	153	J K M	•	•	•	•	•			•	•	•	•			
18,000	183	J K M	•	•	•	•	•			•	•	•	•			
22,000	223	J K M	•	•	•	•	•			•	•	•	•			
27,000	273	J K M	•	•	•	•				•	•	•				
33,000	333	J K M	•	•	•	•				•	•	•				
39,000	393	J K M	•	•	•	•				•	•	•				
47,000	473	J K M	•	•	•	•				•	•	•				
56,000	563	J K M	•	•	•					•	•	•				
68,000	683	J K M	•	•	•					•	•	•				
82,000	823	J K M	•	•	•					•	•	•				
100,000	104	J K M	•	•	•					•	•	•				
120,000	124	J K M														
150,000	154	J K M														
180,000	184	J K M														
220,000	224	J K M														

Packaging Quantities

PACKAGING TYPE	LOOSE PACKAGING		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.

2. 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.

3. 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 GΩ or 1000 Megohm - Microfarads (100% of lot).

***5. Insulation Resistance**: The 125°C measurement with rated voltage applied shall be the lesser of 10 GΩ 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.

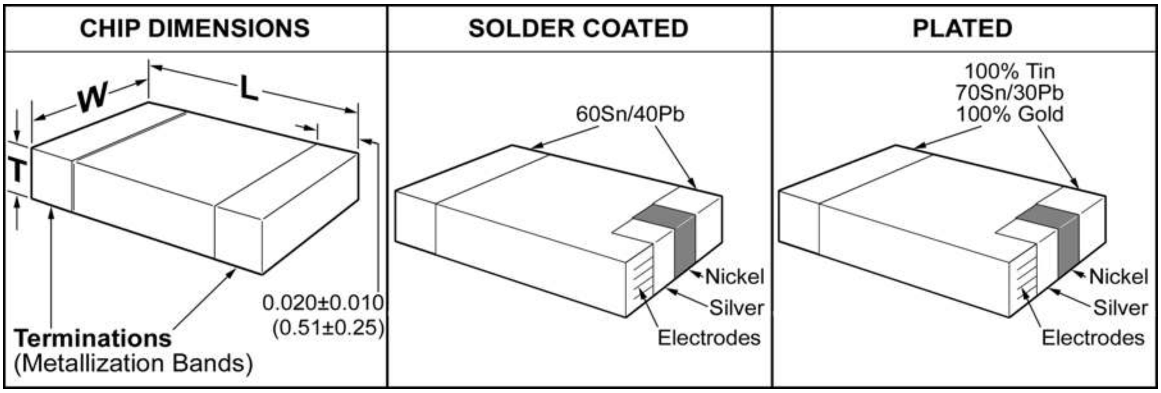
3. Summary of Group A Testing.

Group B

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

KEMET CHARGED.

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)

Size Code	L Length	W Width	T Thickness 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)

ORDERING INFORMATION

C 0805 A 103 K 5 X A C

CERAMIC

SIZE CODE
See table above

SPECIFICATION
A — KEMET GR900 (CHIPS); Q — KEMET Q-**SPEC**

CAPACITANCE CODE
Expressed in Picofarads (pF)
First two digit-significant figures.
Third digit-number of zeros. (Use 9 for 1.0 thru 9.9 pF.
Example: 2.2 pF — 229).

CAPACITANCE TOLERANCE
M — ±20% G — ±2% (G(BP) Temperature Characteristic Only)
K — ±10% F — ±1% (G(BP) Temperature Characteristic Only)
J — ±5% *D — ±0.5 pF (G(BP) Temperature Characteristic Only)
*C — ±0.25 pF (G(BP) Temperature Characteristic Only)

*Thesetolera nces available only for 1.0 through 10 pF capacitors.

VOLTAGE
1—100V 3—25V
2—200V 4—16V
5—50V

END METALLIZATION
C—100% Tin(Sn) Plated
H—60/40 SnPb Coated (Dipped)
L—70/30 SnPb Plated
G—Gold Plated

FAILURE RATE LEVEL (%/1,000 HOURS)
A—Standard—Not applicable

TEMPERATURE CHARACTERISTIC
Designated by Capacitance Change over Temperature Range
G—BP (±30 PPM/°C)
X—BX (±15%, -55 +125°C)(+15%, -25% @ rated Vdc)

BX dielectric is a suitable substitute for BR (X7R) dielectric
BR Dielectric (±15%, -55 +125°C / +15%, -40% @ rated Vdc)

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
200 VOLT - BP	
1.0	C0504A109(1)2GA(2)
1.1	C0504A119(1)2GA(2)
1.2	C0504A129(1)2GA(2)
1.5	C0504A159(1)2GA(2)
1.6	C0504A169(1)2GA(2)
1.8	C0504A189(1)2GA(2)
2.0	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)
6.8	C0504A689(1)2GA(2)
7.5	C0504A759(1)2GA(2)
8.2	C0504A829(1)2GA(2)
9.1	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)
36.0	C0504A360(1)2GA(2)
39.0	C0504A390(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 VOLT - BP	
91.0	C0504A910(1)1GA(2)
100	C0504A101(1)1GA(2)
110	C0504A111(1)1GA(2)
120	C0504A121(1)1GA(2)
130	C0504A131(1)1GA(2)
50 VOLT - BP	
150	C0504A151(1)5GA(2)
160	C0504A161(1)5GA(2)
180	C0504A181(1)5GA(2)

CAPACITANCE pF	KEMET PART NUMBER
200 VOLT - BX	
220	C0504A221(1)2XA(2)
270	C0504A271(1)2XA(2)
330	C0504A331(1)2XA(2)
100 VOLT - BX	
360	C0504A361(1)1XA(2)
390	C0504A391(1)1XA(2)
470	C0504A471(1)1XA(2)
560	C0504A561(1)1XA(2)
680	C0504A681(1)1XA(2)
820	C0504A821(1)1XA(2)
1000	C0504A102(1)1XA(2)
1200	C0504A122(1)1XA(2)

CAPACITANCE pF	KEMET PART NUMBER
50 VOLT - 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)

CAPACITANCE pF	KEMET PART NUMBER
200 VOLT - 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)
6.8	C0805A689(1)2GA(2)
7.5	C0805A759(1)2GA(2)
8.2	C0805A829(1)2GA(2)
9.1	C0805A919(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)
56.0	C0805A560(1)2GA(2)
62.0	C0805A620(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 pF	KEMET PART NUMBER
100 VOLT - 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 VOLT - BP	
510	C0805A511(1)5GA(2)
560	C0805A561(1)5GA(2)

CAPACITANCE pF	KEMET PART NUMBER
200 VOLT - 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 VOLT - 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 VOLT - 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 VOLT - 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

RATINGS AND PART NUMBER REFERENCE
STYLE C1005

CAPACITANCE pF	KEMET 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)

CAPACITANCE pF	KEMET PART NUMBER
200 VOLT - BP	
180	C1005A181(1)2GA(2)
200	C1005A201(1)2GA(2)
220	C1005A221(1)2GA(2)
240	C1005A241(1)2GA(2)
270	C1005A271(1)2GA(2)
300	C1005A301(1)2GA(2)
330	C1005A331(1)2GA(2)
360	C1005A361(1)2GA(2)
390	C1005A391(1)2GA(2)
430	C1005A431(1)2GA(2)
470	C1005A471(1)2GA(2)
100 VOLT - BP	
510	C1005A511(1)1GA(2)
560	C1005A561(1)1GA(2)
620	C1005A621(1)1GA(2)
680	C1005A681(1)1GA(2)
750	C1005A751(1)1GA(2)
820	C1005A821(1)1GA(2)
50 VOLT - BP	
910	C1005A911(1)5GA(2)
1000	C1005A102(1)5GA(2)
1100	C1005A112(1)5GA(2)
1200	C1005A122(1)5GA(2)
200 VOLT - BX	
330	C1005A331(1)2XA(2)
390	C1005A391(1)2XA(2)
470	C1005A471(1)2XA(2)
560	C1005A561(1)2XA(2)
680	C1005A681(1)2XA(2)
820	C1005A821(1)2XA(2)
1000	C1005A102(1)2XA(2)
1200	C1005A122(1)2XA(2)
1500	C1005A152(1)2XA(2)
1800	C1005A182(1)2XA(2)
100 VOLT - BX	
2200	C1005A222(1)1XA(2)
2700	C1005A272(1)1XA(2)
3300	C1005A332(1)1XA(2)
3900	C1005A392(1)1XA(2)
4700	C1005A472(1)1XA(2)
5600	C1005A562(1)1XA(2)
6800	C1005A682(1)1XA(2)
8200	C1005A822(1)1XA(2)
10,000	C1005A103(1)1XA(2)
50 VOLT - BX	
12,000	C1005A123(1)5XA(2)
15,000	C1005A153(1)5XA(2)
18,000	C1005A183(1)5XA(2)
22,000	C1005A223(1)5XA(2)

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 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: ±5%, ±10%, ±20% TEMPERATURE CHARACTERISTIC "X"
(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 pF	KEMET 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 VOLT - 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 pF	KEMET PART NUMBER
50 VOLT - BP	
1800	C1206A182(1)5GA(2)
2000	C1206A202(1)5GA(2)
16 VOLT - BP	
4700	C1206A472(1)4GA(2)
5600	C1206A562(1)4GA(2)
200 VOLT - 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 VOLT - 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 VOLT - 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 pF	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)

CAPACITANCE pF	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)

(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

RATINGS AND PART NUMBER REFERENCE
STYLE C1210 (continued)

CAPACITANCE pF	KEMET PART NUMBER
100 VOLT - BP	
1100	C1210A112(1)1GA(2)
1200	C1210A122(1)1GA(2)
1300	C1210A132(1)1GA(2)
1500	C1210A152(1)1GA(2)
1600	C1210A162(1)1GA(2)
1800	C1210A182(1)1GA(2)
2000	C1210A202(1)1GA(2)
2200	C1210A222(1)1GA(2)
2400	C1210A242(1)1GA(2)
2700	C1210A272(1)1GA(2)
3000	C1210A302(1)1GA(2)
3300	C1210A332(1)1GA(2)
50 VOLT - BP	
3600	C1210A362(1)5GA(2)
16 VOLT - BP	
10,000	C1210A103(1)4GA(2)
200 VOLT - BX	
470	C1210A471(1)2XA(2)
560	C1210A561(1)2XA(2)
680	C1210A681(1)2XA(2)
820	C1210A821(1)2XA(2)
1000	C1210A102(1)2XA(2)
1200	C1210A122(1)2XA(2)
1500	C1210A152(1)2XA(2)
1800	C1210A182(1)2XA(2)

CAPACITANCE pF	KEMET PART NUMBER
200 VOLT - 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 VOLT - 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 VOLT - 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 VOLT - BX	
330,000	C1210A334(1)3XA(2)
16 VOLT - BX	
470,000	C1210A474(1)4XA(2)

RATINGS AND PART NUMBER REFERENCE
STYLE C1805

CAPACITANCE pF	KEMET PART NUMBER
200 VOLT - 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 VOLT - 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 VOLT - BP	
1600	C1805A162(1)5GA(2)
1800	C1805A182(1)5GA(2)
2000	C1805A202(1)5GA(2)
2200	C1805A222(1)5GA(2)

CAPACITANCE pF	KEMET PART NUMBER
200 VOLT - 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 VOLT - 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 VOLT - 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

RATINGS AND PART NUMBER REFERENCE
STYLE C1808

CAPACITANCE pF	KEMET 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)

CAPACITANCE pF	KEMET PART NUMBER
50 VOLT - 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 VOLT - 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 pF	KEMET 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 pF	KEMET 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 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)

RATINGS AND PART NUMBER REFERENCE
STYLE C1825

CAPACITANCE pF	KEMET 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 VOLT - BP	
20,000	C1825A203(1)5GA(2)
22,000	C1825A223(1)5GA(2)

CAPACITANCE pF	KEMET 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 pF	KEMET 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 VOLT - BP	
24,000	C2225A243(1)5GA(2)
27,000	C2225A273(1)5GA(2)
33,000	C2225A333(1)5GA(2)

CAPACITANCE pF	KEMET 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 VOLT - 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% TEMPERATURE CHARACTERISTIC “X”
(2) Complete part number by inserting end Metallization, as applicable as shown in ordering information on page 17.

High Temperature 200°C, C0G Dielectric, 10 – 200 VDC (Industrial Grade)

Overview

KEMET's High Temperature surface mount C0G Multilayer Ceramic Capacitors (MLCCs) are constructed of a robust and proprietary C0G/NP0 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 C0G 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/ºC 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

C	1210	H	124	J	5	G	A	C	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 = ±0.10 pF C = ±0.25 pF D = ±0.5 pF F = ±1% G = ±2% J = ±5% K = ±10% M = ±20%	8 = 10 V 4 = 16 V 3 = 25 V 5 = 50 V 1 = 100 V 2 = 200 V	G = C0G	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.*

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 down-hole 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]		
C = 100% Matte Sn L = SnPb (5% Pb min.) F = Gold (Au) 30 – 70 µin G = Gold (Au) 100 µin minimum	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)
	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	T1K0
Moisture Sensitive Packaging[5] – Unmarked[3]		
E = Gold (Au) 1.97 – 11.8 µin F = Gold (Au) 30 – 70 µin G = Gold (Au) 100 µin minimum	Waffle Tray[2]	7282
	7" Tape & Reel	7130
	7" Tape & Reel – 50 pieces	Contact KEMET[6]
	7" Tape & Reel – 100 pieces	
	7" Tape & Reel – 250 pieces	
	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.*

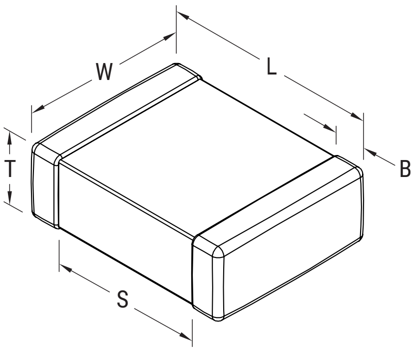
[3] *Reeling quantities are dependent upon chip size and thickness dimension. When ordering using the "T1K0" packaging option, 1812 through 2225 case size devices with chip thickness of ≥ 1.9 mm (nominal) may be shipped on multiple 7" reels or a single 13" reel. Additional reeling or packaging options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

[5] *Moisture sensitive packaging is required for Gold (Au) termination option "E" (1.97 – 11.8 µin)*

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

Dimensions – Millimeters (Inches)



<table>
<tr><th>EIA Size Code</th><th>Metric Size Code</th><th>L Length</th><th>W Width</th><th>T Thickness</th><th>B Bandwidth</th><th>S Separation Minimum</th><th>Mounting Technique</th></tr>
<tr><td>0402</td><td>1005</td><td>1.00 (0.040) ±0.05 (0.002)</td><td>0.50 (0.020) ±0.05 (0.002)</td><td rowspan="7">See Table 2 for Thickness</td><td>0.30 (0.012) ±0.10 (0.004)</td><td>0.30 (0.012)</td><td>Solder Reflow Only</td></tr>
<tr><td>0603</td><td>1608</td><td>1.60 (0.063) ±0.15 (0.006)</td><td>0.80 (0.032) ±0.15 (0.006)</td><td>0.35 (0.014) ±0.15 (0.006)</td><td>0.70 (0.028)</td><td rowspan="3">Solder Wave or Solder Reflow</td></tr>
<tr><td>0805</td><td>2012</td><td>2.00 (0.079) ±0.20 (0.008)</td><td>1.25 (0.049) ±0.20 (0.008)</td><td>0.50 (0.02) ±0.25 (0.010)</td><td>0.75 (0.030)</td></tr>
<tr><td>1206</td><td>3216</td><td>3.20 (0.126) ±0.20 (0.008)</td><td>1.60 (0.063) ±0.20 (0.008)</td><td>0.50 (0.02) ±0.25 (0.010)</td><td rowspan="4">N/A</td></tr>
<tr><td>1210</td><td>3225</td><td>3.20 (0.126) ±0.20 (0.008)</td><td>2.50 (0.098) ±0.20 (0.008)</td><td>0.50 (0.02) ±0.25 (0.010)</td><td rowspan="3">Solder Reflow Only</td></tr>
<tr><td>1812</td><td>4532</td><td>4.50 (0.177) ±0.30 (0.012)</td><td>3.20 (0.126) ±0.30 (0.012)</td><td>0.60 (0.024) ±0.35 (0.014)</td></tr>
<tr><td>2220</td><td>5650</td><td>5.70 (0.224) ±0.40 (0.016)</td><td>5.00 (0.197) ±0.40 (0.016)</td><td>0.60 (0.024) ±0.35 (0.014)</td></tr>
</table>

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 MΩ-µF value by the capacitance and compare to GΩ limit. Select the lower of the two limits.

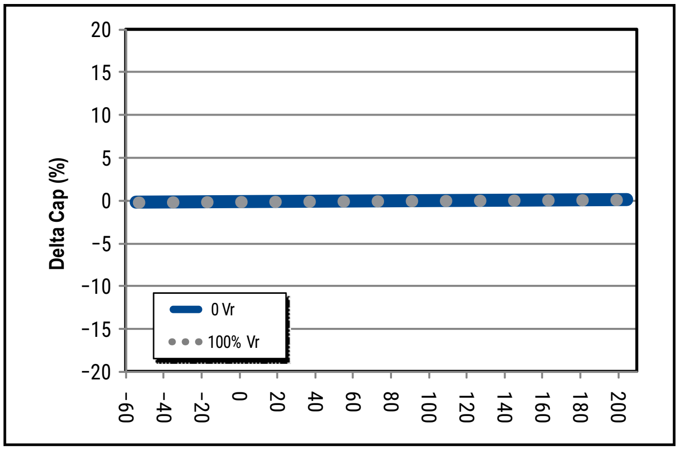
Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 & Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

Post Environmental Limits

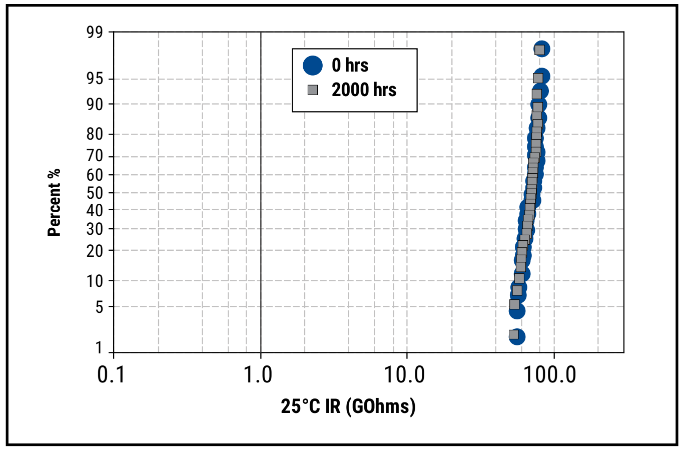
High Temperature Life, Biased Humidity, Moisture Resistance					
Dielectric	Rated DC Voltage	Capacitance Value	Dissipation Factor (Maximum %)	Capacitance Shift	Insulation Resistance
C0G	All	All	0.5	0.3% or ±0.25 pF	10% of Initial Limit

Electrical Characteristics

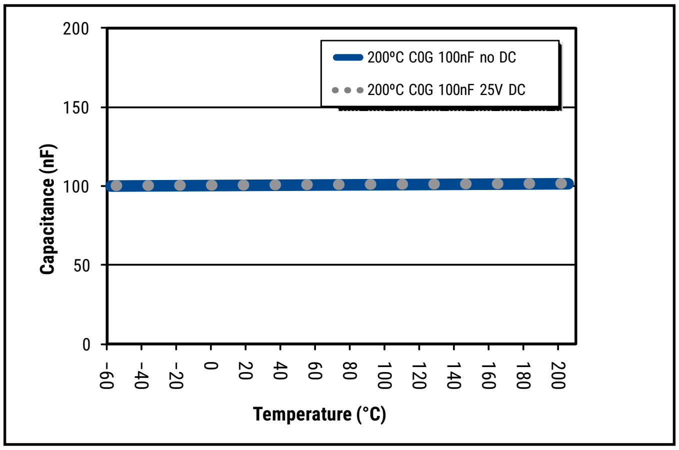
Delta Cap vs. Temperature (Typical)



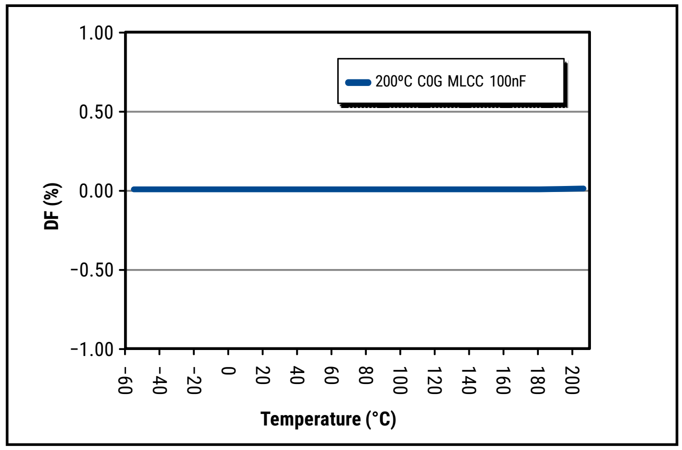
C1210H104J1GAC - Life Test IR Distribution (Lognormal)



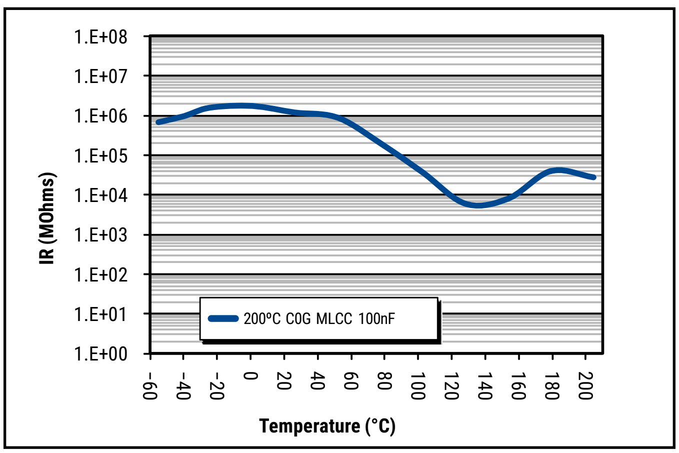
Capacitance vs. Temperature with 25 V DC Bias (Rated Voltage)



DF vs. Temperature without DC Bias.



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



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

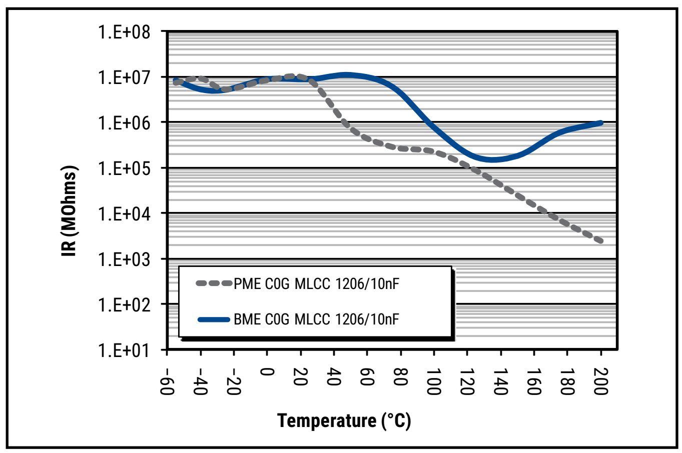


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Table 1A – Capacitance Range/Selection Waterfall (0402 – 1206 Case Sizes)

Capacitance	Cap Code	Case Size / Series								C0402H					C0603H						C0805H						C1206H					
		Voltage Code								8	4	3	5	1	8	4	3	5	1	2	8	4	3	5	1	2	8	4	3	5	1	2
		Rated Voltage (VDC)								10	16	25	50	100	10	16	25	50	100	200	10	16	25	50	100	200	10	16	25	50	100	200
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																						
0.5 & 0.75 pF	508 & 758	B	C	D						BB	BB	BB	BB		CF	CF	CF	CF	CF	CF	DN	DN	DN	DN	DN	DN						
1.0 - 9.0 pF*	109 - 919*	B	C	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*	101 - 181*				F	G	J	K	M	BB	BB	BB	BB	BB	CF	CF	CF	CF	CF	CF	DN	DN	DN	DN	DN	DN	EB	EB	EB	EB	EB	EB
200 - 430 pF*	201 - 431*				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
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	K	M	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	K	M	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				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
750 pF	751				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
820 pF	821				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
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	K	M	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	K	M	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				F	G	J	K	M	BB	BB	BB	BB		CF	CF	CF	CF	CF		DP	DP	DP	DP	DP		EB	EB	EB	EB	EC	EC
1,500 pF	152				F	G	J	K	M	BB	BB	BB	BB		CF	CF	CF	CF	CF		DP	DP	DP	DP	DP		EB	EB	EB	EB	ED	EC
1,600 pF	162				F	G	J	K	M						CF	CF	CF	CF	CF		DP	DP	DP	DP	DP		EB	EB	EB	EB	ED	ED
1,800 pF	182				F	G	J	K	M						CF	CF	CF	CF	CF		DP	DP	DP	DP	DP		EB	EB	EB	EB	ED	ED
2,000 pF	202				F	G	J	K	M						CF	CF	CF	CF	CF		DN	DN	DN	DN	DN		EB	EB	EB	EB	ED	ED
2,200 pF	222				F	G	J	K	M						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	272				F	G	J	K	M						CF	CF	CF	CF	CF		DN	DN	DN	DN	DN		EB	EB	EB	EB	EC	EC
3,000 pF	302				F	G	J	K	M						CF	CF	CF	CF	CF		DP	DP	DP	DP	DN		EC	EC	EC	EC	EC	
3,300 pF	332				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	K	M						CF	CF	CF	CF	CF		DP	DP	DP	DP	DN		EC	EC	EC	EC	EE	
3,900 pF	392				F	G	J	K	M						CF	CF	CF	CF	CF		DE	DE	DE	DE	DN		EC	EC	EC	EC	EF	
4,300 pF	432				F	G	J	K	M						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	K	M						CF	CF	CF	CF			DE	DE	DE	DE	DN		ED	ED	ED	ED	ED	
5,600 pF	562				F	G	J	K	M						CF	CF	CF	CF			DN	DN	DN	DN	DN		ED	ED	ED	ED	ED	
6,200 pF	622				F	G	J	K	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	K	M						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	DN		EC	EC	EC	EC	EB	
10,000 pF	103				F	G	J	K	M						CF	CF	CF				DN	DN	DN	DN	DP		ED	ED	ED	ED	EB	
12,000 pF	123				F	G	J	K	M												DN	DN	DN	DN	DE		EB	EB	EB	EB	EB	
15,000 pF	153				F	G	J	K	M												DN	DN	DN	DP	DG		EB	EB	EB	EB	EB	
18,000 pF	183				F	G	J	K	M												DN	DN	DN	DP			EB	EB	EB	EB	EB	
22,000 pF	223				F	G	J	K	M												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	333				F	G	J	K	M												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			
Capacitance	Cap Code	Rated Voltage (VDC)								10	16	25	50	100	10	16	25	50	100	200	10	16	25	50	100	200	10	16	25	50	100	200
		Voltage Code								8	4	3	5	1	8	4	3	5	1	2	8	4	3	5	1	2	8	4	3	5	1	2
		Case Size / Series								C0402H					C0603H						C0805H						C1206H					

**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 Code	Case Size / Series								C1210H						C1812H						C2220H					
		Voltage Code								8	4	3	5	1	2	8	4	3	5	1	2	8	4	3	5	1	2
		Rated Voltage (VDC)								10	16	25	50	100	200	10	16	25	50	100	200	10	16	25	50	100	200
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																	
0.5 & 0.75 pF	508 & 758	B	C	D																							
1.0 - 9.1 pF*	109 - 919*	B	C	D						FB	FB	FB	FB	FB	FB												
10 - 91 pF*	100 - 910*				F	G	J	K	M	FB	FB	FB	FB	FB	FB												
100 - 910 pF*	101 - 911*				F	G	J	K	M	FB	FB	FB	FB	FB	FB												
1,000 pF	102				F	G	J	K	M	FB	FB	FB	FB	FB	FB												
1,100 pF	112				F	G	J	K	M	FB	FB	FB	FB	FB	FB												
1,200 pF	122				F	G	J	K	M	FB	FB	FB	FB	FB	FB												
1,300 pF	132				F	G	J	K	M	FB	FB	FB	FB	FB	FC												
1,500 pF	152				F	G	J	K	M	FB	FB	FB	FB	FB	FE												
1,600 pF	162				F	G	J	K	M	FB	FB	FB	FB	FB	FE												
1,800 pF	182				F	G	J	K	M	FB	FB	FB	FB	FB	FE												
2,000 pF	202				F	G	J	K	M	FB	FB	FB	FB	FC	FE												
2,200 pF	222				F	G	J	K	M	FB	FB	FB	FB	FC	FG												
2,400 pF	242				F	G	J	K	M	FB	FB	FB	FB	FC	FC												
2,700 pF	272				F	G	J	K	M	FB	FB	FB	FB	FC	FC												
3,000 pF	302				F	G	J	K	M	FB	FB	FB	FB	FC	FF												
3,300 pF	332				F	G	J	K	M	FB	FB	FB	FB	FF	FF												
3,600 pF	362				F	G	J	K	M	FB	FB	FB	FB	FF	FF												
3,900 pF	392				F	G	J	K	M	FB	FB	FB	FB	FF	FF												
4,300 pF	432				F	G	J	K	M	FB	FB	FB	FB	FF	FF												
4,700 pF	472				F	G	J	K	M	FF	FF	FF	FF	FG	FG												
5,100 pF	512				F	G	J	K	M	FB	FB	FB	FB	FG	FG												
5,600 pF	562				F	G	J	K	M	FB	FB	FB	FB	FG	FG												
6,200 pF	622				F	G	J	K	M	FB	FB	FB	FB	FG													
6,800 pF	682				F	G	J	K	M	FB	FB	FB	FB	FG													
7,500 pF	752				F	G	J	K	M	FC	FC	FC	FC	FC													
8,200 pF	822				F	G	J	K	M	FC	FC	FC	FC	FC													
9,100 pF	912				F	G	J	K	M	FE	FE	FE	FE	FE													
10,000 pF	103				F	G	J	K	M	FF	FF	FF	FF	FF													
12,000 pF	123				F	G	J	K	M	FG	FG	FG	FG	FB													
15,000 pF	153				F	G	J	K	M	FG	FG	FG	FG	FB		GB	GB	GB	GB	GB							
18,000 pF	183				F	G	J	K	M	FB	FB	FB	FB	FB		GB	GB	GB	GB	GB							
22,000 pF	223				F	G	J	K	M	FB	FB	FB	FB	FB		GB	GB	GB	GB	GB							
27,000 pF	273				F	G	J	K	M	FB	FB	FB	FB	FB		GB	GB	GB	GB	GB							
33,000 pF	333				F	G	J	K	M	FB	FB	FB	FB	FB		GB	GB	GB	GB	GB							
39,000 pF	393				F	G	J	K	M	FB	FB	FB	FB	FE		GB	GB	GB	GB	GB							
47,000 pF	473				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	FB	FB	FB	FF		GB	GB	GB	GB	GB							
68,000 pF	683				F	G	J	K	M	FB	FB	FB	FC	FG		GB	GB	GB	GB	GB							
82,000 pF	823				F	G	J	K	M	FC	FC	FC	FF	FH		GB	GB	GB	GB	GB							
0.10 µF	104				F	G	J	K	M	FE	FE	FE	FG	FM		GB	GB	GB	GB	GD							
0.12 µF	124				F	G	J	K	M	FG	FG	FG	FH			GB	GB	GB	GB	GH							
0.15 µF	154				F	G	J	K	M	FH	FH	FH	FM			GD	GD	GD	GD	GN							
0.18 µF	184				F	G	J	K	M							GH	GH	GH	GH								
0.22 µF	224				F	G	J	K	M							GK	GK	GK	GK								
0.47 µF	474				F	G	J	K	M													JJ	JJ	JJ	JJ		
Capacitance	Cap Code	Rated Voltage (VDC)								10	16	25	50	100	200	10	16	25	50	100	200	10	16	25	50	100	200
		Voltage Code								8	4	3	5	1	2	8	4	3	5	1	2	8	4	3	5	1	2
		Case Size / Series								C1210H						C1812H						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.

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

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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 Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[1]		Plastic Quantity	

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

Packaging Type			Loose Packaging		Secure Packaging	
			Bulk Bag (default)		2” x 2” Waffle Pack/ Tray[3]	
Packaging C-Spec[1]			N/A[2]		7282/7292	
Case Size		Chip Thickness (mm)	Packaging Quantities (pieces/unit packaging)			
EIA (in)	Metric (mm)		Minimum	Maximum	Minimum	Maximum
0402	1005	All	1	50,000	1	368
0603	1608	All	1	50,000	1	368
0805	2012	All	1	50,000	1	100
1206	3216	≤ 1.25 (nominal)	1	50,000	1	126
1206	3216	> 1.25 (nominal)	1	50,000	1	50
1210	3225	All	1	50,000	1	80
1808	4520	All	1	20,000	1	50
1812	4532	All	1	20,000	1	42
1825	4564	All	1	20,000	1	20
2220	5650	All	1	20,000	1	20
2225	5664	All	1	20,000	1	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	Density Level A: Maximum (Most) Land 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
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

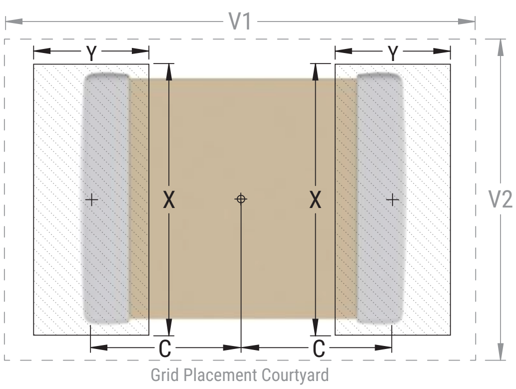
[1] *Only for capacitance values ≥ 22 µF*

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	
	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.

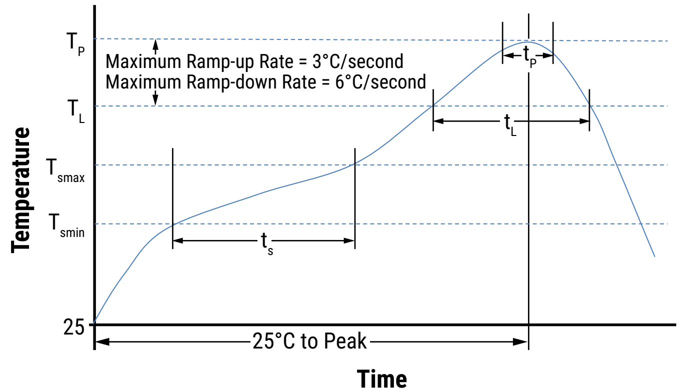


Table 4 – Performance & Reliability: Test Methods and Conditions

Product Qualification Test Plan	
Reliability/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, Mechanical & 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

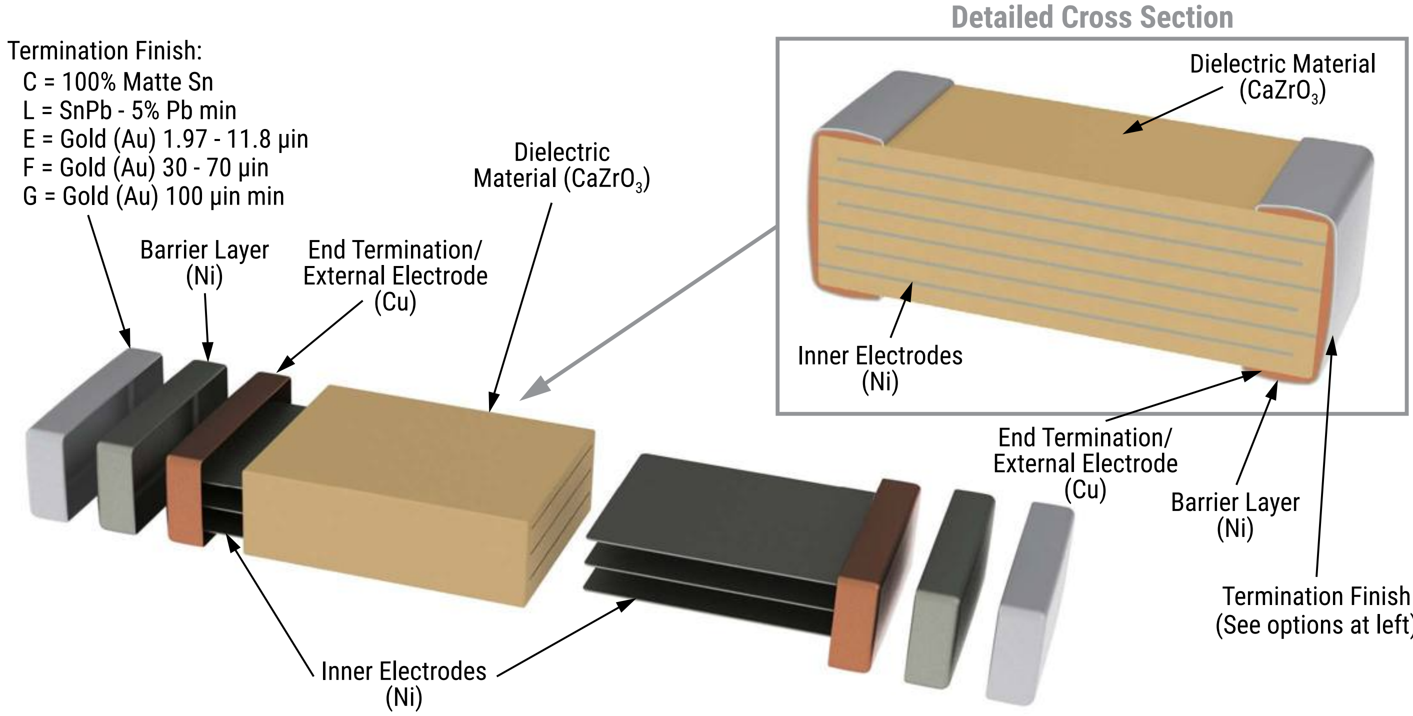
Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will 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)	C	1.5 years upon receipt
SnPb (5% Pb min.)	L	1.5 years upon receipt
Gold (Au) 1.97 – 11.8 µin[2]	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):

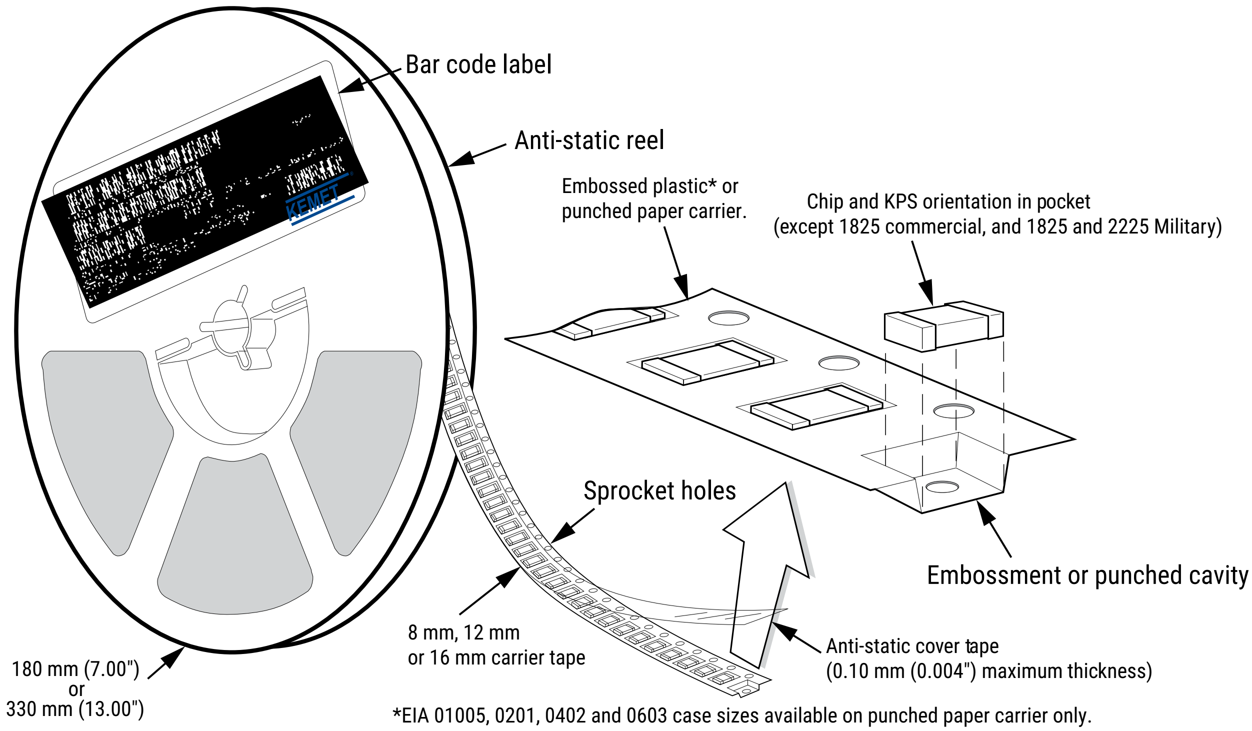
Laser marking option is not available on:

- C0G, 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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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 & 2220	16	12	12		
Array 0508 & 0612	8	4	4		

Refer to Figures 1 & 2 for W and P_1 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

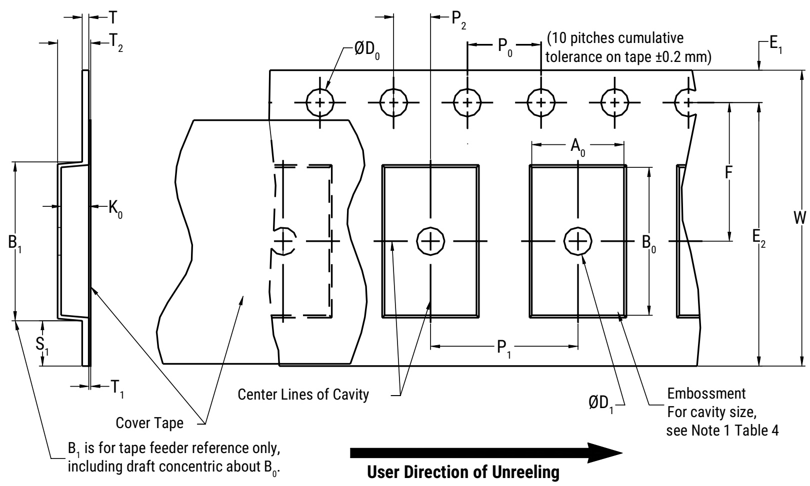


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	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)			
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)	Note 5
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)	
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 S_1 < 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_1 dimension is a reference dimension for tape feeder clearance only.
5. The cavity defined by A_0, B_0 and K_0 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

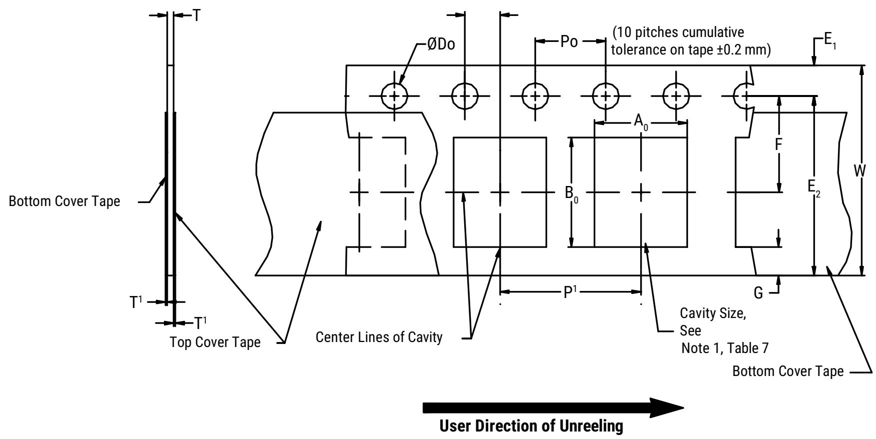


Table 7 – Punched (Paper) Carrier Tape Dimensions

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)	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_0, B_0 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

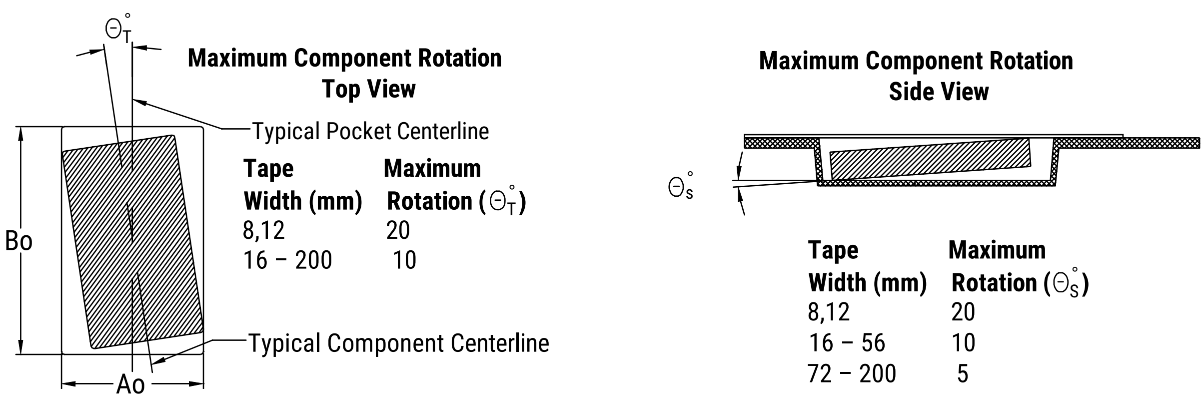


Figure 4 – Maximum Lateral Movement

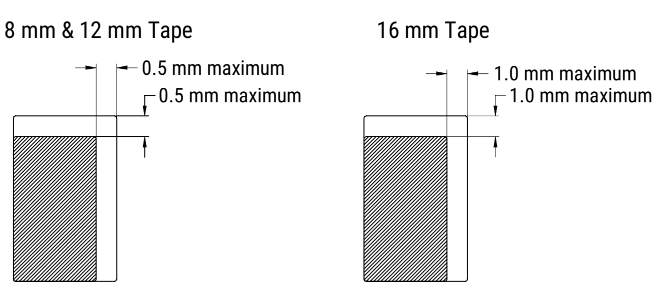


Figure 5 – Bending Radius

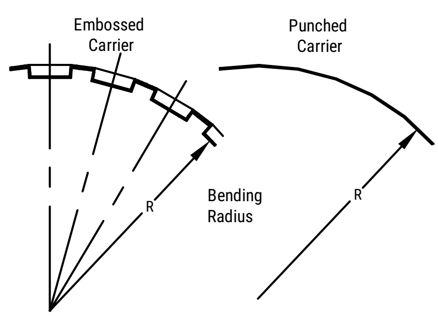
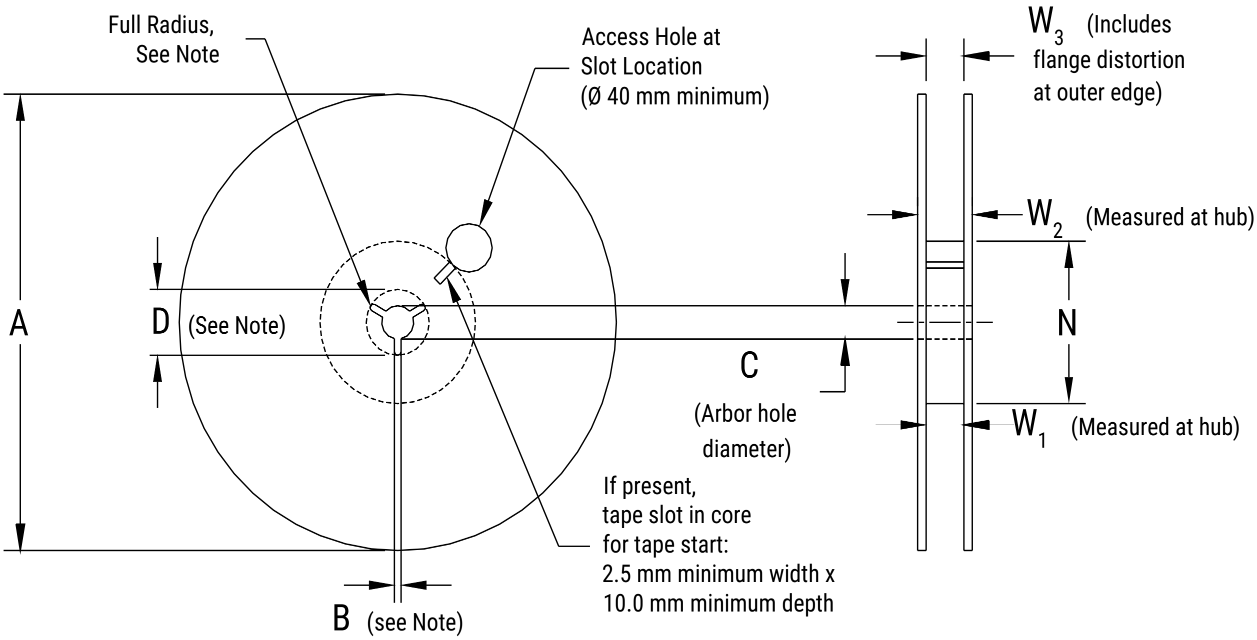


Figure 6 – Reel Dimensions



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	A	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

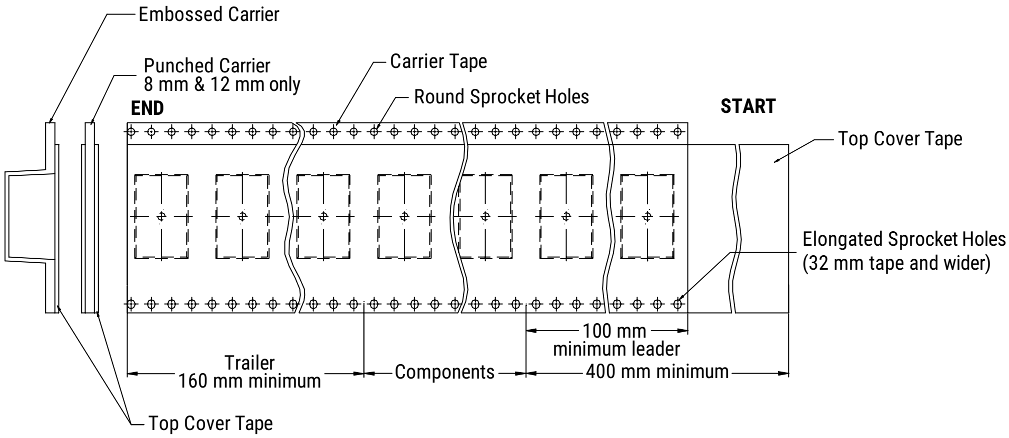
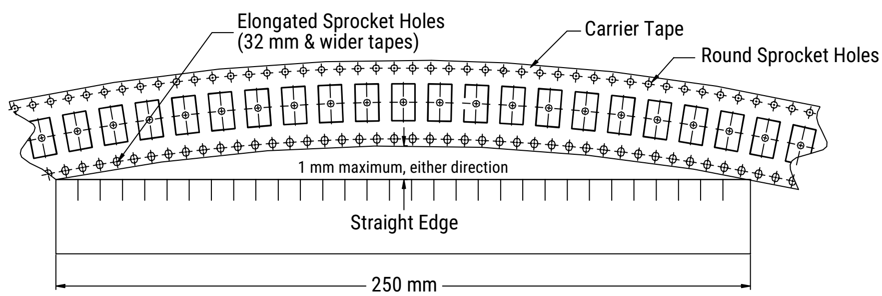


Figure 8 – Maximum Camber



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

Figure 9 – Waffle Tray Dimensions – Inches (Millimeters)

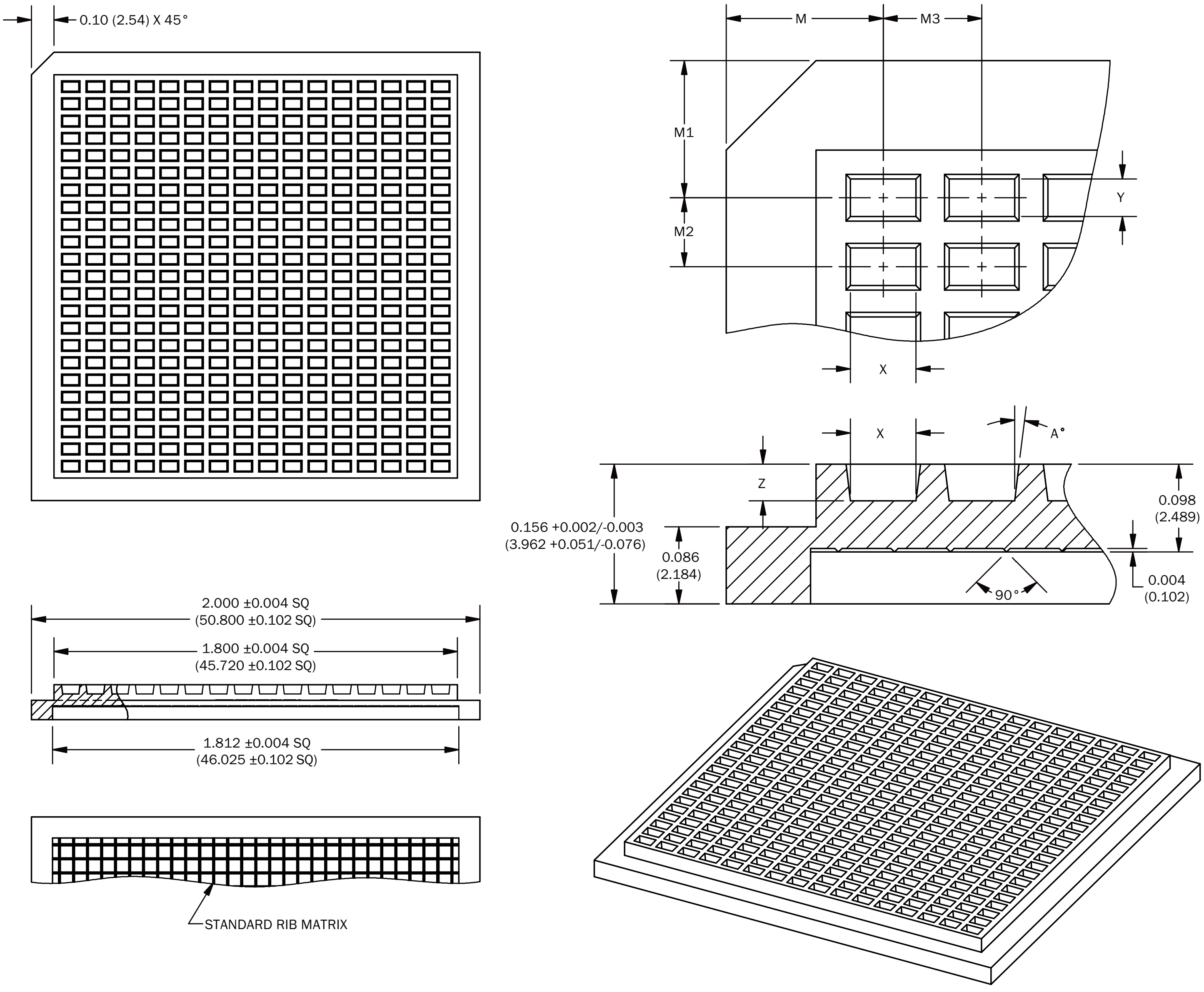


Table 9A – Waffle Tray Dimensions – Inches

Case Size		2" x 2" Waffle Tray Dimensions – Inches									Packaging Quantity (pcs/unit packaging)
		M	M1	M2	M3	X	Y	Z	A°	MATRIX	
EIA (in)	Metric (mm)	±0.003	±0.003	±0.002	±0.002	±0.002	±0.002	±0.003	± 1/2°	(X x Y)	
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

[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 ≤ 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

Case Size		2" x 2" Waffle Tray Dimensions – Millimeters									Packaging Quantity (pcs/unit packaging)
		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)	
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 ≤ 1.25mm (0.049 inches).
[3] Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of > 1.25mm (0.049 inches).

Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs)

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 ±15% from −55°C to +150°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 qualification requirements.

Ordering Information

C	1210	C	184	K	3	H	A	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 = ±0.10 pF C = ±0.25 pF D = ±0.5 pF F = ±1% G = ±2% J = ±5% K = ±10% M = ±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)
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	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 +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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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:

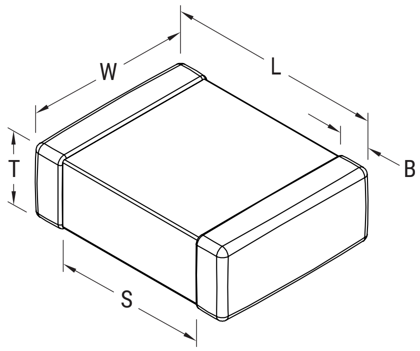
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

[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 +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 MΩ-µF value by the capacitance and compare to GΩ 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 ≤ 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)

Capacitance	Cap Code	Case Size/Series								C0402C					C0603C					C0805C					C1206C					C1210C					C1812C	
		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
		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								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																										
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	758	B	C	D						BB	BB	BB	BB		CF	CF	CF	CF	CF	DN	DN	DN	DN	DN												
1.0 - 9.1 pF*	109 - 919*	B	C	D						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				F	G	J	K	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		
11 pF	110				F	G	J	K	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		
12 pF	120				F	G	J	K	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		
13 pF	130				F	G	J	K	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				F	G	J	K	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		
16 pF	160				F	G	J	K	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				F	G	J	K	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	200				F	G	J	K	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		
22 pF	220				F	G	J	K	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		
24 pF	240				F	G	J	K	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				F	G	J	K	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		
30 pF	300				F	G	J	K	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	330				F	G	J	K	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		
36 pF	360				F	G	J	K	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		
39 pF	390				F	G	J	K	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		
43 pF	430				F	G	J	K	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		
47 pF	470				F	G	J	K	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		
51 pF	510				F	G	J	K	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		
56 pF	560				F	G	J	K	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 pF	620				F	G	J	K	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		
68 pF	680				F	G	J	K	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				F	G	J	K	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		
82 pF	820				F	G	J	K	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	910				F	G	J	K	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		
100 pF	101				F	G	J	K	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		
110 pF	111				F	G	J	K	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		
120 pF	121				F	G	J	K	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				F	G	J	K	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		
150 pF	151				F	G	J	K	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		
160 pF	161				F	G	J	K	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	181				F	G	J	K	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		
200 pF	201				F	G	J	K	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		
220 pF	221				F	G	J	K	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	J	K	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				F	G	J	K	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		
300 pF	301				F	G	J	K	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		
330 pF	331				F	G	J	K	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				F	G	J	K	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		
390 pF	391				F	G	J	K	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		
430 pF	431				F	G	J	K	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		
470 pF	471				F	G	J	K	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				F	G	J	K	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
560 pF	561				F	G	J	K	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
620 pF	621				F	G	J	K	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	681				F	G	J	K	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
750 pF	751				F	G	J	K	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
820 pF	821				F	G	J	K	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
910 pF	911				F	G	J	K	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				F	G	J	K	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
1,100 pF	112				F	G	J	K	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
1,200 pF	122				F	G	J	K	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				F	G	J	K	M	BB	BB	BB	BB		CF	CF	CF	CF	CF	DP	DP	DP	DP	DP	EB	EB	EB	EB	EC	FB	FB	FB	FB	FB	GB	GB
1,500 pF	152				F	G	J	K	M	BB	BB	BB	BB		CF	CF	CF	CF	CF	DP	DP	DP	DP	DP	EB	EB	EB	EB	ED	FB	FB	FB	FB	FB	GB	GB
1,600 pF	162				F	G	J	K	M						CF	CF	CF	CF	CF	DP	DP	DP	DP	DP	EB	EB	EB	EB	ED	FB	FB	FB	FB	FB	GB	GB
1,800 pF	182				F	G	J	K	M						CF	CF	CF	CF	CF	DP	DP	DP	DP	DP	EB	EB	EB	EB	ED	FB	FB	FB	FB	FB	GB	GB
Capacitance	Cap Code	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
		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								C0402C					C0603C					C0805C					C1206C					C1210C					C1812C	

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

Capacitance	Cap Code	Case Size/Series	C0402C					C0603C					C0805C					C1206C					C1210C					C1812C	
		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
		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	Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																										
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						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						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						CF	CF	CF	CF		DN	DN	DN	DN	DN	ED	ED	ED	ED	ED	FB	FB	FB	FB	FG		
5,600 pF	562	F G J K M						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	F G J K M						CF	CF	CF	CF		DN	DN	DN	DN	DN	EB	EB	EB	EB	EB	FB	FB	FB	FB	FG		
6,800 pF	682	F G J K M						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	F G J K M						CF	CF	CF			DN	DN	DN	DN	DN	EB	EB	EB	EB	EB	FC	FC	FC	FC	FC		
8,200 pF	822	F G J K M						CF	CF	CF			DN	DN	DN	DN	DN	EB	EB	EB	EB	EB	FC	FC	FC	FC	FC	GB	GH
9,100 pF	912	F G J K M						CF	CF	CF			DN	DN	DN	DN	DN	EB	EB	EB	EB	EB	FE	FE	FE	FE	FE		
10,000 pF	103	F G J K M						CF	CF	CF			DN	DN	DN	DN	DP	EB	EB	EB	EB	EB	FF	FF	FF	FF	FF	GB	GH
12,000 pF	123	F G J K M											DN	DN	DN	DN	DE	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB	GB	GG
15,000 pF	153	F G J K M											DN	DN	DN	DP	DG	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB	GB	GB
18,000 pF	183	F G J K M											DN	DN	DN	DP		EB	EB	EB	EB	EB	FB	FB	FB	FB	FB	GB	GB
22,000 pF	223	F G J K M											DP	DP	DP	DF		EB	EB	EB	EB	EC	FB	FB	FB	FB	FB	GB	GB
27,000 pF	273	F G J K M											DF	DF	DF			EB	EB	EB	EB	EE	FB	FB	FB	FB	FB	GB	GB
33,000 pF	333	F G J K M											DG	DG	DG			EB	EB	EB	EB	EE	FB	FB	FB	FB	FB	GB	GB
39,000 pF	393	F G J K M																EC	EC	EC	EE	EH	FB	FB	FB	FB	FE	GB	GB
47,000 pF	473	F G J K M																EC	EC	EC	EE	EH	FB	FB	FB	FB	FE	GB	GB
56,000 pF	563	F G J K M																ED	ED	ED	EF		FB	FB	FB	FB	FF	GB	GB
68,000 pF	683	F G J K M																EF	EF	EF	EH		FB	FB	FB	FC	FG	GB	GB
82,000 pF	823	F G J K M																EH	EH	EH	EH		FC	FC	FC	FF	FH	GB	GB
100,000 pF	104	F G J K M																EH	EH	EH			FE	FE	FE	FG	FM	GB	GD
120,000 pF	124	F G J K M																					FG	FG	FG	FH		GB	GH
150,000 pF	154	F G J K M																					FH	FH	FH	FM		GD	GN
180,000 pF	184	F G J K M																					FJ	FJ	FJ			GH	
220,000 pF	224	F G J K M																										GK	
Capacitance	Cap Code	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
		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	C0402C					C0603C					C0805C					C1206C					C1210C					C1812C	

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

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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 Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[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

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		Packaging Quantities (pieces/unit packaging)	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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 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)				
		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

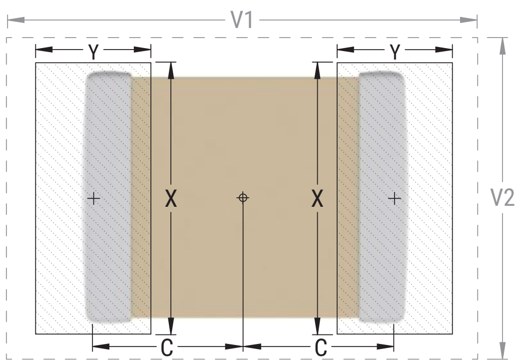
[1] *Only for capacitance values ≥ 22 µF.*

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	
	SnPb	100% Matte Sn
Preheat/Soak Temperature Minimum (T_{Smin}) Temperature Maximum (T_{Smax}) Time (t_S) from T_{Smin} to T_{Smax}	 100°C 150°C 60 – 120 seconds	 150°C 200°C 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.

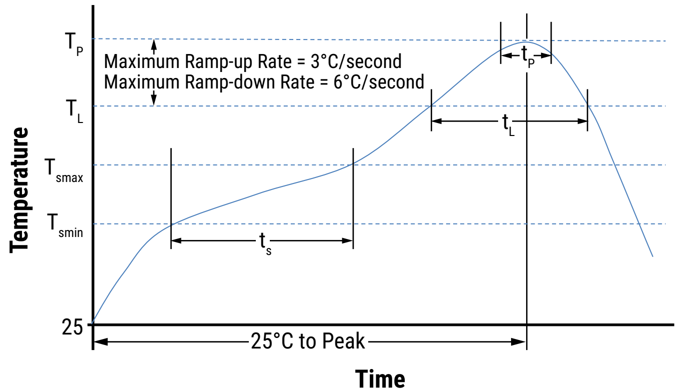


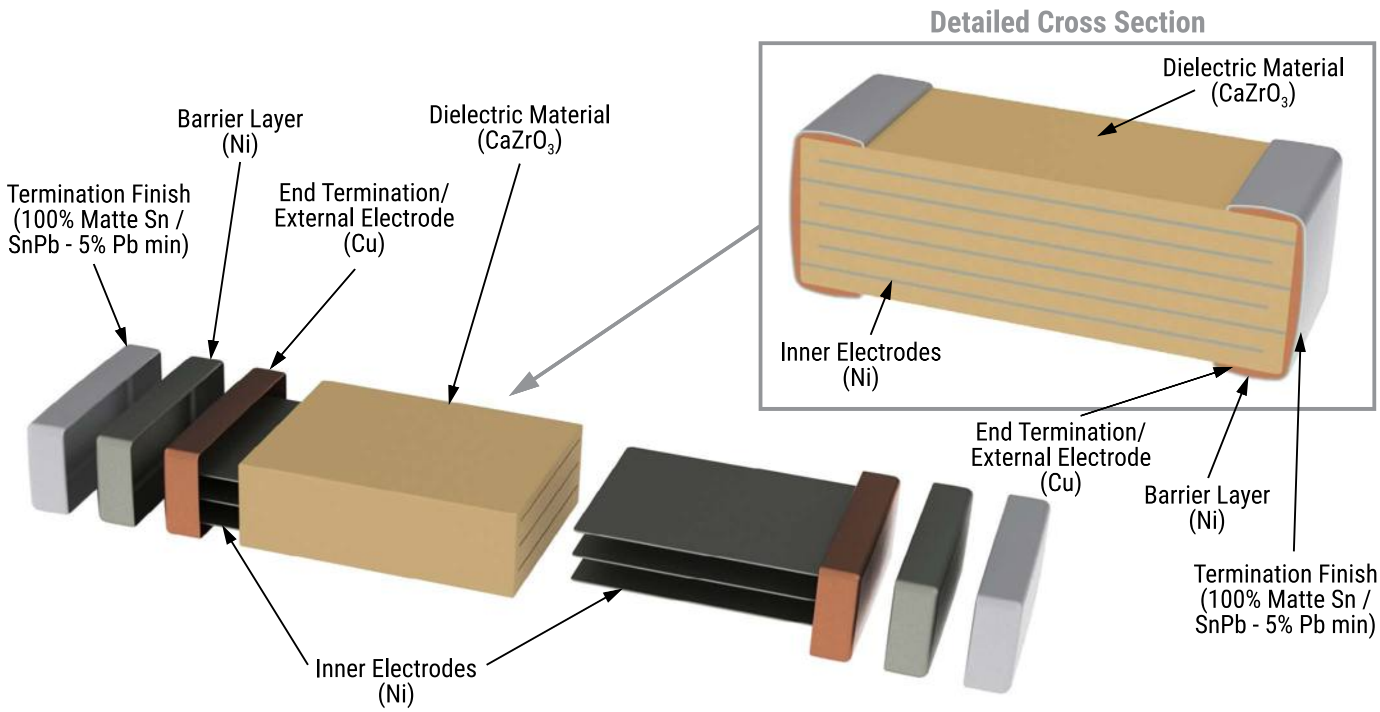
Table 4 – Performance & Reliability: Test Methods & Conditions

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 C0G. 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 +150°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 100K 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/+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)

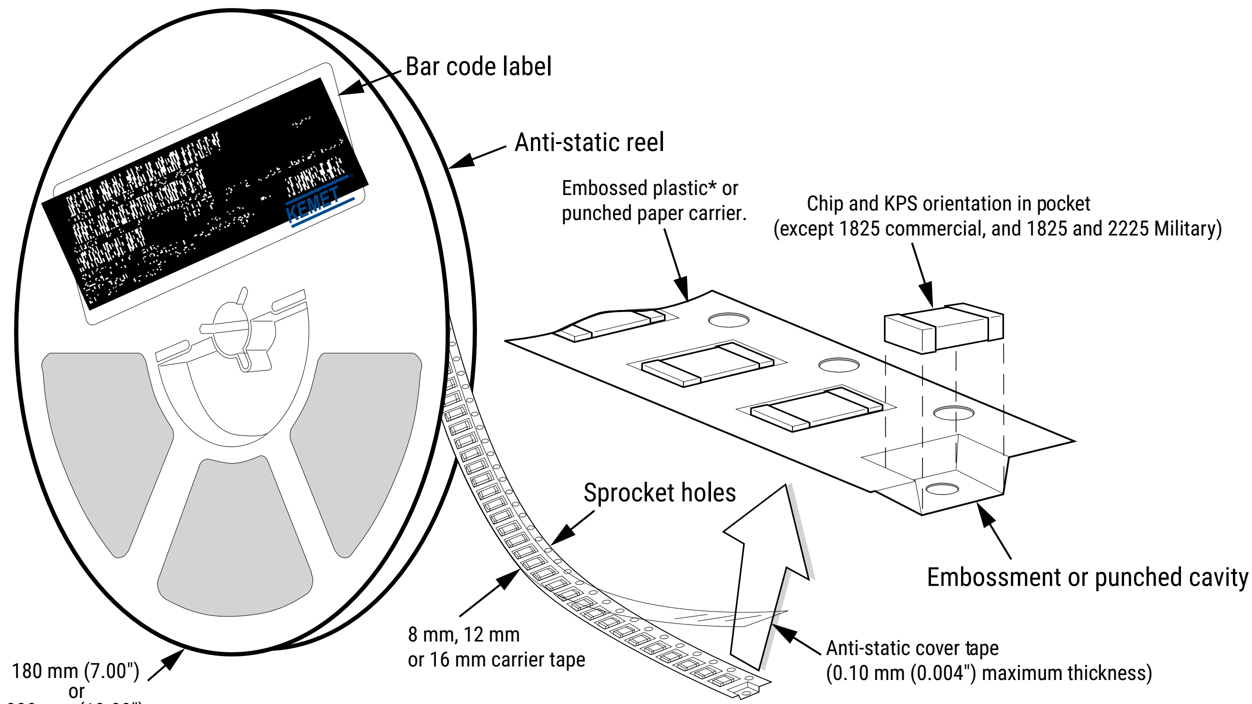
Laser marking option is not available on:

- C0G, 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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic 7" Reel	Embossed Plastic 13" Reel	Punched Paper 7" Reel	Punched Paper 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

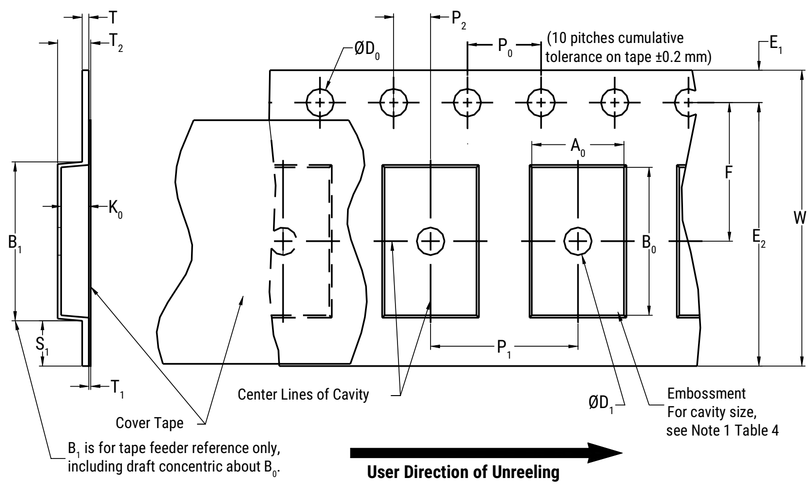


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +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)			
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)	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 S_1 < 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_0, B_0 and K_0 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

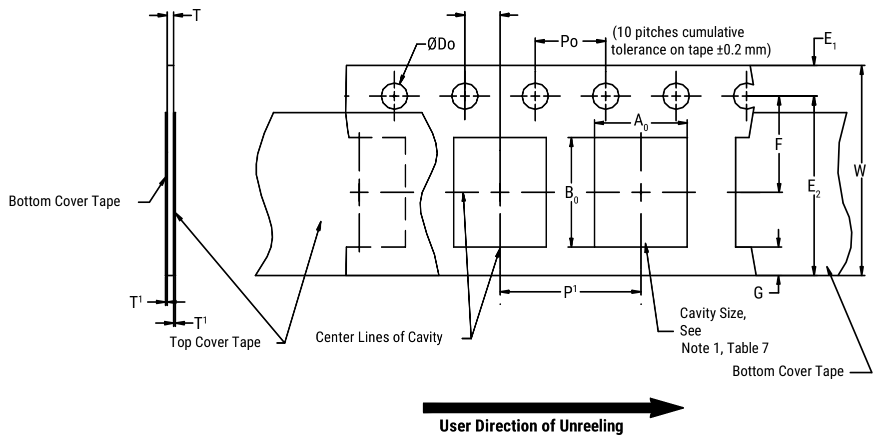


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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

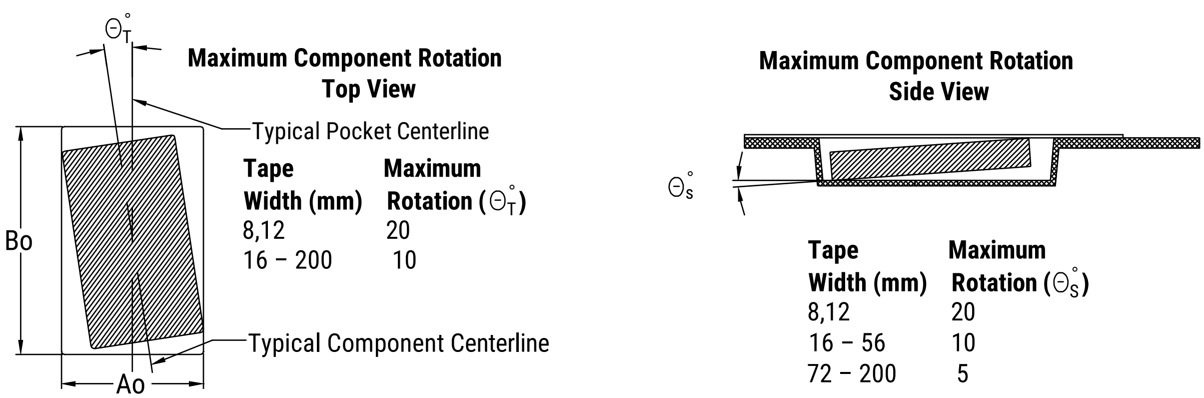


Figure 4 – Maximum Lateral Movement

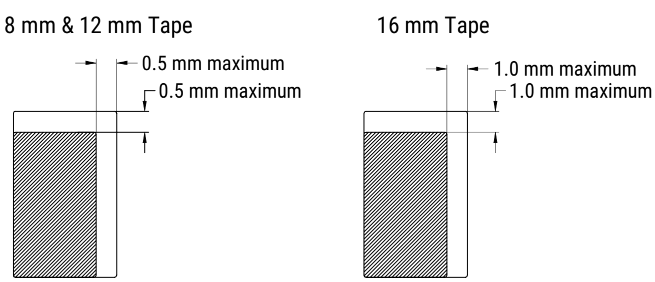


Figure 5 – Bending Radius

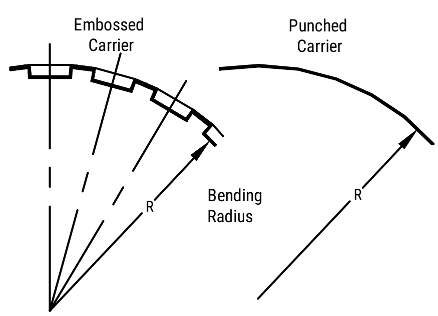
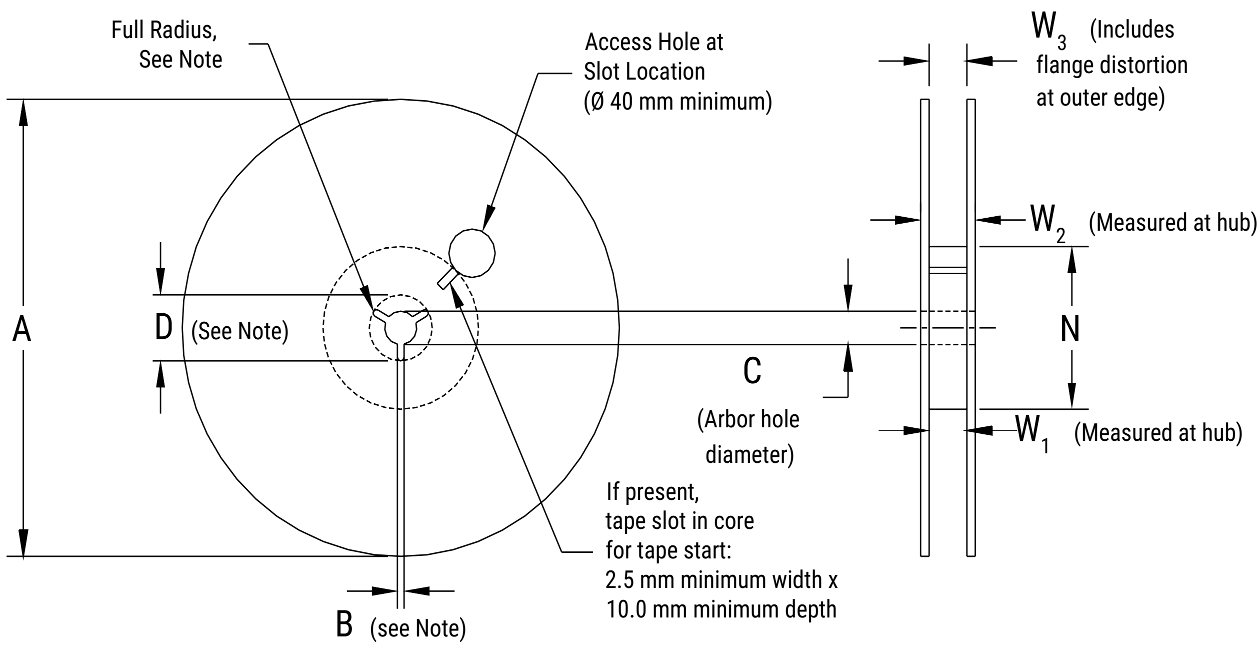


Figure 6 – Reel Dimensions



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	A	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

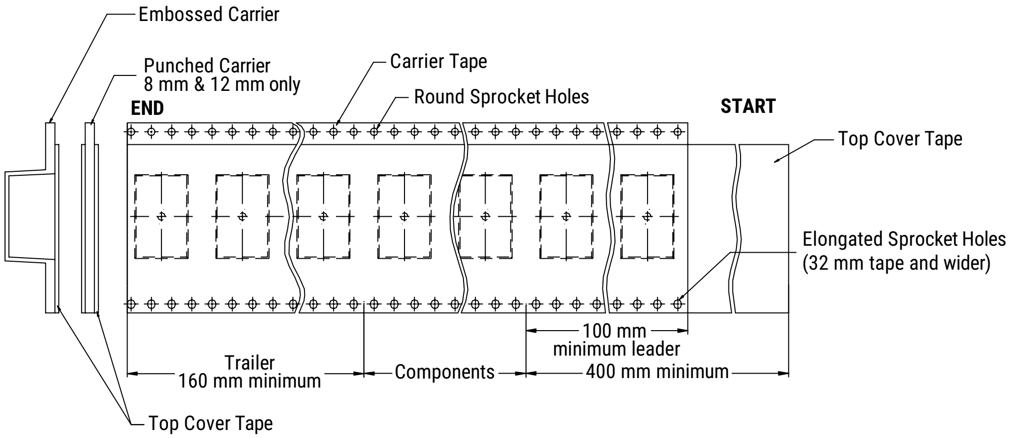
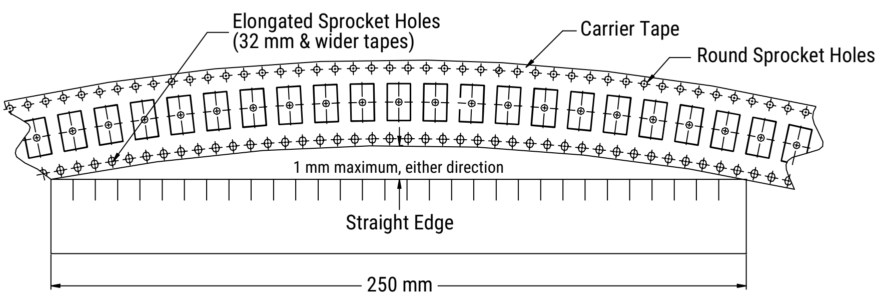


Figure 8 – Maximum Camber



High Temperature 150°C, X8L Dielectric, 10 – 50 VDC (Commercial & Automotive Grade)

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.

Ordering Information

C	1210	X	106	K	8	N	A	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"

[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)
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	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
Automotive 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 +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 μF to 10 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)
- 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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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:

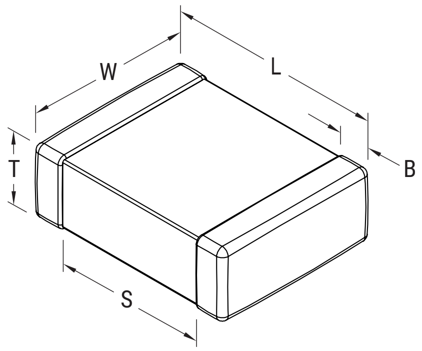
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

[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 – 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)		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 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)		
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

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)	
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 (0.020) ±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)	N/A	Solder Reflow 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 +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.*
[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 ≤10µF
120Hz ± 10Hz and 0.5 ± 0.1 Vrms if capacitance >10µF
[4] *To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ 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
X8L	≥ 25	All	3.0	±20%	10% of Initial Limit
	≤ 16		5.0		

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

Cap	Cap Code	Case Size/ Series			C0402C				C0603C					C0805C					C1206C					C1210C				
		Voltage Code			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
		Capacitance Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																							
12,000 pF	123	J	K	M	BB	BB	BB	BB																				
15,000 pF	153	J	K	M	BB	BB	BB	BB																				
18,000 pF	183	J	K	M	BB	BB	BB	BB																				
22,000 pF	223	J	K	M	BB	BB	BB	BB																				
27,000 pF	273	J	K	M	BB	BB	BB																					
33,000 pF	333	J	K	M	BB	BB	BB																					
39,000 pF	393	J	K	M	BB	BB	BB																					
47,000 pF	473	J	K	M	BB	BB	BB		CF	CF	CF	CF	CF															
56,000 pF	563	J	K	M	BB	BB																						
68,000 pF	683	J	K	M	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	K	M					CF	CF	CF			DP	DP	DP	DP	DG										
0.27 µF	274	J	K	M										DP	DP	DP	DP											
0.33 µF	334	J	K	M										DP	DP	DP	DP											
0.39 µF	394	J	K	M										DE	DE	DE	DE							FD	FD	FD	FD	FD
0.47 µF	474	J	K	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							FF	FF	FF	FF	FF
0.68 µF	684	J	K	M										DG	DG	DH	DH							FG	FG	FG	FG	FG
0.82 µF	824	J	K	M										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	EF	EH	EH		FG	FG	FG	FG	
2.7 µF	275	J	K	M															EH	EH	EH			FG	FG	FH	FH	
3.3 µF	335	J	K	M															EH	EH	EH			FM	FM	FM	FM	
3.9 µF	395	J	K	M															EH	EH	EH			FG	FG	FK	FK	
4.7 µF	475	J	K	M															EH	EH	EH			FG	FG	FS	FS	
5.6 µF	565	J	K	M																				FH	FH	FH		
6.8 µF	685	J	K	M																				FM	FM	FM		
8.2 µF	825	J	K	M																				FK	FK	FK		
10 µF	106	J	K	M																				FS	FS	FS		
Cap	Cap Code	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
		Voltage Code			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			C0402C				C0603C					C0805C					C1206C					C1210C				

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

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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 Code	**Case Size[1]**	**Thickness ± Range (mm)**	**7" Reel**	**13" Reel**	**7" Reel**	**13" Reel**
			Paper Quantity[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

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		Packaging Quantities (pieces/unit packaging)	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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 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)				
		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	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.

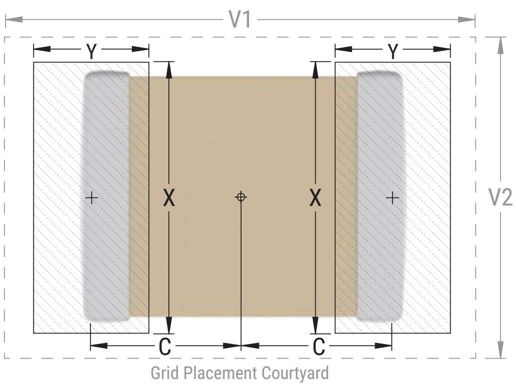
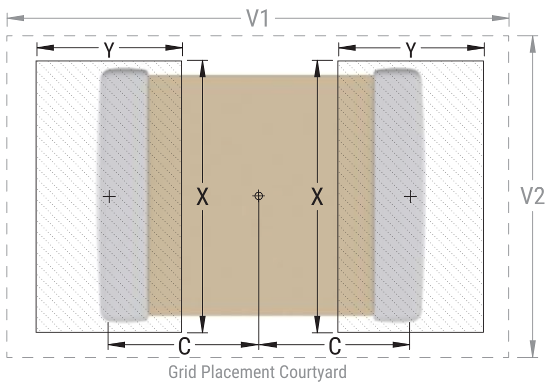


Table 3B – Land Pattern Design Recommendations per IPC–7351 – Flexible Termination

EIA Size Code	Metric Size Code	Density Level A: Maximum (Most) Land Protrusion (mm)					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
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	Termination Finish	
	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.

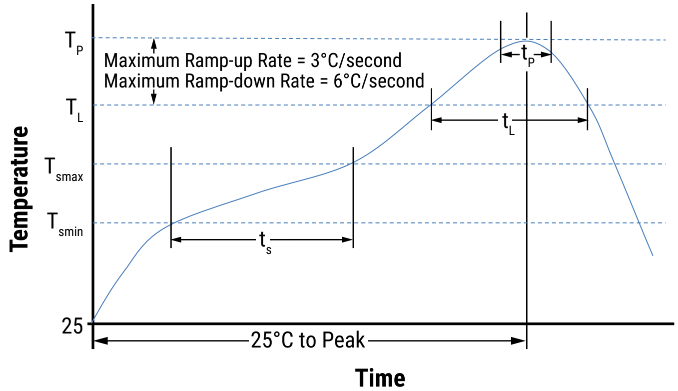


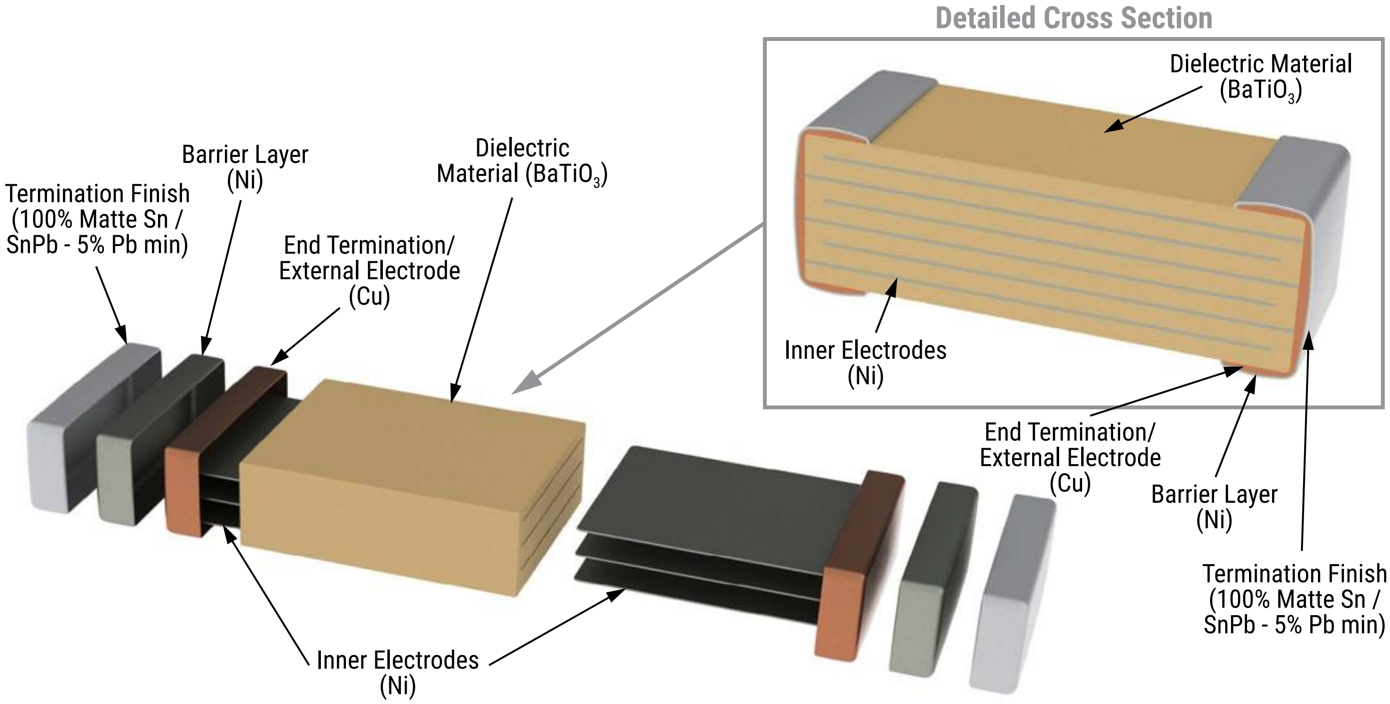
Table 4 – Performance & Reliability: Test Methods and Conditions

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 C0G. 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 +150°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 100K 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/+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.

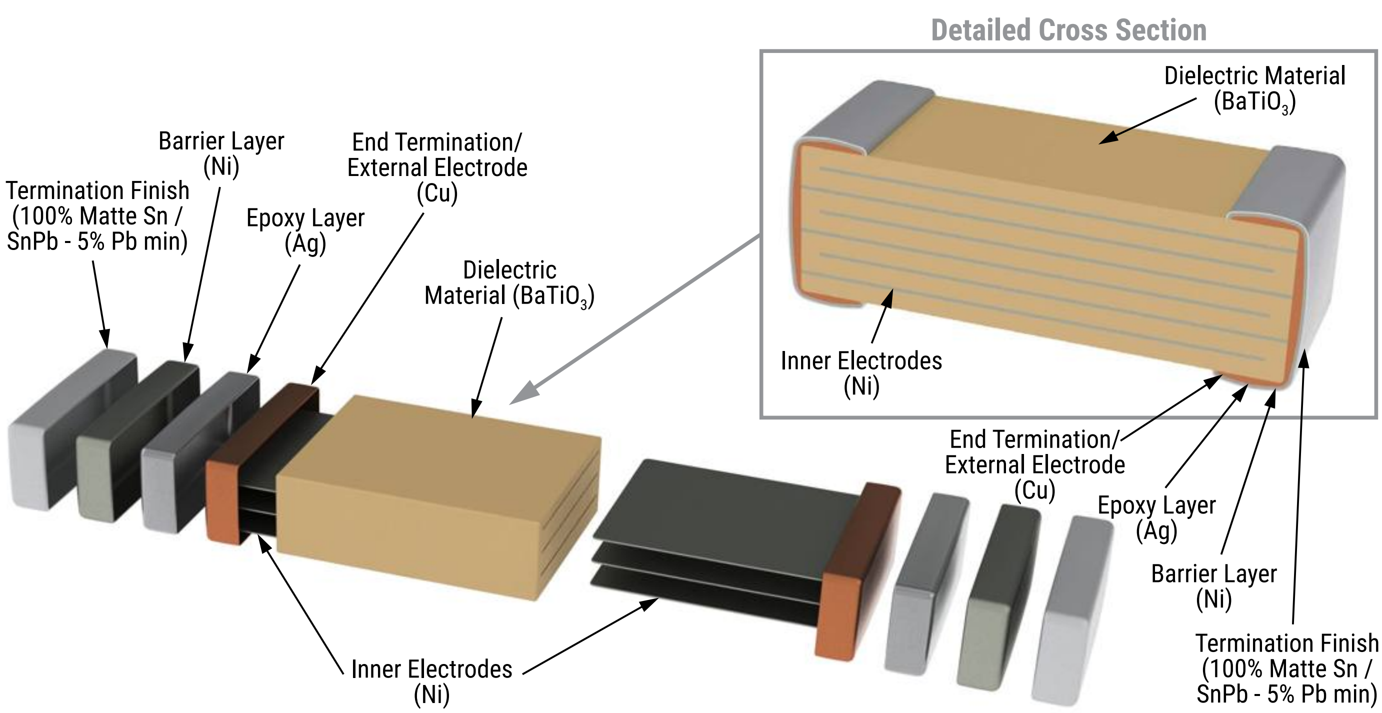
Storage and Handling

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 40ºC 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)

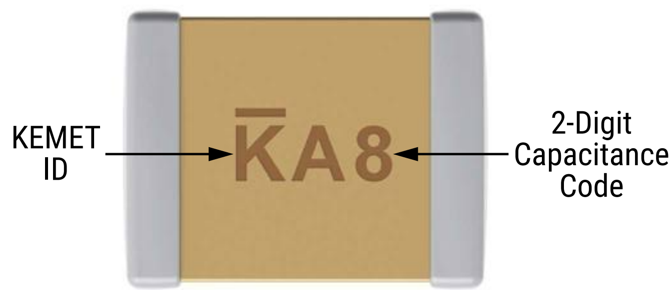
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic 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:

- C0G, 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 µF. Orientation of marking is vendor optional.

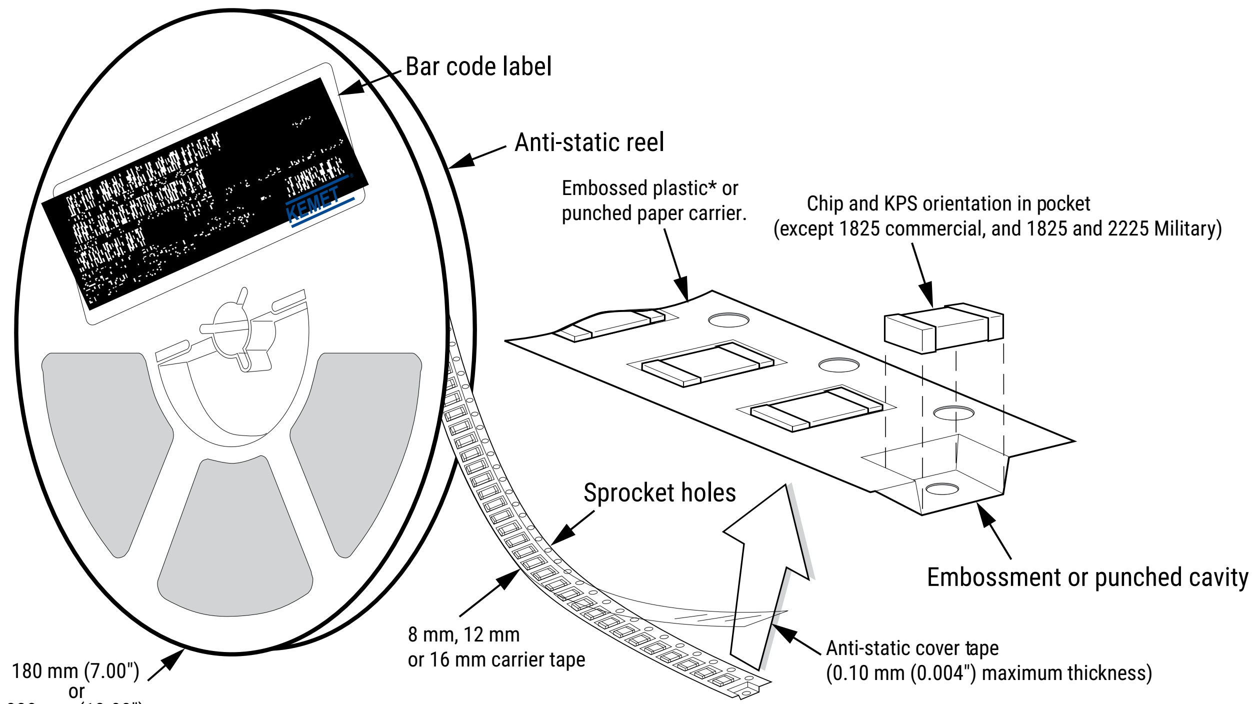


Capacitor Marking (Optional) cont.

Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.10	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

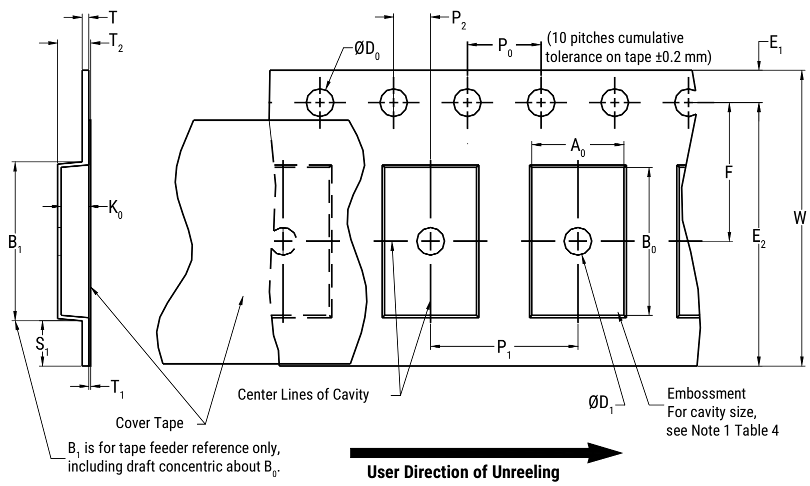


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +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)			
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)	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 S_1 < 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_0, B_0 and K_0 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

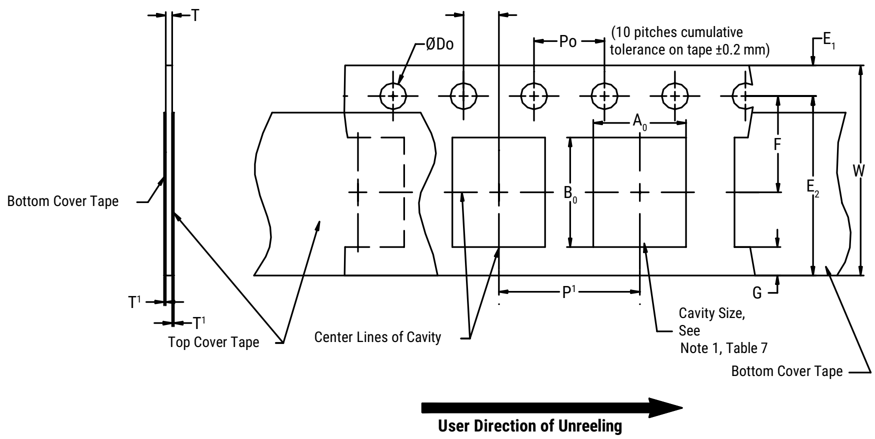


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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

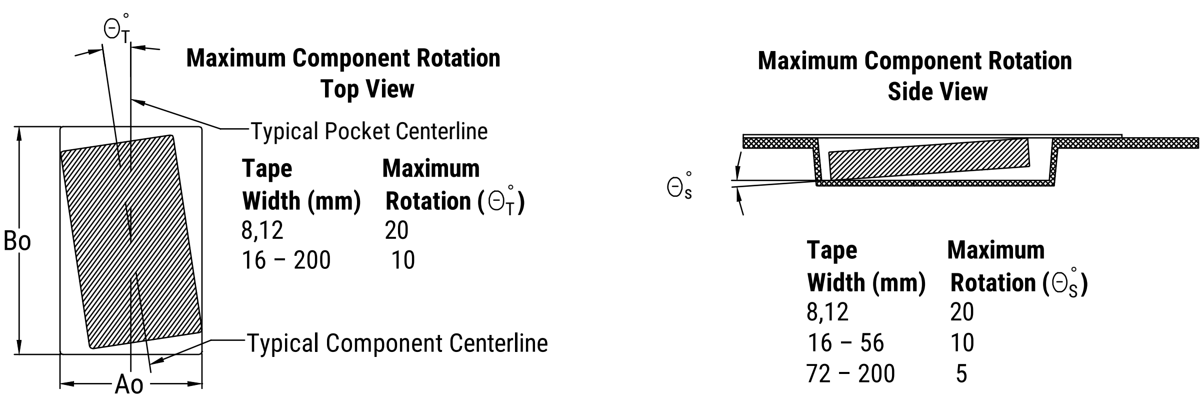


Figure 4 – Maximum Lateral Movement

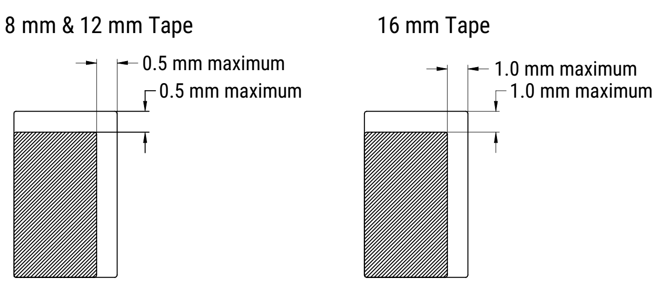


Figure 5 – Bending Radius

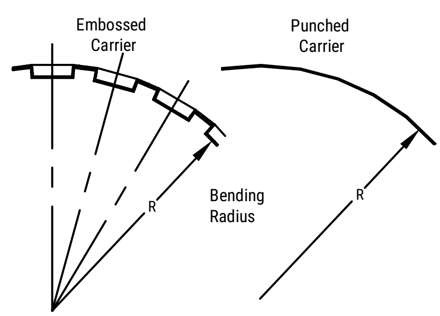
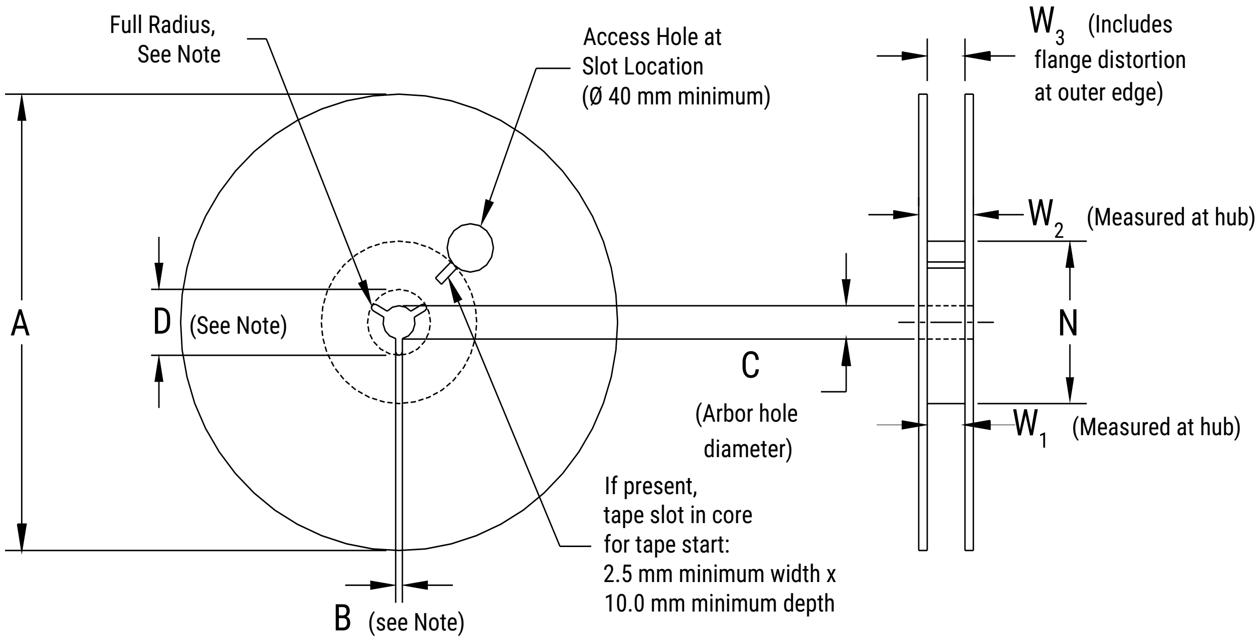


Figure 6 – Reel Dimensions



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	A	B Minimum	C	D Minimum
8 mm 12 mm 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	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

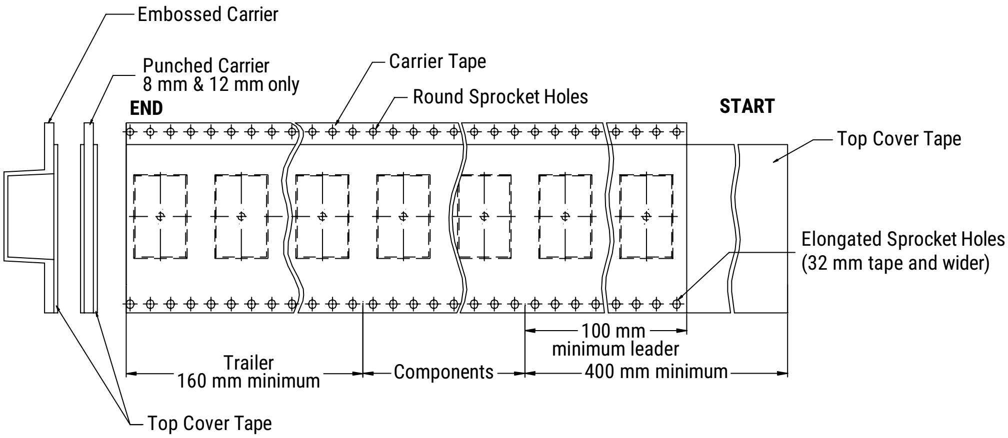
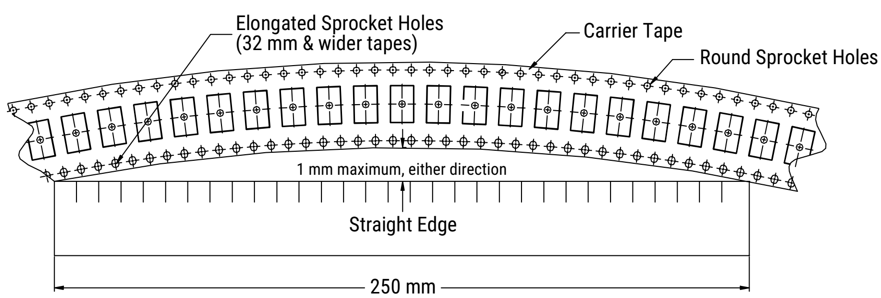


Figure 8 – Maximum Camber



High Voltage C0G Dielectric, 500 – 10,000 VDC (Commercial Grade)

Overview

KEMET's High Voltage surface mount MLCCs in C0G dielectric are temperature compensating and are suited for resonant circuit applications or those where Q and stability of capacitance characteristics are required. C0G 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 C0G 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

C	1210	C	332	J	C	G	A	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)
	0402 0603 0805 1206 1210 1808 1812 1825 2220 2225 2824 3040 3640 4540	C = Standard	Two significant digits and number of zeros.	B = ±0.10 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 = C0G	A = N/A	C = 100% Matte Sn L = SnPb (5% Pb minimum)	See "Packaging C-Spec Ordering Options Table"

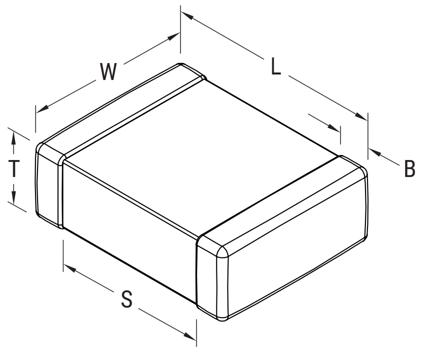
[1] *Additional capacitance tolerance offerings may be available. Contact KEMET for details.*
[2] *Additional termination finish options may be available. Contact KEMET for details.*

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)	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
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)		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)		
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)

Capacitance	Cap Code	Case Size/Series								C0402C	C0603C			C0805C			C1206C					C1210C					C1808C						
		Voltage Code								C	C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		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								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																							
1.0 - 9.1 pF*	109 - 919*	B	C	D										DG	DG	DG											LB	LB	LB	LB	LB	LB	LB
10 pF - 47pF*	100 - 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
11 pF	110				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
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	M					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	M					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	M					DG	DG	DG	ED	ED	ED	ED	ED	FM	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				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
22 pF	220				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
24 pF	240				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
27 pF	270				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
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	K	M					DG	DG	DG	ED	ED	ED	ED	ED	FM	FM	FM	FM	FM	LB	LB	LB	LB	LB	LB	LB
36 pF	360				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
39 pF	390				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
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				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
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	LB	LB
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	LB	LB
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	LB	LB	LB
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	K	M					DG	DG	DG	ED	ED	ED	ED	EF	FM	FM	FM	FM	FM	LB	LB	LB	LB	LB	LB	LB
91 pF	910				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
100 pF	101				F	G	J	K	M	BB	CG	CG	CG	DG	DG	DG	ED	ED	ED	ED	EF	FM	FM	FM	FM	FM	LB	LB	LB	LB	LB	LC	LB
110 pF	111				F	G	J	K	M	BB	CG	CG	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	CG	CG	DG	DG	DG	ED	ED	ED	ED	EG	FG	FG	FG	FM	FM	LA	LA	LA	LA	LB	LC	LB
130 pF	131				F	G	J	K	M	BB	CG	CG	CG	DG	DG	DG	ED	ED	ED	ED	EG	FG	FG	FG	FM	FM	LA	LA	LA	LA	LB	LC	LC
150 pF	151				F	G	J	K	M	BB	CG	CG	CG	DG	DG	DG	ED	ED	ED	EF	EG	FG	FG	FG	FM	FM	LA	LA	LA	LA	LB	LC	LC
160 pF	161				F	G	J	K	M	BB	CG	CG	CG	DG	DG	DG	ED	ED	ED	EF	EG	FG	FG	FG	FM	FM	LA	LA	LA	LA	LC	LC	LC
180 pF	181				F	G	J	K	M	BB	CG	CG	CG	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	K	M	BB	CG	CG	CG	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	K	M	BB	CG	CG	CG	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	M	BB	CG	CG		DG	DG	DG	ED	ED	ED	EG	EG	FG	FG	FG	FM	FM	LA	LA	LA	LB	LC	LC	
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
		Voltage Code								C	C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		Case Size/Series								C0402C	C0603C			C0805C			C1206C					C1210C					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)*
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.

Capacitance	Cap Code	Case Size/Series	C0402C	C0603C			C0805C			C1206C					C1210C					C1808C						
		Voltage Code	C	C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		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	Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																							
270 pF	271	F G J K M	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	FM	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	FM	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	FM	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	FM	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	FM	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	272	F G J K M					DG	DG		EG	EB	EG			FS	FL	FS			LC	LA	LC				
3,000 pF	302	F G J K M								EB	EB				FS	FL	FF			LA	LA	LA				
3,300 pF	332	F G J K M								EB	EB				FS	FM	FG			LA	LA	LA				
3,600 pF	362	F G J K M								EC	EC				FL	FM	FG			LA	LB	LA				
3,900 pF	392	F G J K M								EC	EC				FL	FY	FL			LA	LB	LA				
4,300 pF	432	F G J K M								ED	ED				FM	FY	FL			LA	LC	LA				
4,700 pF	472	F G J K M								ED	ED				FM	FY	FM			LA	LC	LB				
5,100 pF	512	F G J K M								EE	EE				FY	FS	FM			LA	LB	LB				
5,600 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								EG	EG				FY	FE	FY			LC	LC	LC				
7,500pF	752	F G J K M								EG	EG				FS	FF	FS			LA	LA					
8,200 pF	822	F G J K M								EG	EG				FS	FF	FS			LA	LA					
9,100 pF	912	F G J K M								EG	EG				FF	FF	FS			LA	LA					
10,000 pF	103	F G J K M								EH	EH				FG	FG	FS			LA	LA					
12,000 pF	123	F G J K M								EG					FG	FG	FM			LA	LA					
15,000 pF	153	F G J K M								EG					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										
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
		Voltage Code	C	C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		Case Size/Series	C0402C	C0603C			C0805C			C1206C					C1210C					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)*
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 (1812 – 2225 Case Sizes)

Capacitance	Cap Code	Case Size/Series					C1812C							C1825C							C2220C							C2225C							
		Voltage Code					C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	K
		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	10000
		Capacitance Tolerance					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																												
10 pF - 47pF*	100 - 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	
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	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	
15 pF	150	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	
16 pF	160	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	
18 pF	180	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	
20 pF	200	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	
22 pF	220	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	
24 pF	240	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	
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	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	
36 pF	360	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	
39 pF	390	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	
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	111	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	KJ
120 pF	121	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	KJ
130 pF	131	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	KJ
150 pF	151	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	
160 pF	161	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	
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	K	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	
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	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	M	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	M	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	
680 pF	681	F	G	J	K	M	GB	GB	GB	GD	GH	GO		HE	HE	HE	HE	HG	HG	HK	JE	JE	JE	JK	JK	JK	JL	KF	KF	KF	KF	KE	KF	KH	
750 pF	751	F	G	J	K	M	GB	GB	GB	GD	GK			HE	HE	HE	HG	HG	HG		JE	JE	JE	JK	JK	JK	JL	KE	KE	KE	KF	KE	KF	KH	
820 pF	821	F	G	J	K	M	GB	GB	GB	GD	GK			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	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	
Capacitance	Cap 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	10000
		Voltage Code					C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	K
		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.

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

Capacitance	Cap Code	Case Size/Series					C1812C							C1825C							C2220C							C2225C							
		Voltage Code					C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	K
		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	10000
		Capacitance Tolerance					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																												
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	F	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	F	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	F	G	J	K	M	GB	GB	GB	GH	GO			HE	HE	HE	HG	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	HE	HE	HG	HE	HK		JE	JK	JK	JK	JE	JL		KE	KE	KE	KF	KF	KH		
1,600 pF	162	F	G	J	K	M	GB	GD	GD	GK				HE	HG	HG	HG	HG	HK		JE	JK	JK	JK	JE	JL		KE	KE	KE	KF	KE	KH		
1,800 pF	182	F	G	J	K	M	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	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	F	G	J	K	M	GB	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	K	M	GB	GH	GK	GO				HE	HG	HG	HE	HK			JK	JK	JK	JE	JL			KE	KE	KE	KE	KH			
3,000 pF	302	F	G	J	K	M	GB	GH	GK					HG	HG	HG	HE	HK			JK	JK	JK	JE	JL			KE	KE	KE	KE	KH			
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	KH				
5,100 pF	512	F	G	J	K	M	GH	GK	GO					HG	HE	HG	HK				JK	JK	JK	JL				KE	KF	KF	KH				
5,600 pF	562	F	G	J	K	M	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	GH					HG	HE	HG					JK	JE	JE	JN				KE	KF	KF	KJ				
6,800pF	682	F	G	J	K	M	GH	GM	GH					HG	HE	HJ					JK	JE	JK	JN				KE	KF	KF	KJ				
7,500pF	752	F	G	J	K	M	GH	GM	GK					HG	HE	HJ					JK	JE	JK					KF	KE	KF					
8,200 pF	822	F	G	J	K	M	GK	GO	GK					HG	HE	HJ					JK	JE	JL					KF	KE	KF					
9,100 pF	912	F	G	J	K	M	GM	GO	GM					HE	HG	HK					JE	JE	JL					KF	KE	KH					
10,000 pF	103	F	G	J	K	M	GM	GO	GM					HE	HG	HK					JE	JE	JL					KF	KE	KH					
12,000 pF	123	F	G	J	K	M	GO	GH	GO					HE	HG	HE					JE	JK	JN					KE	KE	KH					
15,000 pF	153	F	G	J	K	M	GO	GH	GO					HE	HJ	HE					JE	JL	JE					KE	KF	KJ					
18,000 pF	183	F	G	J	K	M	GH	GH						HG	HK	HG					JE	JL	JE					KE	KH	KE					
22,000 pF	223	F	G	J	K	M	GH	GH						HJ	HE	HJ					JK	JN	JK					KF	KJ	KF					
27,000 pF	273	F	G	J	K	M	GK	GK						HJ	HE	HK					JL	JN	JL					KF	KJ	KH					
33,000 pF	333	F	G	J	K	M	GM	GM						HK	HE	HK					JN	JE	JN					KH	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						
0.12 µF	124	F	G	J	K	M																						KJ	KJ						
Capacitance	Cap 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	10000
		Voltage Code					C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	K
		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).
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Table 1C – Capacitance Range/Selection Waterfall (2824 – 4540 Case Sizes)

Capacitance	Cap Code	Case Size/ Series			C2824C					C3040C					C3640C					C4540C				
		Voltage Code			C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Rated Voltage (VDC)			500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000
		Capacitance Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																			
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	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	M	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	K	M	TB	TB				QB	QC	QC			MA	MA	MB			SA	SA	SA		
39,000 pF	393	J	K	M	TB	TC				QB	QC	QD			MA	MA	MB			SA	SA	SB		
47,000 pF	473	J	K	M	TB					QB	QC				MA	MB	MC			SA	SA	SB		
56,000 pF	563	J	K	M	TC					QC	QD				MA	MB				SA	SA	SB		
68,000 pF	683	J	K	M						QC	QD				MB	MC				SA	SB	SC		
82,000 pF	823	J	K	M						QC					MB					SA	SB			
0.1 µF	104	J	K	M						QD					MC					SB	SC			
0.12 µF	124	J	K	M											MC					SB				
0.15 µF	154	J	K	M																SC				
Capacitance	Cap Code	Rated Voltage (VDC)			500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000
		Voltage Code			C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Case Size/Series			C2824C					C3040C					C3640C					C4540C				

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

Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			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 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 2A – Chip Thickness/Tape & Reel Packaging Quantities cont.

Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			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
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 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 – Bulk Packaging Quantities

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		Packaging Quantities (pieces/unit packaging)	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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.

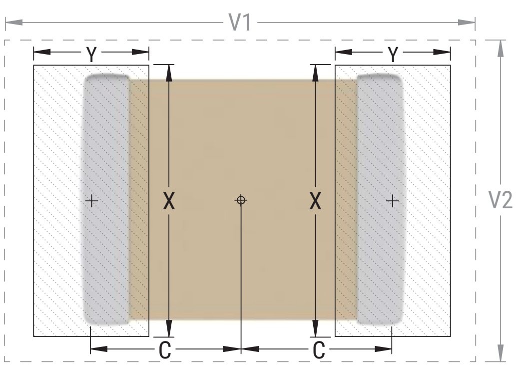
[2] A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard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

Table 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)				
		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	Termination Finish	
	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.

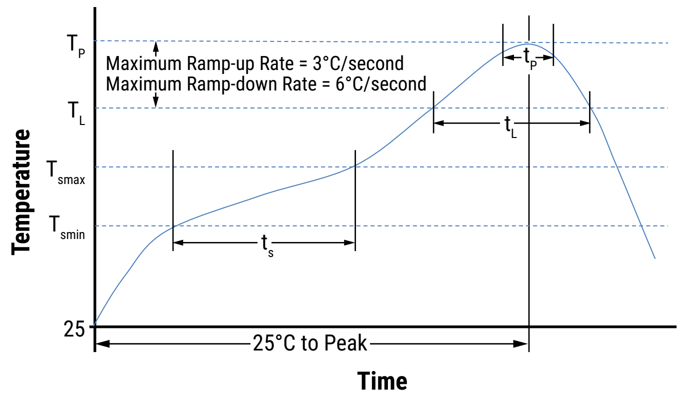


Table 4 – Performance & Reliability: Test Methods and Conditions

<table>
<tr><th>Stress</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Visual and Mechanical</td><td>KEMET Internal</td><td>No defects that may affect performance (10X)</td><td>Dimensions according KEMET Spec Sheet</td></tr>
<tr><td>Capacitance (Cap)</td><td>KEMET Internal</td><td>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</td><td>Within Tolerance</td></tr>
<tr><td>Dissipation Factor (DF)</td><td>KEMET Internal</td><td>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</td><td>Within Specification
Dissipation factor (DF) maximum limit at 25°C = 0.1%</td></tr>
<tr><td>Insulation Resistance (IR)</td><td>KEMET Internal</td><td>500 VDC applied for 120 ±5 seconds at 25°C</td><td>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.</td></tr>
<tr><td>Temperature Coefficient of Capacitance (TCC)</td><td>KEMET Internal</td><td>Capacitance change with reference to +25°C and 0 VDC applied.

* See part number specification sheet for voltage
<table><tr><th>Step</th><th>Temperature (°C)</th></tr><tr><td>1</td><td>+25°C</td></tr><tr><td>2</td><td>−55°C</td></tr><tr><td>3</td><td>+25°C (Reference Temperature)</td></tr><tr><td>4</td><td>+125°C</td></tr></table></td><td>Within Specification: ±30 ppm / °C</td></tr>
</table>

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

<table>
<tr><th>Stress</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Dielectric Withstanding Voltage (DWV)</td><td>KEMET Internal</td><td>See Dielectric Withstanding Voltage (DWV) Table
(5 ±1 seconds and charge/discharge not exceeding 50 mA)
<table>
<tr><th>EIA Case Size</th><th>500 V</th><th>630 V</th><th>≥ 1,000 V</th></tr>
<tr><td>0402</td><td>120% of rated voltage</td><td>N/A</td><td>N/A</td></tr>
<tr><td>0603</td><td rowspan="10">150%</td><td>130% of rated voltage</td><td rowspan="10">120% of</td></tr>
<tr><td>0805</td><td>< 620pF 150% of rated voltage
≥ 620pF 130% of rated voltage</td></tr>
<tr><td>1206</td><td>< 5.1nF 150% of rated voltage
≥ 5.1nF 130% of rated voltage</td></tr>
<tr><td>1210</td><td>< 7.5nF 150% of rated voltage
≥ 7.5nF 130% of rated voltage</td></tr>
<tr><td>1808</td><td>< 5.1nF 150% of rated voltage
≥ 5.1nF 130% of rated voltage</td></tr>
<tr><td>1812</td><td>< 12nF 150% of rated voltage
≥ 12nF 130% of rated voltage</td></tr>
<tr><td>1825</td><td>< 22nF 150% of rated voltage
≥ 22nF 130% of rated voltage</td></tr>
<tr><td>2220</td><td>< 27nF 150% of rated voltage
≥ 27nF 130% of rated voltage</td></tr>
<tr><td>2225</td><td>< 33nF 150% of rated voltage
≥ 33nF 130% of rated voltage</td></tr>
</table></td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit

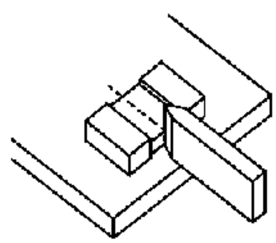
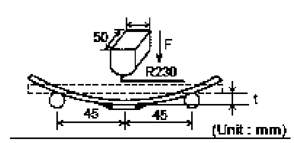
Withstand test voltage without insulation breakdown or damage.</td></tr>
<tr><td>Aging Rate (Maximum % Capacitance Loss/Decade Hour)</td><td>KEMET Internal</td><td>Maximum % capacitance loss/decade hour</td><td>0% Loss/Decade Hour</td></tr>
<tr><td>Terminal Strength</td><td>KEMET Internal</td><td>Shear stress test per specific case size,
Time: 60 ±1 second.
<table>
<tr><th>Case Size</th><th>Force</th></tr>
<tr><td>0402</td><td>3N</td></tr>
<tr><td>0603</td><td>5N</td></tr>
<tr><td>0805</td><td>9N</td></tr>
<tr><td>≥ 1206</td><td>18N</td></tr>
</table>
</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Board Flex</td><td>AEC-Q200-005</td><td>Standard Termination
System 2.0 mm
Flexible Termination
System 3.0 mm
Test Time: 60 ±5 seconds
Ramp Time: 1 mm/second

</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Solderability</td><td>J-STD-002</td><td>Condition: 4 hours ± 15 minutes at 155°C dry bake
apply all methods
Test 245 ±5°C (SnPb & Pb-Free)</td><td>Visual Inspection. 95% coverage on termination. No leaching</td></tr>
<tr><td>Temperature Cycling</td><td>JESD22
Method JA-104</td><td>1,000 cycles (−55°C to +125°C)
2 – 3 cycles per hour
Soak Time 1 or 5 minutes</td><td>Measurement at 24 hours ±4 hours after test conclusion.
Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit</td></tr>
</table>

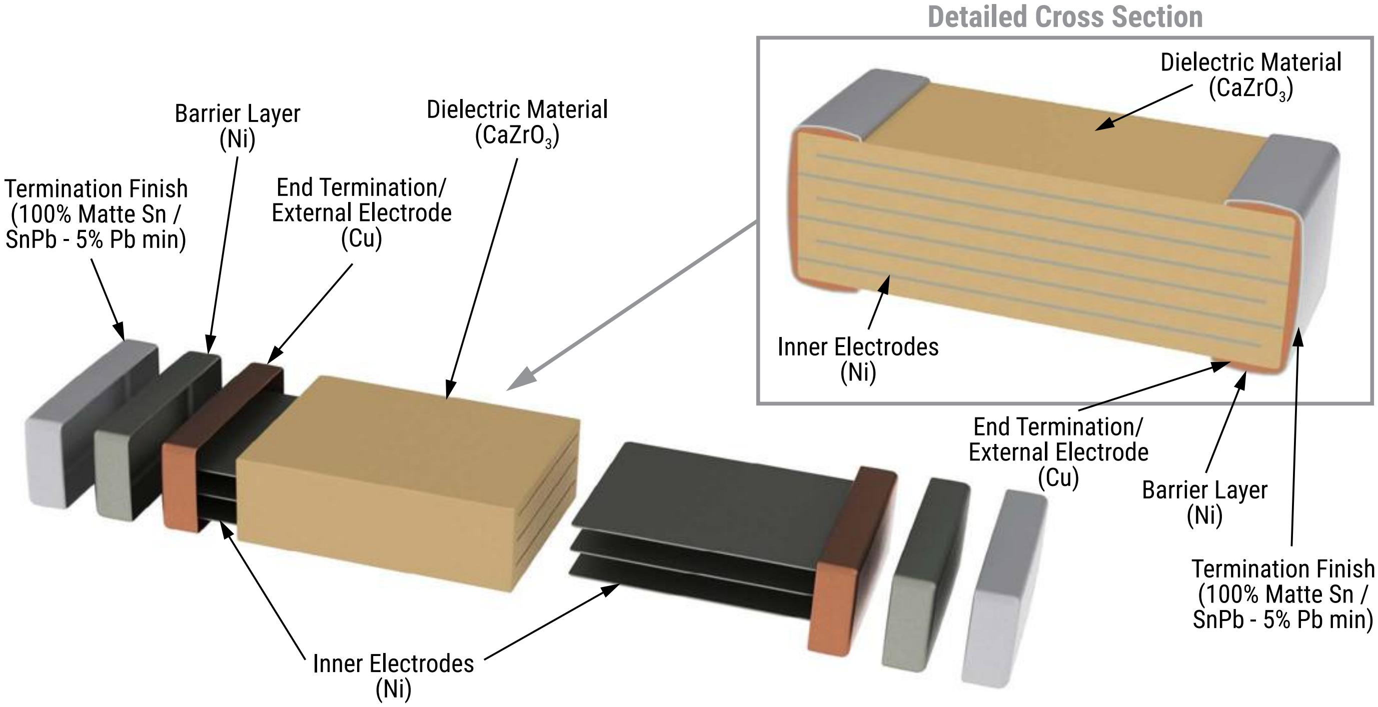
Table 4 – Performance & Reliability: Test Methods and Conditions

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 Method 108	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 DF Limits Maximum: 0.5% IR: 10% of Initial Limit
Storage Life		1,000 hours at 150°C, Unpowered	
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)

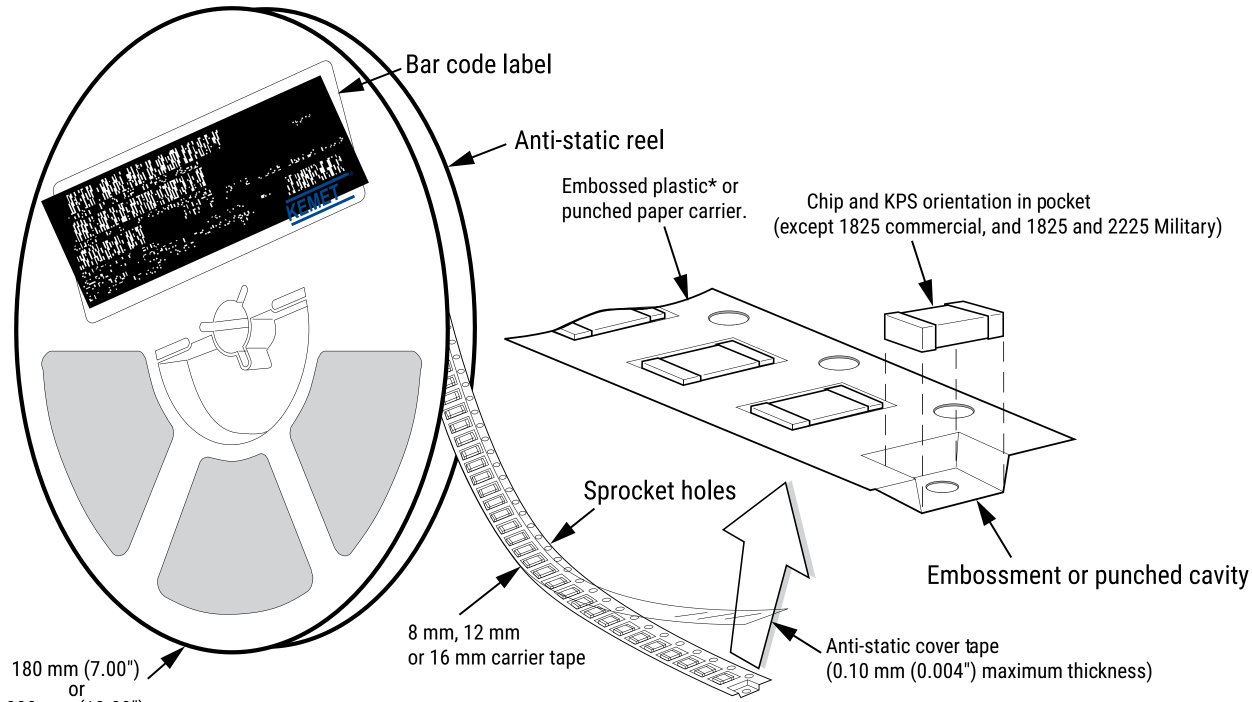
Laser marking option is not available on:

- C0G, 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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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		
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

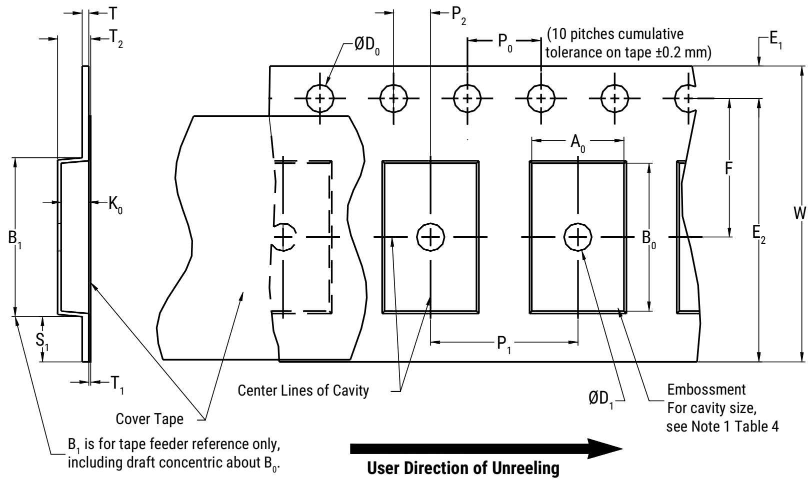


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	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)	25.0 (0.984)	0.600 (0.024)	0.600 (0.024)	0.100 (0.004)
12 mm					30 (1.181)			
16 mm								
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)	Note 5	
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)		
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)		
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 S_1 < 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_1 dimension is a reference dimension for tape feeder clearance only.
5. The cavity defined by A_0, B_0 and K_0 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

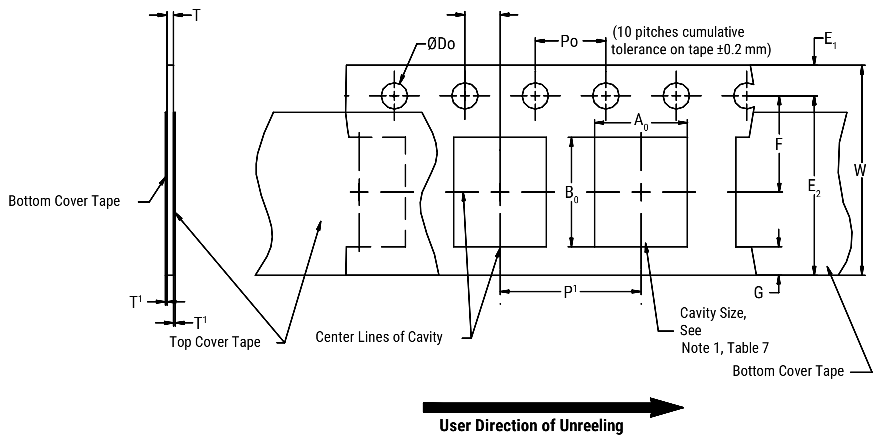


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 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_0, B_0 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

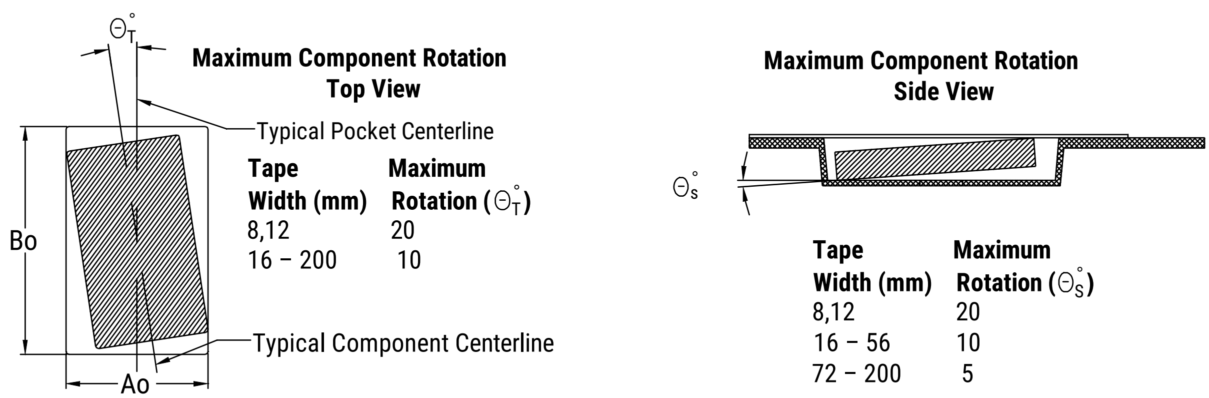


Figure 4 – Maximum Lateral Movement

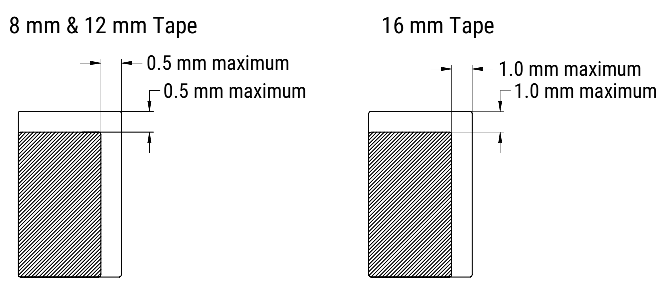


Figure 5 – Bending Radius

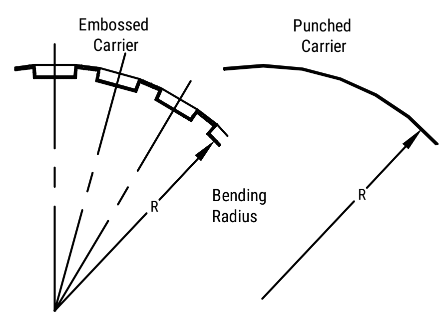
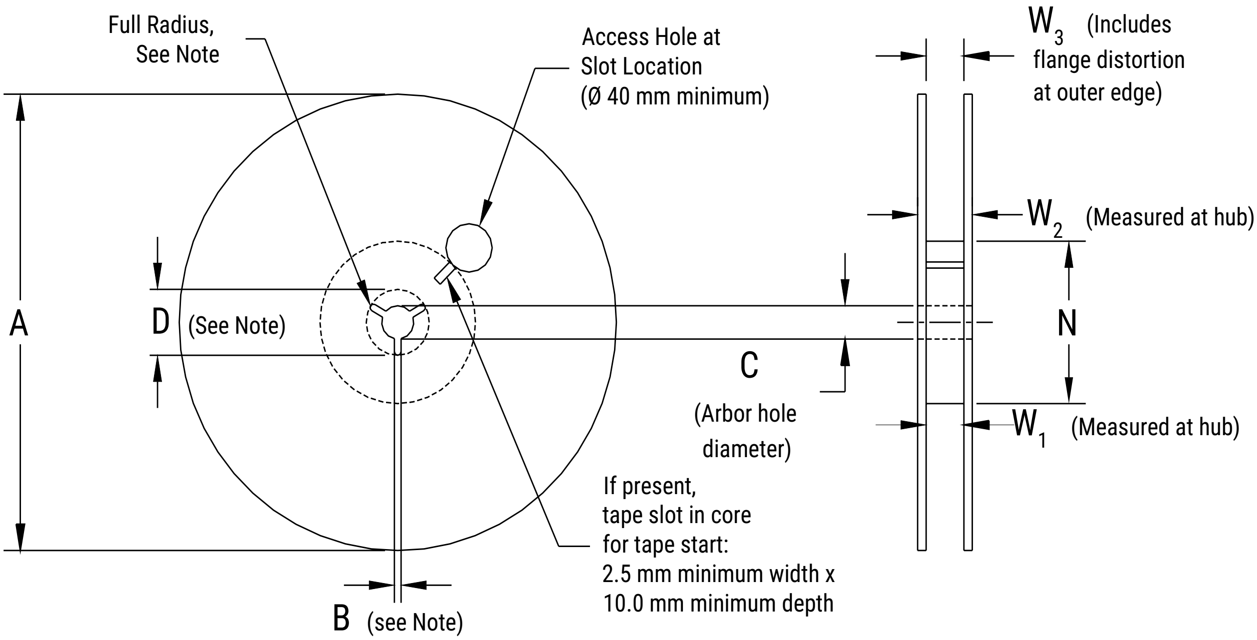


Figure 6 – Reel Dimensions



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	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				
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/−1.0 (1.078+0.039/−0.039)	

Figure 7 – Tape Leader & Trailer Dimensions

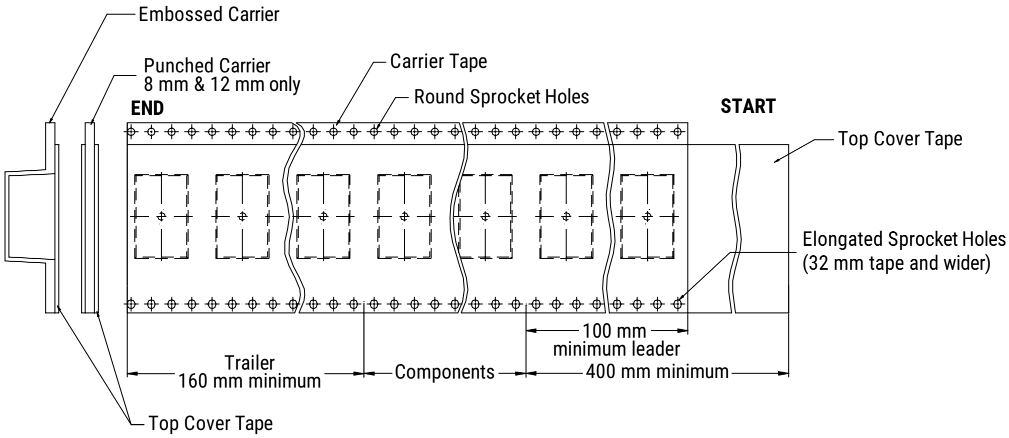
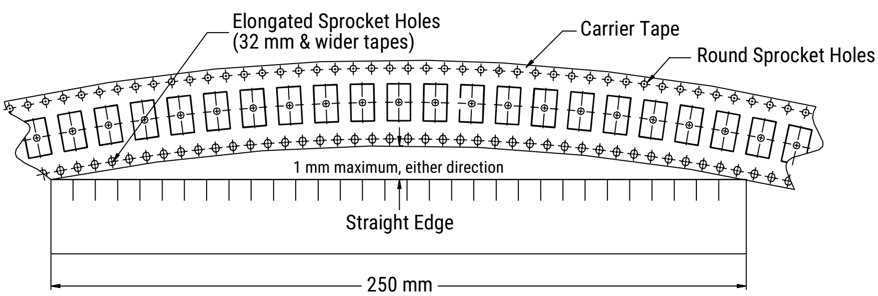


Figure 8 – Maximum Camber



Application Guide

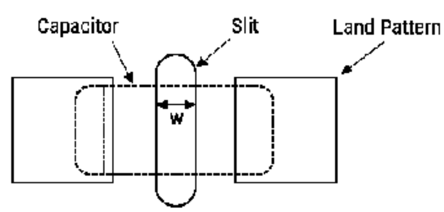
Solder Fluxes and Cleaning
The use of water-soluble fluxes provides advantages of excellent solderability due to high activation. However, these fluxes contain organic acids that can induce arcing under high DC or AC voltages. Notable problem areas are underneath the MLCC where flux can be trapped between 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 ≥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 $BaTiO_3$	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.

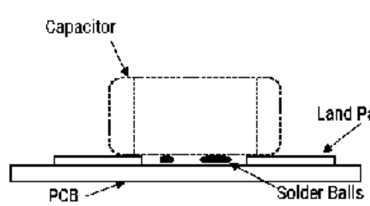
- Recommended for case sizes ≥1206
- The width (w) of the slit should be 1mm
- Length of the slit should be as short as possible to prevent damaging the MLCC due to mechanical stress of the PCB.
- Slits also reduce the risk of solder balls under MLCC which decreased the creepage distance.



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 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 ±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.

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

C	1210	C	154	K	C	R	A	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	TM
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)

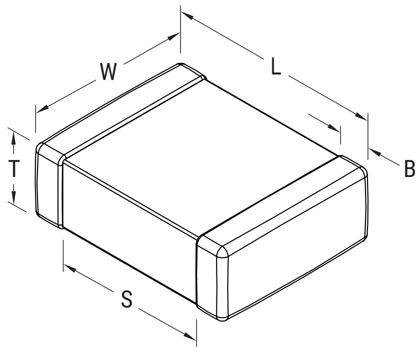
Applications

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)	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
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)		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

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

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

Cap	Cap Code	Case Size/ Series			C0402C	C0603C			C0805C			C1206C					C1210C					C1808C							C1812C[2]						
		Voltage Code			C	C	B	D	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	H
		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	500	630	1000	1500	2000	2500	3000
		Capacitance Tolerance			Product Availability and Chip Thickness Codes - See Table 2 for Chip Thickness Dimensions																														
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
12 pF	120	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
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	160	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
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	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
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	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
27 pF	270	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	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
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
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	GK	GK	GK	GK	GK	GK	GK
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	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
47 pF	470	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
51 pF	510	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
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	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
68 pF	680	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
75 pF	750	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
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	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
100 pF	101	J	K	M					DG	DG	DG	ED	ED	ED	ED	EF	FM	FM	FM	FM	FM	LB	LB	LB	LB	LB	LC	LB	GK	GK	GK	GK	GK	GK	GK
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	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	K	M					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	LB	LC	LB	GK	GK	GK	GK	GK	GK	GK
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	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	K	M					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	LA	LB	LC	LC	LC	GH	GH	GH	GH	GH	GK	GK
390 pF	391	J	K	M					DG	DG	DG	ED	ED	EF	EF	EF	FG	FG	FG	FK	FS	LA	LA	LA	LB	LB	LB	LC	GK	GK	GK	GK	GK	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	M					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	J	K	M					DG	DG	DG	ED	ED	EF	EF	EF	FG	FM	FM	FS	FL	LB	LB	LB	LA	LB	LC	LC	GH	GH	GH	GK	GH	GK	GK
820 pF	821	J	K	M					DG	DG	DG	ED	ED	ED	EF	EF	FG	FM	FM	FL	FL	LB	LB	LB	LA	LB	LC	LC	GH	GH	GH	GK	GH	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	M	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	152	J	K	M	BD	CG	CG		DG	DG	DG	ED	ED	ED	EG	EG	FK	FS	FS	FL	FM	LC	LC	LC	LB	LC	LB		GK	GK	GK	GH	GH	GK	
1,800 pF	182	J	K	M		CG			DG	DG	DG	ED	ED	ED	EG	EG	FK	FS	FS	FL	FM	LC	LC	LC	LB	LC	LC		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	M		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	332	J	K	M		CG			DG	DG	DG	ED	ED	ED	EG		FS	FL	FL	FL	FM	LA	LA	LA	LB	LA			GK	GH	GH	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	LB			GK	GH	GH	GH	GM	GO	
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	M					DG	DG		ED	EF	EF	EF		FL	FL	FL	FM	FK	LA	LB	LB	LC				GH	GH	GH	GK	GK		
6,800 pF	682	J	K	M					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	EG	EG	EF		FL	FL	FL	FK		LA	LB	LB	LC				GH	GH	GH	GK	GM		
10,000 pF	103	J	K	M					DG	DG		EF	EG	EG	EG		FL	FL	FL	FK		LA	LB	LB	LC				GH	GH	GH	GK	GO		
Cap	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	500	630	1000	1500	2000	2500	3000
		Voltage Code			C	C	B	D	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	H
		Case Size/ Series			C0402C	C0603C			C0805C			C1206C					C1210C					C1808C							C1812C[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 X7R with KONNEKT Technology.

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

Cap	Cap Code	Case Size/ Series			C0402C	C0603C			C0805C			C1206C					C1210C					C1808C							C1812C[2]						
		Voltage Code			C	C	B	D	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	H
		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	500	630	1000	1500	2000	2500	3000
		Capacitance Tolerance			Product Availability and Chip Thickness Codes - See Table 2 for Chip Thickness Dimensions																														
12,000 pF	123	J	K	M					DG	DG		EG	EJ	EJ			FL	FL	FL	FK		LA	LC	LC	LB				GH	GK	GK	GK			
15,000 pF	153	J	K	M					DG			EG	EJ	EJ			FL	FL	FL	FL		LA	LC	LC	LC				GH	GK	GK	GH			
18,000 pF	183	J	K	M					DG			EJ	EJ	EJ			FL	FL	FL	FM		LA	LE	LE					GH	GK	GK	GM			
22,000 pF	223	J	K	M					DG			EJ	EJ	EJ			FL	FM	FM	FM		LA	LE	LE					GH	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	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	M								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																									GS						
Cap	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	500	630	1000	1500	2000	2500	3000
		Voltage Code			C	C	B	D	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	H
		Case Size/ Series			C0402C	C0603C			C0805C			C1206C					C1210C					C1808C							C1812C[2]						

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

Capacitance	Cap Code	Case Size/ Series			C1825C							C2220C							C2225C						
		Voltage Code			C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		Rated Voltage (VDC)			500	630	1000	1500	2000	2500	3000	500	630	1000	1500	2000	2500	3000	500	630	1000	1500	2000	2500	3000
		Capacitance Tolerance			Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions																				
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	KE	KF
Capacitance	Cap 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
		Voltage Code			C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		Case Size/ Series			C1825C							C2220C							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).
[2] Available capacitance values available in X7R with KONNEKT Technology.

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

Capacitance	Cap Code	Case Size/ Series			C1825C							C2220C							C2225C						
		Voltage Code			C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		Rated Voltage (VDC)			500	630	1000	1500	2000	2500	3000	500	630	1000	1500	2000	2500	3000	500	630	1000	1500	2000	2500	3000
		Capacitance Tolerance			Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions																				
1,000 pF	102	J	K	M	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	M	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	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	K	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	K	M	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	K	M	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	M	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	M	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	M	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	HK				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	HK					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					
0.39 µF	394	J	K	M	HK							JN							KH	KJ					
0.47 µF	474	J	K	M								JN							KH	KJ					
0.56 µF	564	J	K	M															KJ						
Capacitance	Cap 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
		Voltage Code			C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		Case Size/ Series			C1825C							C2220C							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 Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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
EF	1206	1.20 ± 0.15	0	0	2,500	10,000
EG	1206	1.60 ± 0.15	0	0	2,000	8,000
EJ	1206	1.70 ± 0.20	0	0	2,000	8,000
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
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	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
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	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 Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[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

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		Packaging Quantities (pieces/unit packaging)	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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.

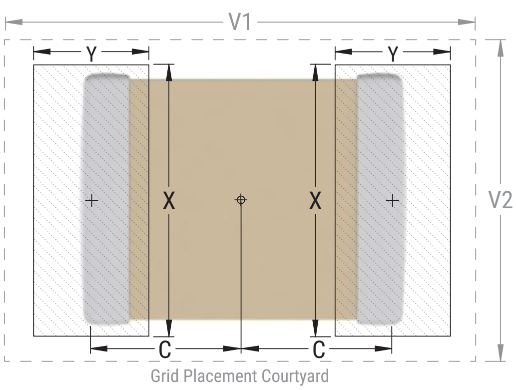
[2] A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard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

Table 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)				
		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.

Profile Feature	Termination Finish	
	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.

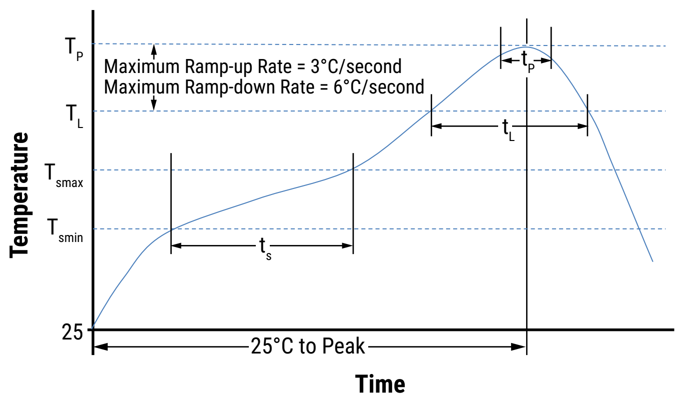


Table 4 – Performance & Reliability: Test Methods and Conditions

<table>
<tr><th>Stress</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Visual and Mechanical</td><td>KEMET Internal</td><td>No defects that may affect performance (10X)</td><td>Dimensions according KEMET Spec Sheet</td></tr>
<tr><td>Capacitance (Cap)</td><td>KEMET Internal</td><td>C ≤ 10 µF 1 kHz ±50 Hz and 1.0 ±0.2 V_{rms} or 0.5 ±0.2 V_{rms}*
C > 10 µF120 Hz ±10 Hz and 0.5 ±0.1 V_{rms}

* See part number specification sheet for voltage

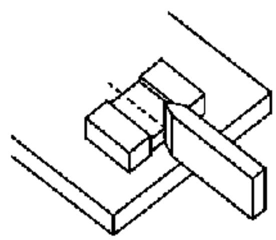
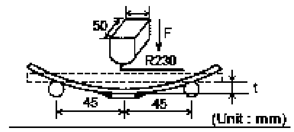
Capacitance measurements (including tolerance) are indexed to a referee time of 48 or 1,000 hours

Please refer to a part number specification sheet for referee time details</td><td>Within Tolerance</td></tr>
<tr><td>Dissipation Factor (DF)</td><td>KEMET Internal</td><td>C ≤ 10 µF
Frequency: 1 kHz ±50 Hz
Voltage*:1.0 ±0.2 V_{rms}, 0.5 ±0.2 V_{rms},
C > 10 µF
Frequency: 120 Hz ±10 Hz
Voltage: 0.5 ±0.1 V_{rms}

* See part number specification sheet for voltage</td><td>Within Specification
Dissipation factor (DF) maximum limit at 25°C = 2.5%</td></tr>
<tr><td>Insulation Resistance (IR)</td><td>KEMET Internal</td><td>500 VDC applied for 120 ±5 seconds at 25°C</td><td>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.
<table>
<tr><th>EIA Case Size</th><th>1,000 Megohm Microfarads or 100 GΩ</th><th>100 Megohm Microfarads or 10 GΩ</th></tr>
<tr><td>0402</td><td>N/A</td><td>All</td></tr>
<tr><td>0603</td><td>N/A</td><td>All</td></tr>
<tr><td>0805</td><td>< 0.0039 µF</td><td>≥ 0.0039 µF</td></tr>
<tr><td>1206</td><td>< 0.012 µF</td><td>≥ 0.012 µF</td></tr>
<tr><td>1210</td><td>< 0.033 µF</td><td>≥ 0.033 µF</td></tr>
<tr><td>1808</td><td>< 0.018 µF</td><td>≥ 0.018 µF</td></tr>
<tr><td>1812</td><td>< 0.027 µF</td><td>≥ 0.027 µF</td></tr>
<tr><td>1825</td><td>< 0.120 µF</td><td>≥ 0.120 µF</td></tr>
<tr><td>2220</td><td>< 0.150 µF</td><td>≥ 0.150 µF</td></tr>
<tr><td>2225</td><td>< 0.180 µF</td><td>≥ 0.180 µF</td></tr>
</table></td></tr>
<tr><td>Temperature Coefficient of Capacitance (TCC)</td><td>KEMET Internal</td><td>C ≤ 10 µF
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 µF
Frequency: 120 Hz ±10 Hz
Voltage: 0.5 ±0.1 V_{rms}
* See part number specification sheet for voltage
<table>
<tr><th>Step</th><th>Temperature (°C)</th></tr>
<tr><td>1</td><td>+25°C</td></tr>
<tr><td>2</td><td>−55°C</td></tr>
<tr><td>3</td><td>+25°C (Reference Temperature)</td></tr>
<tr><td>4</td><td>+125°C</td></tr>
</table></td><td>Capacitance ±15% over −55°C to +125°C</td></tr>
</table>

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

<table>
<tr><th>Stress</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Dielectric Withstanding Voltage (DWV)</td><td>KEMET Internal</td><td>See Dielectric Withstanding Voltage (DWV) Table
(5 ±1 second and charge/discharge not exceeding 50 mA)
<table>
<tr><th>EIA Case Size</th><th>500 V</th><th>630 V</th><th>≥ 1,000 V</th></tr>
<tr><td>0402</td><td>120% of rated voltage</td><td>N/A</td><td>N/A</td></tr>
<tr><td>0603</td><td colspan="2" rowspan="9">150% of rated voltage</td><td rowspan="9">120% of rated voltage</td></tr>
<tr><td>0805</td></tr>
<tr><td>1206</td></tr>
<tr><td>1210</td></tr>
<tr><td>1808</td></tr>
<tr><td>1812</td></tr>
<tr><td>1825</td></tr>
<tr><td>2220</td></tr>
<tr><td>2225</td></tr>
</table></td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit

Withstand test voltage without insulation breakdown or damage.</td></tr>
<tr><td>Aging Rate (Maximum % Capacitance Loss/Decade Hour)</td><td>KEMET Internal</td><td>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.</td><td>Please refer to a part number specification sheet for specific Aging rate</td></tr>
<tr><td>Terminal Strength</td><td>KEMET Internal</td><td>Shear stress test per specific case size,
Time: 60 ±1 second.
<table>
<tr><th>Case Size</th><th>Force</th></tr>
<tr><td>0402</td><td>3N</td></tr>
<tr><td>0603</td><td>5N</td></tr>
<tr><td>0805</td><td>9N</td></tr>
<tr><td>≥ 1206</td><td>18N</td></tr>
</table>
</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Board Flex</td><td>AEC-Q200-005</td><td>Standard Termination System 2.0 mm
Flexible Termination System 3.0 mm
Test Time: 60± 5 seconds
Ramp Time: 1 mm/second

</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Solderability</td><td>J-STD-002</td><td>Condition: 4 hours ±15 minutes at 155°C dry bake apply all methods
Test 245 ±5°C (SnPb & Pb-Free)</td><td>Visual Inspection.
95% coverage on termination.
No leaching</td></tr>
<tr><td>Temperature Cycling</td><td>JESD22 Method JA-104</td><td>1,000 cycles (−55°C to +125°C)
2 - 3 cycles per hour
Soak Time: 1 or 5 minute</td><td>Measurement at 24 hours ±4 hours after test conclusion.
Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit</td></tr>
<tr><td>Biased Humidity</td><td>MIL-STD-202 Method 103</td><td>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.</td><td>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%</td></tr>
</table>

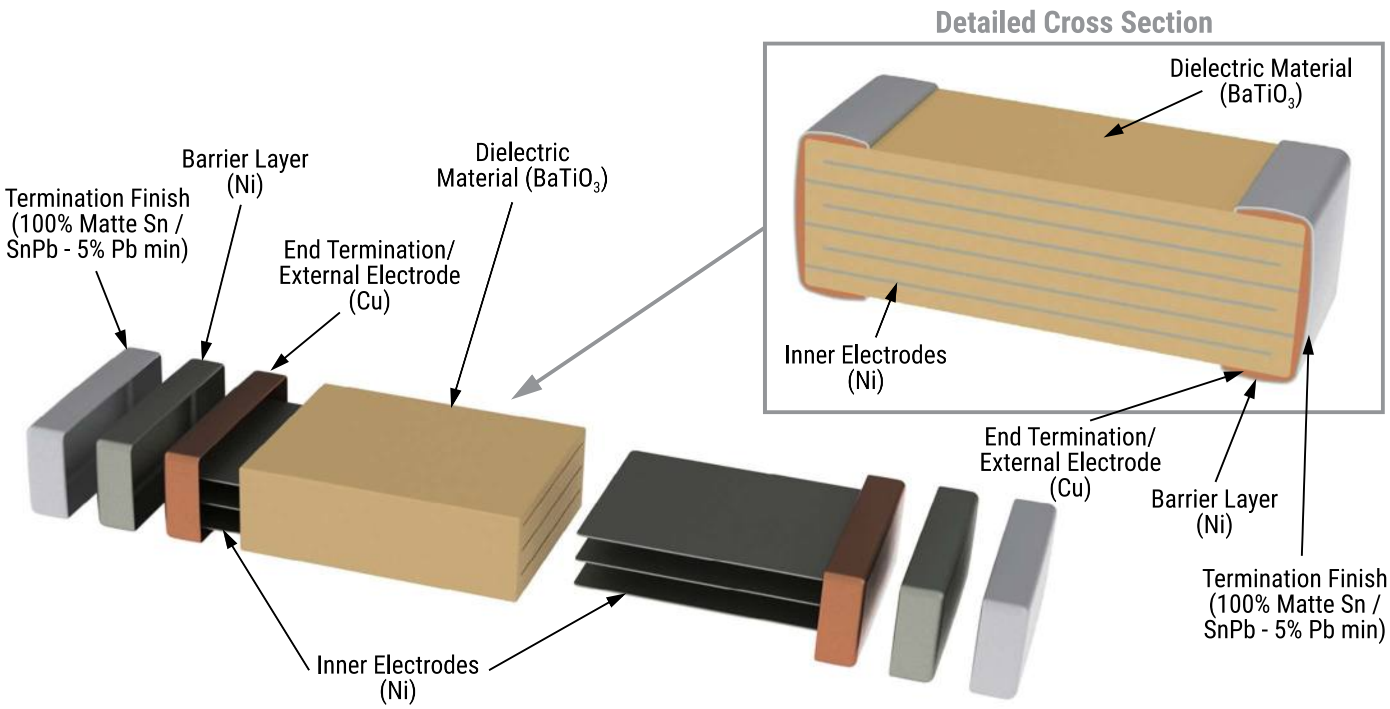
Table 4 – Performance & Reliability: Test Methods and Conditions

Stress	Reference	Test Condition	Limits
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
High Temperature Life	MIL-STD-202 Method 108	1,000 hours at 125°C with 1.2 X rated voltage applied.	Within Post Environmental Limits Cap: ±20% shift IR: 10% of Initial Limit DF Limit Maximum: 3.0%
Storage Life		1,000 hours at 150°C, Unpowered	
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 40ºC 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)

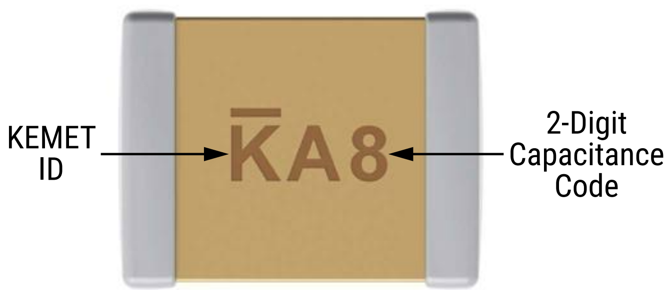
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic 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:

- C0G, 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 µF. Orientation of marking is vendor optional.

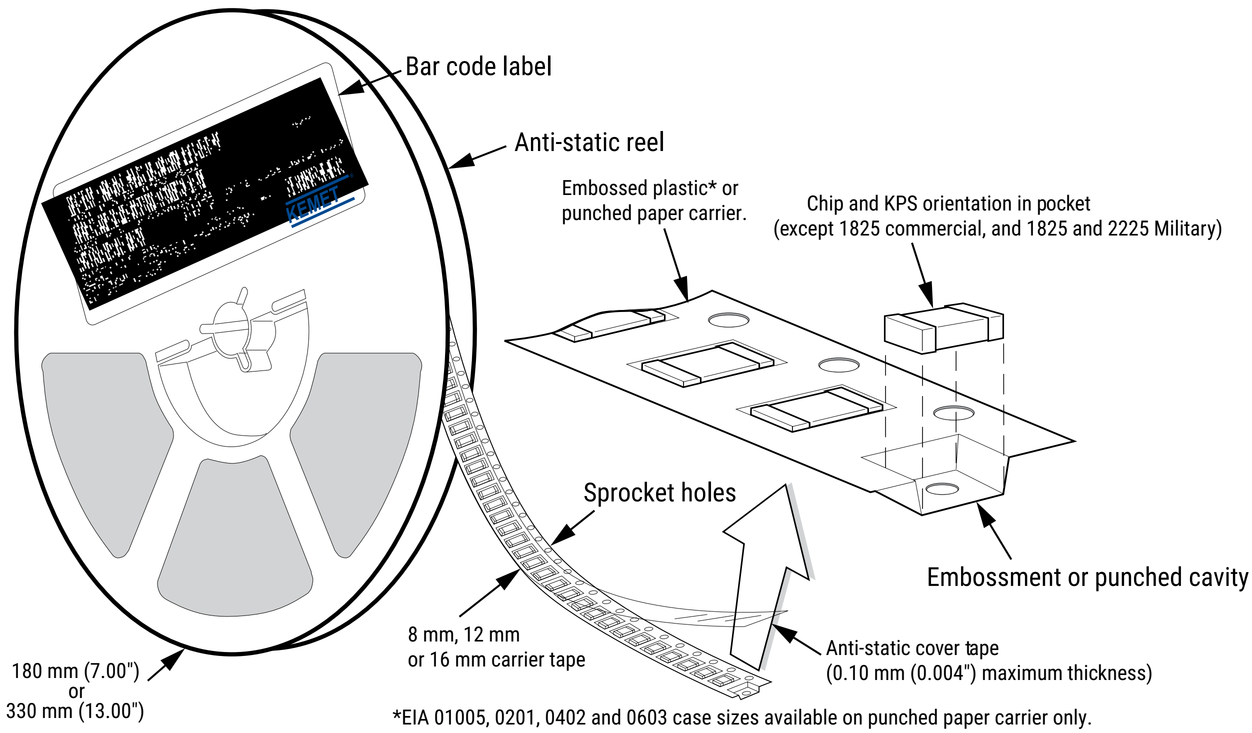


Capacitor Marking (Optional) cont.

Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.10	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

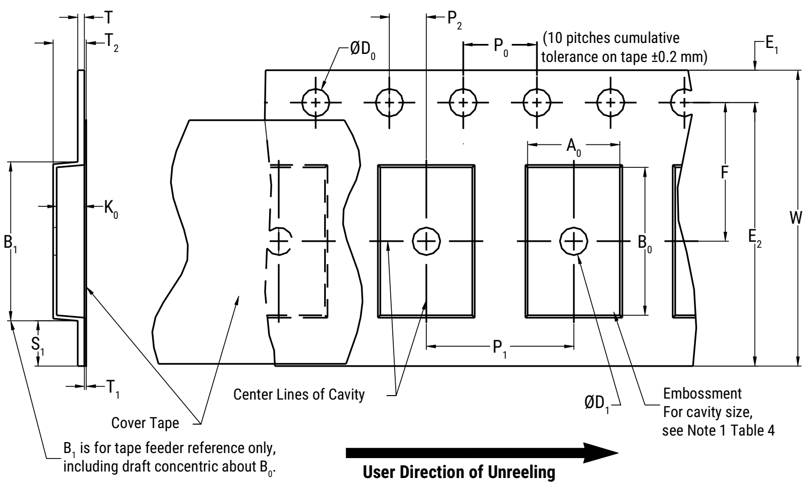


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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 (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)	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 S_1 < 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_0, B_0 and K_0 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

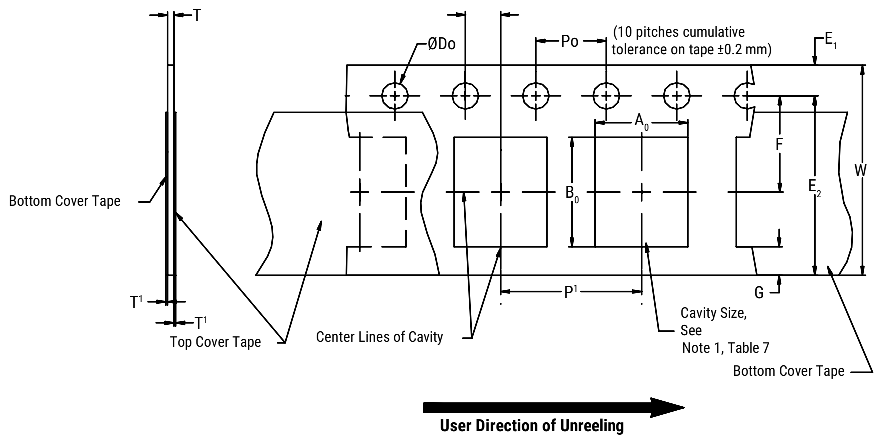


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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.)

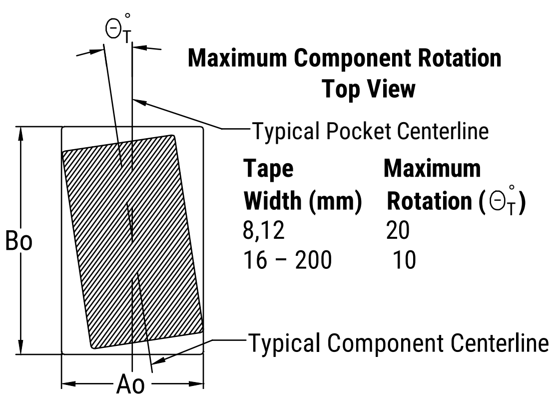
Packaging Information Performance Notes

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



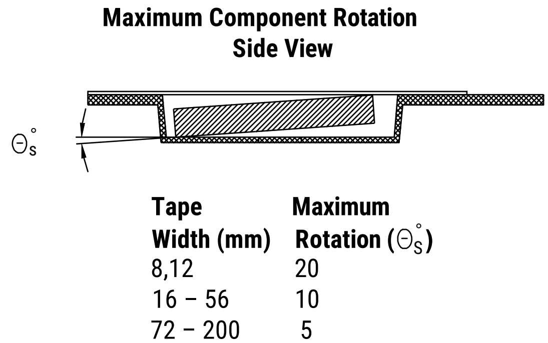


Figure 4 – Maximum Lateral Movement

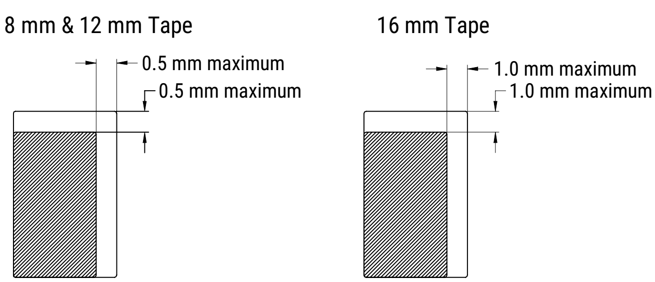


Figure 5 – Bending Radius

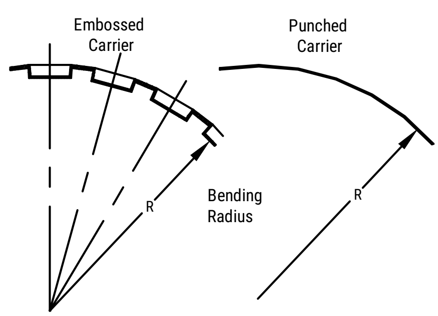
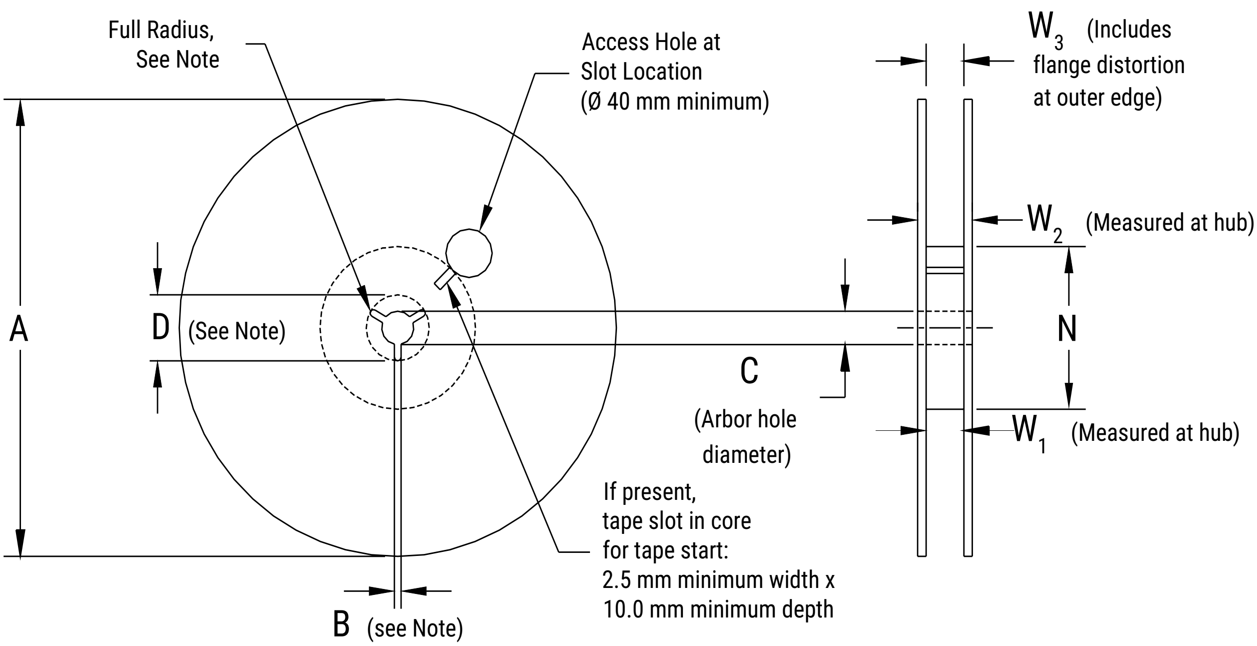


Figure 6 – Reel Dimensions



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	A	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

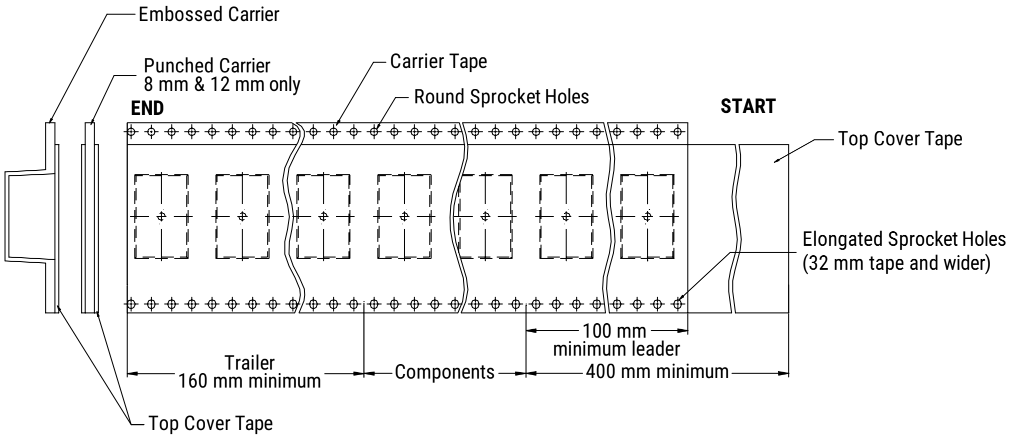
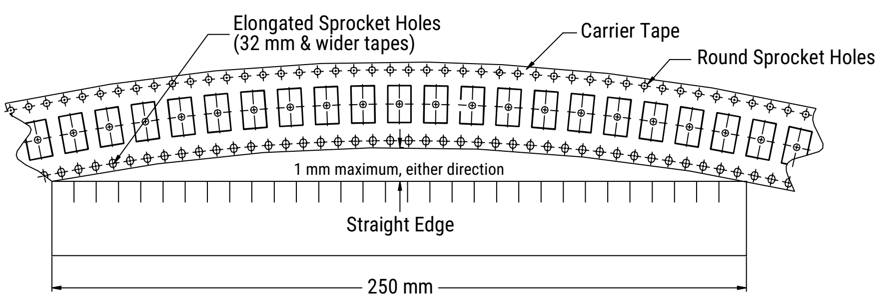


Figure 8 – Maximum Camber



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

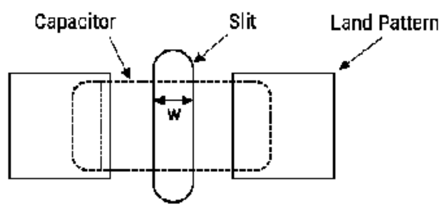
For MLCC ratings ≥1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

Dielectric	CTE (ppm/°C)
Class II $BaTiO_3$	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.



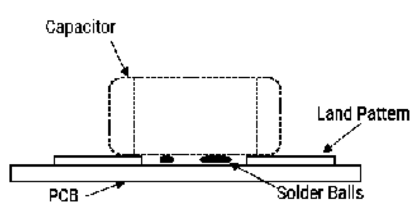
Solder Resist

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)

Telecom Tip & Ring, X7R Dielectric, 250 VDC (Commercial Grade)

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.

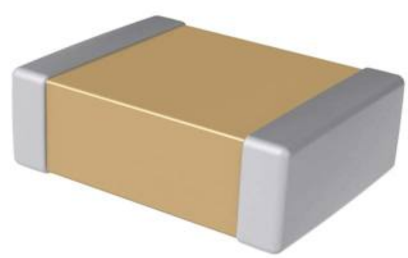
The KEMET Tip and Ring capacitors feature a 125°C maximum operating temperature and are considered temperature stable. The Electronics Industries Alliance (EIA) characterizes X7R dielectric as a Class II material.

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 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 limited to ±15% from −55°C to +125°C.

These devices are able to withstand today's higher lead-free reflow processing temperatures and offer superior high frequency filtering characteristics and low ESR.

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.

Ordering Information

C	1825	C	105	K	A	R	A	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 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	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

[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."*

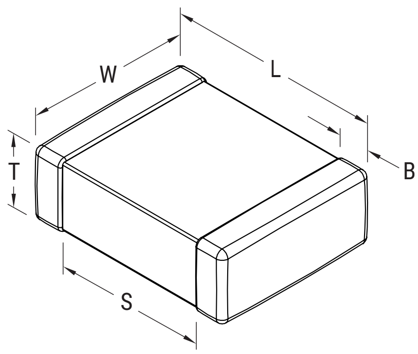
Qualification/Certification

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)	See Table 2 for Thickness	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)		
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)		

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 ≤ 10 µF
120 Hz ±10 Hz and 0.5 ±0.1 V_{rms} if capacitance > 10 µF

[4]To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ 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
X7R	> 25	All	3.0	±20%	10% of Initial limit
	16/25		5.0		
	< 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
0603	≤ 200 V	< .047 µF	≥ .047 µF	N/A
	250 V	N/A	N/A	ALL
0805	≤ 200 V	< 0.15 µF	≥ 0.15 µF	N/A
	250 V	< .027 µF	N/A	≥ .027 µF
1206	≤200 V	< 0.47 µF	≥ 0.47 µF	N/A
	250 V	< 0.12 µF	N/A	≥ 0.12 µF
1210	≤200 V	< 0.39 µF	≥ 0.39 µF	N/A
	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)

Capacitance	Capacitance Code	Case Size/ Series	C0603C	C0805C	C1206C	C1210C	C1812C	C1825C	C2220C	C2225C
		Voltage Code	A	A	A	A	A	A	A	A
		Rated Voltage (VDC)	A	250	250	250	250	250	250	250
		Capacitance Tolerance	Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions							
180 pF	181	J K M		DR						
220 pF	221	J K M		DR						
270 pF	271	J K M		DR						
330 pF	331	J K M		DR						
390 pF	391	J K M		DR						
470 pF	471	J K M		DR						
560 pF	561	J K M		DR						
680 pF	681	J K M		DR						
820 pF	821	J K M		DR						
1,000 pF	102	J K M	CJ	DR	EQ					
1,200 pF	122	J K M	CJ	DR	EQ					
1,500 pF	152	J K M	CJ	DR	EQ					
1,800 pF	182	J K M	CJ	DR	EQ					
2,200 pF	222	J K M	CJ	DR	EQ	FN				
2,700 pF	272	J K M	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 M		DR	EQ	FN	GB			
18,000 pF	183	J K M		DR	EQ	FN	GB			
22,000 pF	223	J K M		DR	EQ	FN	GB	HB		
27,000 pF	273	J K M		DG	EQ	FN	GB	HB		
33,000 pF	333	J K M		DG	EQ	FN	GB	HB		
39,000 pF	393	J K M		DG	EQ	FN	GB	HB		
47,000 pF	473	J K M		DG	ES	FQ	GB	HB		
56,000 pF	563	J K M		DG	ES	FQ	GB	HB		
68,000 pF	683	J K M		DG	ES	FQ	GB	HB		
82,000 pF	823	J K M			ES	FA	GB	HB	JC	
0.10 µF	104	J K M			EM	FZ	GB	HB	JC	KC
0.12 µF	124	J K M			EM	FU	GB	HB	JC	KC
0.15 µF	154	J K M			EH	FM	GE	HB	JC	KC
0.18 µF	184	J K M			EM	FK	GG	HB	JC	KC
0.22 µF	224	J K M			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	474	J K M				FS	GJ	HD	JC	KD
0.56 µF	564	J K M						HD	JD	KD
0.68 µF	684	J K M						HD	JD	KD
0.82 µF	824	J K M						HF	JF	KE
1.0 µF	105	J K M						HF	JF	KE
1.2 µF	125	J K M								KE
Capacitance	Capacitance Code	Rated Voltage (VDC)	250	250	250	250	250	250	250	250
		Voltage Code	A	A	A	A	A	A	A	A
		Case Size/ Series	C0603	C0805C	C1206C	C1210C	C1812C	C1825C	C2220C	C2225C

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

Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			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 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 – Bulk Packaging Quantities

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		**Packaging Quantities (pieces/unit packaging)**	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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 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)				
		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
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 ≥ 22 µF*

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.

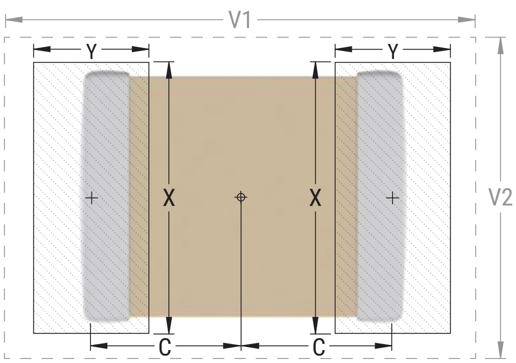
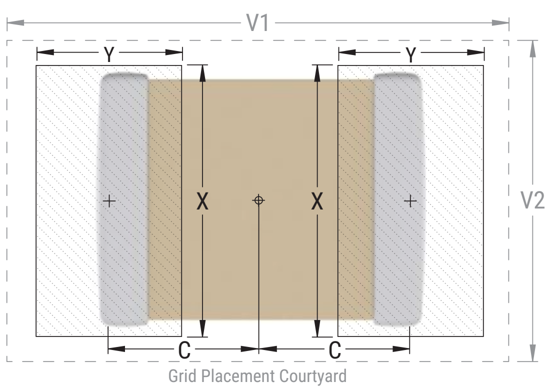


Table 3B – Land Pattern Design Recommendations per IPC–7351 – Flexible Termination

EIA Size Code	Metric Size Code	Density Level A: Maximum (Most) Land Protrusion (mm)					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
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	Termination Finish	
	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.

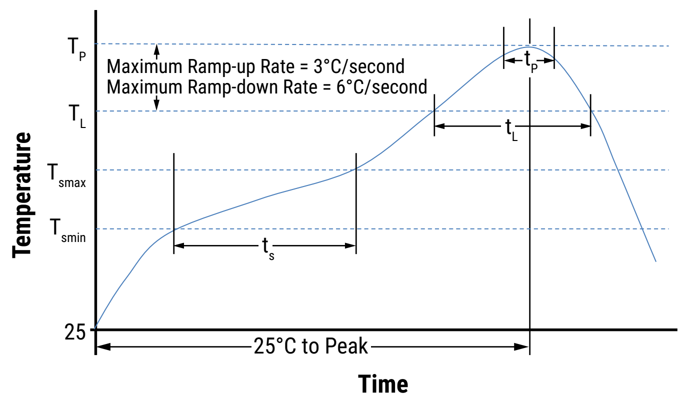


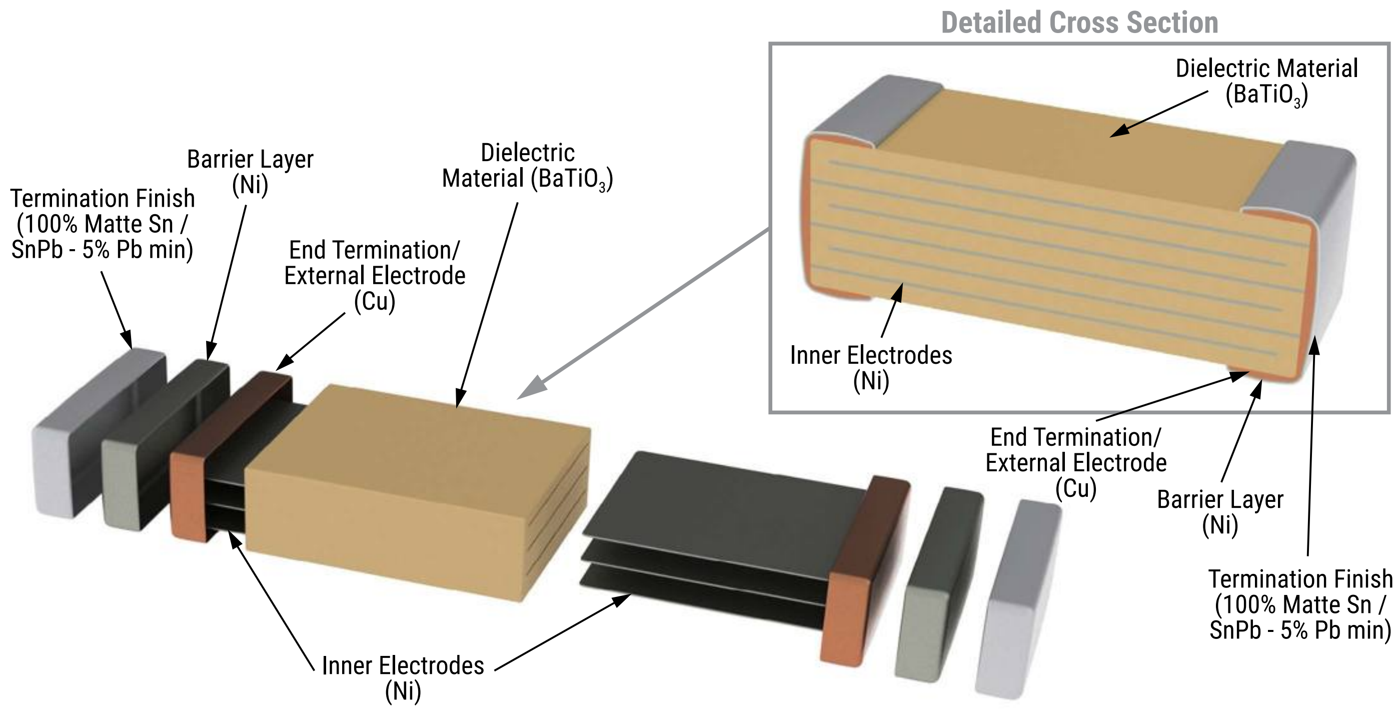
Table 4 – Performance & Reliability: Test Methods and Conditions

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 C0G. 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 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.
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.

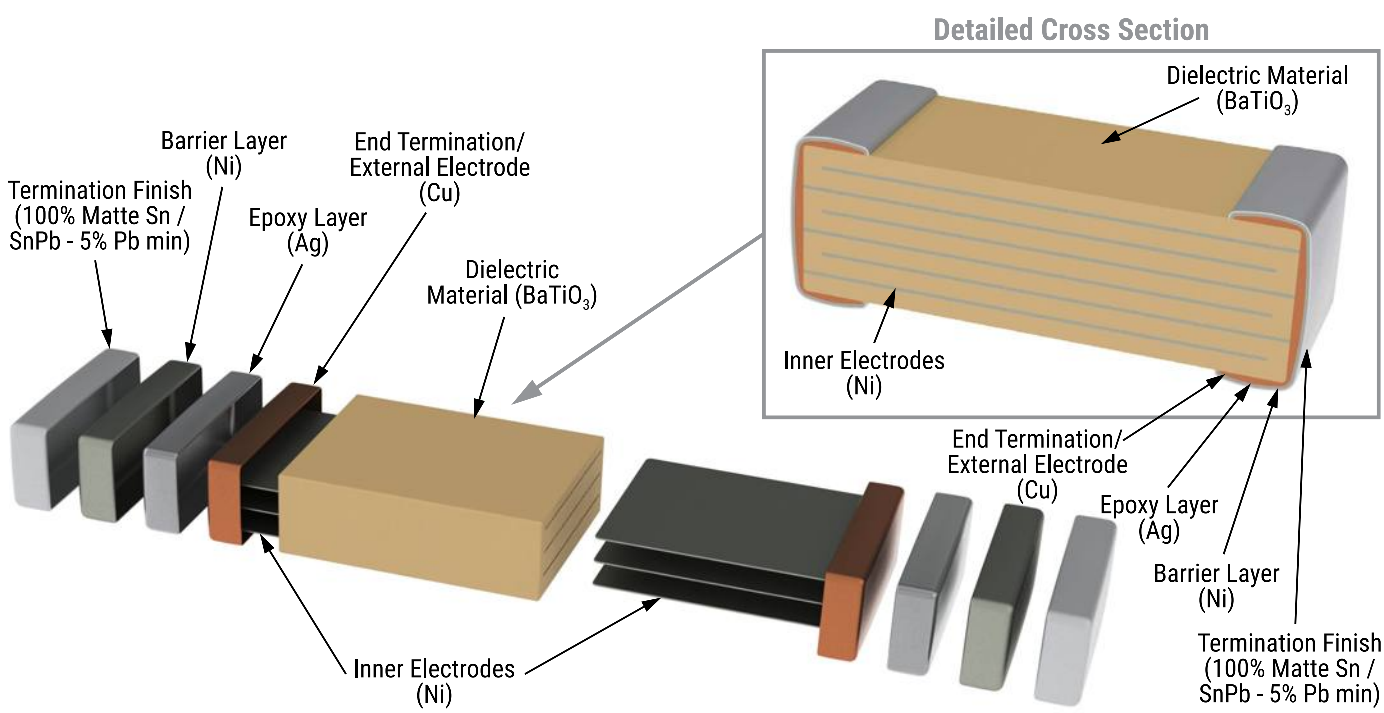
Storage & Handling

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 – Standard Termination



Construction – Flexible Termination



Capacitor Marking (Optional)

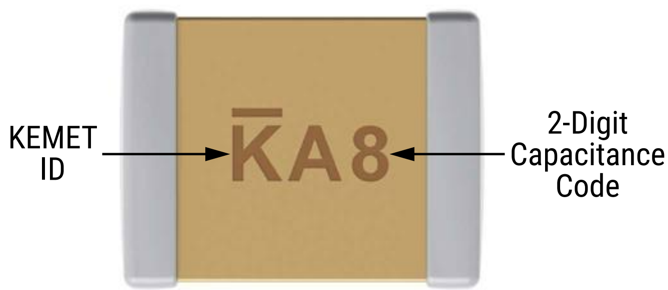
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic 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:

- C0G, 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 µF. Orientation of marking is vendor optional.

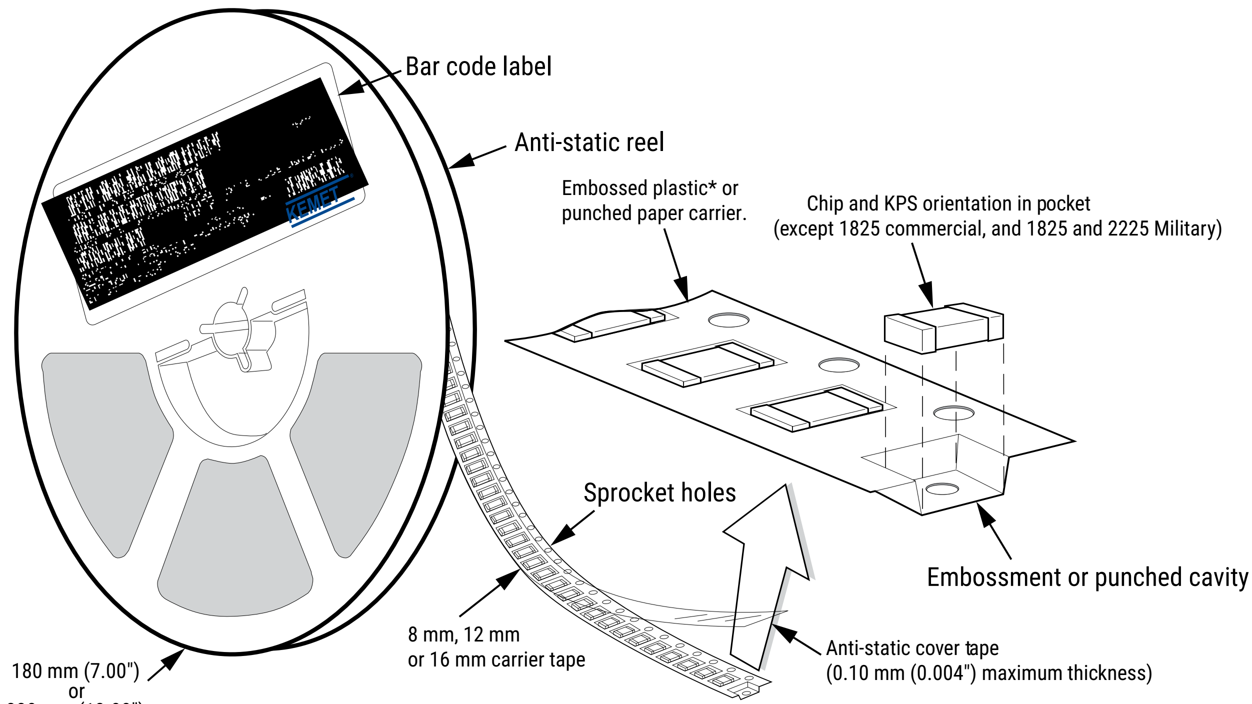


Capacitor Marking (Optional) cont.

Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.10	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

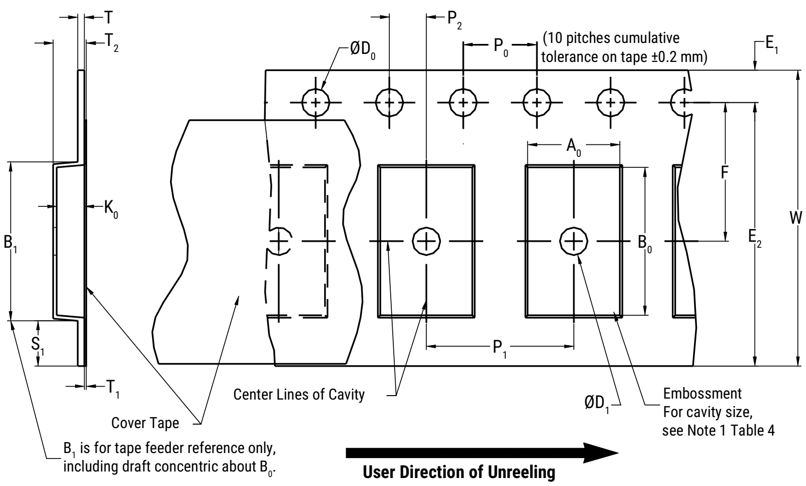


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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 (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)	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 S_1 < 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_0, B_0 and K_0 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

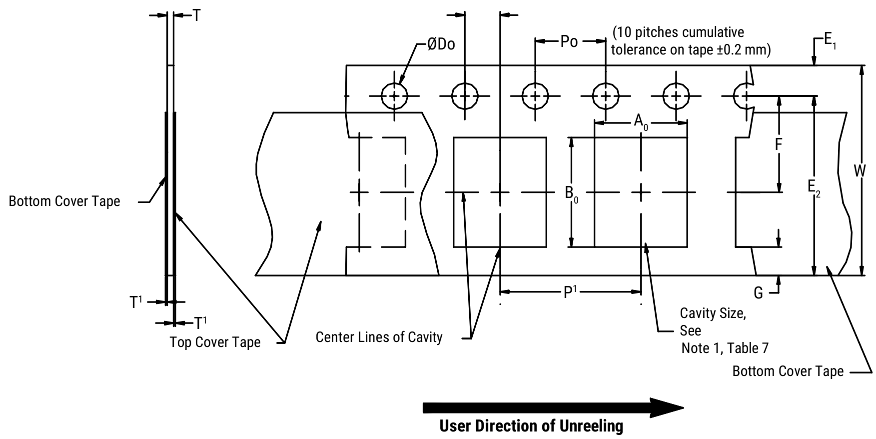


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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

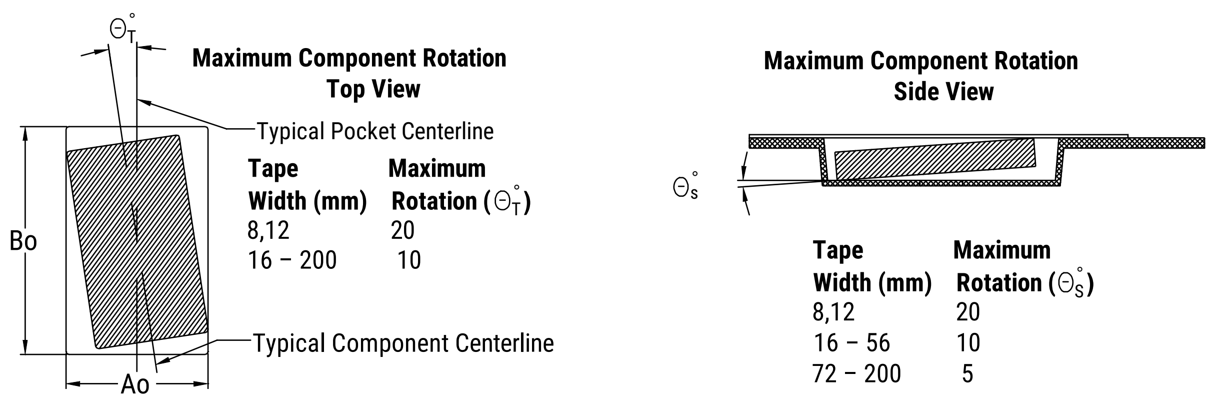


Figure 4 – Maximum Lateral Movement

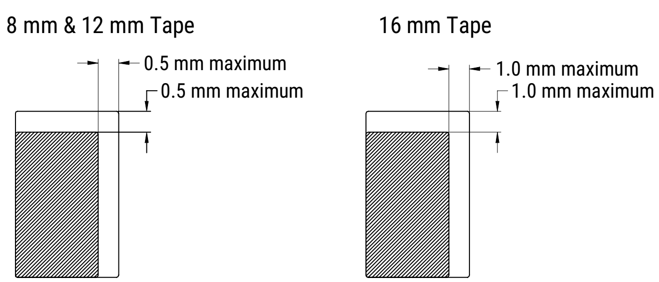


Figure 5 – Bending Radius

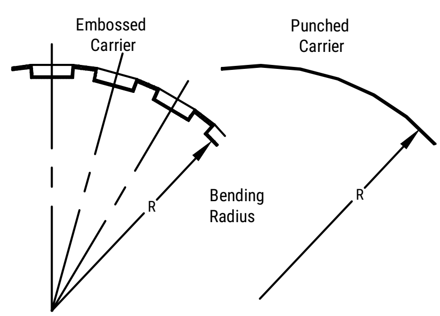
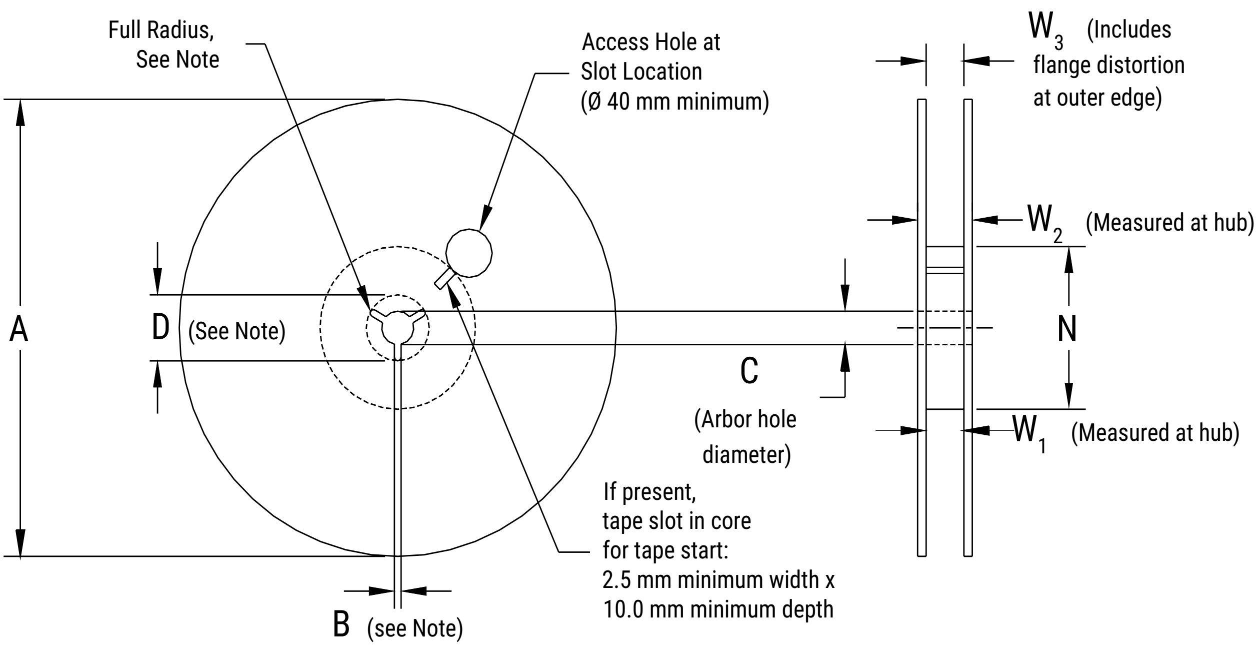


Figure 6 – Reel Dimensions



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	A	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

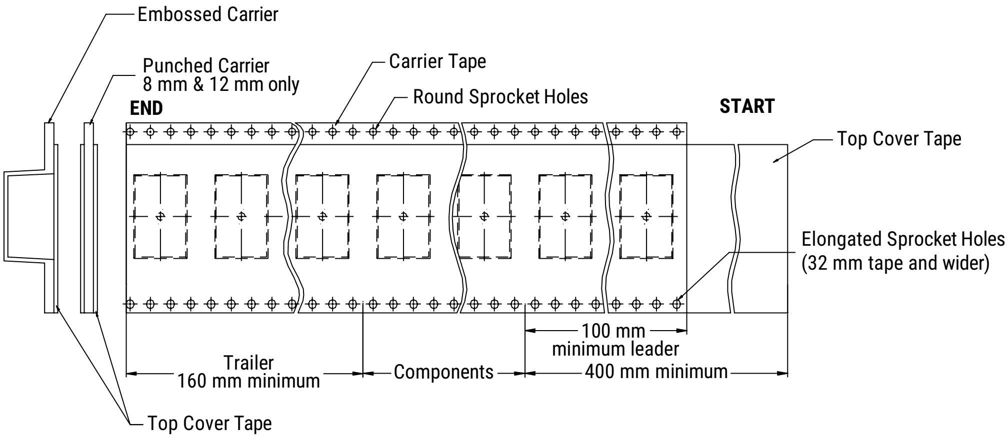
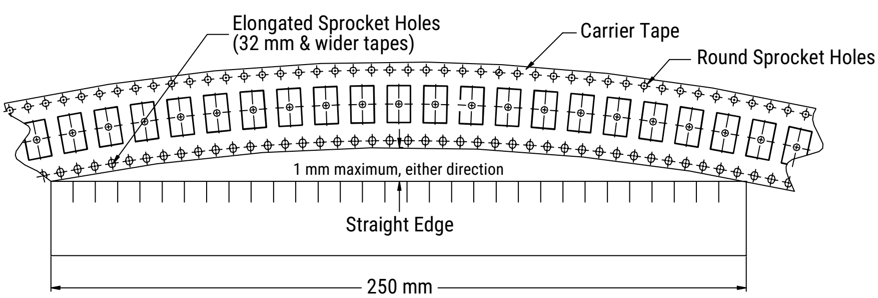


Figure 8 – Maximum Camber



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 ±15% from −55°C to +125°C.

Ordering Information

C	1210	J	685	K	3	R	A	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)
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	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
Automotive 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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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:

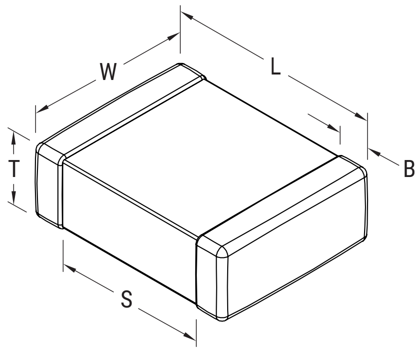
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

[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)	See Table 2 for Thickness	0.50 (0.02) ±0.25 (0.010)	0.75 (0.030)	Solder Wave or Solder Reflow
1206	3216	3.20 (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)		

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)	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	
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
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)		

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.
[3] Capacitance and dissipation factor (DF) measured under the following conditions:
1kHz ± 50Hz and 1.0 ± 0.2 Vrms if capacitance ≤10μF
120Hz ± 10Hz and 0.5 ± 0.1 Vrms if capacitance >10μF
[4] To obtain IR limit, divide MΩ-μF value by the capacitance and compare to GΩ 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	All	3.0	±20%	10% of Initial Limit
	16/25		5.0		
	< 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)

Capacitance	Capacitance Code	Case Size/ Series		C0805F/J					C1206F/J					C1210F/J					C1812F/J			
		Voltage Code		4	3	5	1	2	4	3	5	1	2	4	3	5	1	2	3	5	1	2
		Rated Voltage (VDC)		16	25	50	100	200	16	25	50	100	200	16	25	50	100	200	25	50	100	200
		Capacitance Tolerance		Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																		
1,000 pF	102	K	M	DP	DP	DP	DP	DP														
1,200 pF	122	K	M	DP	DP	DP	DP	DP														
1,500 pF	152	K	M	DP	DP	DP	DP	DP														
1,800 pF	182	K	M	DP	DP	DP	DP	DP														
2,200 pF	222	K	M	DP	DP	DP	DP	DP														
2,700 pF	272	K	M	DP	DP	DP	DP	DP														
3,300 pF	332	K	M	DP	DP	DP	DP	DP														
3,900 pF	392	K	M	DP	DP	DP	DP	DP														
4,700 pF	472	K	M	DP	DP	DP	DP	DP														
5,600 pF	562	K	M	DP	DP	DP	DP	DP														
6,800 pF	682	K	M	DP	DP	DP	DP	DP														
8,200 pF	822	K	M	DP	DP	DP	DP	DP														
10,000 pF	103	K	M	DP	DP	DP	DP	DP														
12,000 pF	123	K	M	DP	DP	DP	DP	DG														
15,000 pF	153	K	M	DP	DP	DP	DP	DG														
18,000 pF	183	K	M	DP	DP	DP	DP		ER	ER	ER	ER	ER									
22,000 pF	223	K	M	DP	DP	DP	DG		ER	ER	ER	ER	ER									
27,000 pF	273	K	M	DP	DP	DP	DG		ER	ER	ER	ER	ER									
33,000 pF	333	K	M	DP	DP	DP	DG		ER	ER	ER	ER	ER									
39,000 pF	393	K	M	DP	DP	DP	DG		ER	ER	ER	ER	ER									
47,000 pF	473	K	M	DP	DP	DP	DS		ER	ER	ER	ER	EU						GB	GB	GB	GB
56,000 pF	563	K	M	DP	DP	DP			ER	ER	ER	ER	EU						GB	GB	GB	GB
68,000 pF	683	K	M	DP	DP	DG	DG		ER	ER	ER	ER	EU	FX	FX	FX	FX	FX	GB	GB	GB	GB
82,000 pF	823	K	M	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	K	M	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				ER	ER	ER	EU		FX	FX	FX	FX	FU	GB	GB	GB	GB
0.22 µF	224	K	M	DG	DP	DG			ER	ER	ER	ES		FX	FX	FX	FZ	FS	GB	GB	GB	GC
0.27 µF	274	K	M	DP	DP				ER	ER	ER			FX	FX	FX	FZ		GB	GB	GB	GF
0.33 µF	334	K	M	DP	DG				EU	EU	EU	EU		FX	FX	FX	FU		GB	GB	GB	GK
0.39 µF	394	K	M	DP	DG				EU	EU				FX	FX	FZ	FU		GB	GB	GB	GL
0.47 µF	474	K	M	DS	DG				EU	EU	ER			FX	FX	FZ	FJ		GB	GB	GC	
0.56 µF	564	K	M						EU					FX	FX	FZ	FR		GB	GB	GD	
0.68 µF	684	K	M	DG					EU					FX	FZ	FU	FR		GD	GD	GF	
0.82 µF	824	K	M						EU					FX	FZ	FU	FR		GD	GD	GK	
1.0 µF	105	K	M						EU	ER	EH			FX	FU	FJ	FS		GN	GN	GM	
1.2 µF	125	K	M											FZ								
1.5 µF	155	K	M											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											FM	FM							
4.7 µF	475	K	M						EH					FZ	FM				GK	GK		
6.8 µF	685	K	M											FS	FS							
Capacitance	Capacitance Code	Rated Voltage (VDC)		16	25	50	100	200	16	25	50	100	200	16	25	50	100	200	25	50	100	200
		Voltage Code		4	3	5	1	2	4	3	5	1	2	4	3	5	1	2	3	5	1	2
		Case Size/ Series		C0805F/J					C1206F/J					C1210F/J					C1812F/J			

Table 1B – Capacitance Range/Selection Waterfall - Flexible Termination (0805 – 1812 Case Sizes)

Capacitance	Capacitance Code	Case Size/ Series		C0805F/J					C1206F/J					C1210F/J					C1812F/J			
		Voltage Code		4	3	5	1	2	4	3	5	1	2	4	3	5	1	2	3	5	1	2
		Rated Voltage (VDC)		16	25	50	100	200	16	25	50	100	200	16	25	50	100	200	25	50	100	200
		Capacitance Tolerance		Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																		
1,000 pF	102	K	M	DD	DD	DD	DD	DD														
1,200 pF	122	K	M	DD	DD	DD	DD	DD														
1,500 pF	152	K	M	DD	DD	DD	DD	DD														
1,800 pF	182	K	M	DD	DD	DD	DD	DD														
2,200 pF	222	K	M	DD	DD	DD	DD	DD														
2,700 pF	272	K	M	DD	DD	DD	DD	DD														
3,300 pF	332	K	M	DD	DD	DD	DD	DD														
3,900 pF	392	K	M	DD	DD	DD	DD	DD														
4,700 pF	472	K	M	DD	DD	DD	DD	DD														
5,600 pF	562	K	M	DD	DD	DD	DD	DD														
6,800 pF	682	K	M	DD	DD	DD	DD	DD														
8,200 pF	822	K	M	DD	DD	DD	DD	DD														
10,000 pF	103	K	M	DD	DD	DD	DD	DD														
12,000 pF	123	K	M	DD	DD	DD	DD	DG														
15,000 pF	153	K	M	DD	DD	DD	DD	DG														
18,000 pF	183	K	M	DD	DD	DD	DD		ER	ER	ER	ER	ER									
22,000 pF	223	K	M	DD	DD	DD	DG		ER	ER	ER	ER	ER									
27,000 pF	273	K	M	DD	DD	DD	DG		ER	ER	ER	ER	ER									
33,000 pF	333	K	M	DD	DD	DD	DG		ER	ER	ER	ER	ER									
39,000 pF	393	K	M	DD	DD	DD	DG		ER	ER	ER	ER	ER									
47,000 pF	473	K	M	DD	DD	DD	DS		ER	ER	ER	ER	EU						GB	GB	GB	GB
56,000 pF	563	K	M	DD	DD	DD			ER	ER	ER	ER	EU						GB	GB	GB	GB
68,000 pF	683	K	M	DD	DD	DG	DG		ER	ER	ER	ER	EU	FX	FX	FX	FX	FX	GB	GB	GB	GB
82,000 pF	823	K	M	DD	DD	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	K	M	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				ER	ER	ER	EU		FX	FX	FX	FX	FU	GB	GB	GB	GB
0.22 µF	224	K	M	DG	DD	DG			ER	ER	ER	ES		FX	FX	FX	FZ	FS	GB	GB	GB	GC
0.27 µF	274	K	M	DD	DD				ER	ER	ER			FX	FX	FX	FZ		GB	GB	GB	GF
0.33 µF	334	K	M	DD	DG				EU	EU	EU	EU		FX	FX	FX	FU		GB	GB	GB	GK
0.39 µF	394	K	M	DD	DG				EU	EU				FX	FX	FZ	FU		GB	GB	GB	GL
0.47 µF	474	K	M	DS	DG				EU	EU	ER			FX	FX	FZ	FJ		GB	GB	GC	
0.56 µF	564	K	M						EU					FX	FX	FZ	FR		GB	GB	GD	
0.68 µF	684	K	M	DG					EU					FX	FZ	FU	FR		GD	GD	GF	
0.82 µF	824	K	M						EU					FX	FZ	FU	FR		GD	GD	GK	
1.0 µF	105	K	M						EU	ER	EH			FX	FU	FJ	FS		GN	GN	GM	
1.2 µF	125	K	M											FZ								
1.5 µF	155	K	M											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											FM	FM							
4.7 µF	475	K	M						EH					FZ	FM				GK	GK		
6.8 µF	685	K	M											FS	FS							
Capacitance	Capacitance Code	Rated Voltage (VDC)		16	25	50	100	200	16	25	50	100	200	16	25	50	100	200	25	50	100	200
		Voltage Code		4	3	5	1	2	4	3	5	1	2	4	3	5	1	2	3	5	1	2
		Case Size/ Series		C0805F/J					C1206F/J					C1210F/J					C1812F/J			

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

Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			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 Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			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

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		Packaging Quantities (pieces/unit packaging)	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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 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)				
		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
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 ≥ 22 µF*
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.

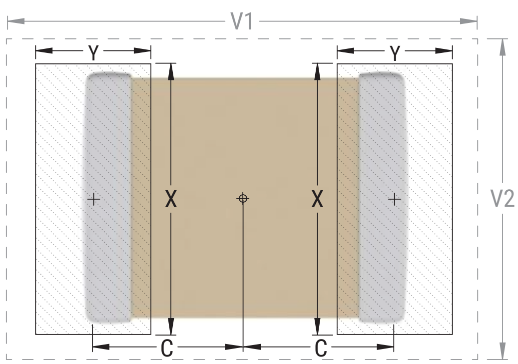
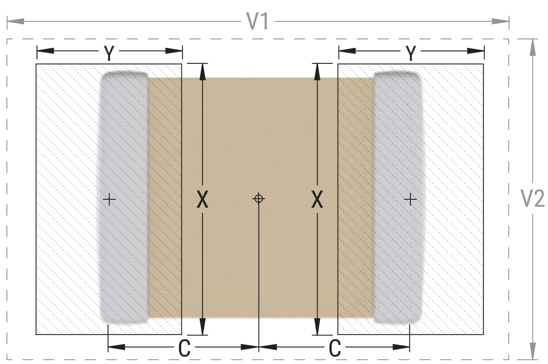


Table 3B – Land Pattern Design Recommendations per IPC–7351 – Flexible Termination

EIA Size Code	Metric Size Code	Density Level A: Maximum (Most) Land Protrusion (mm)					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
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	
	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.

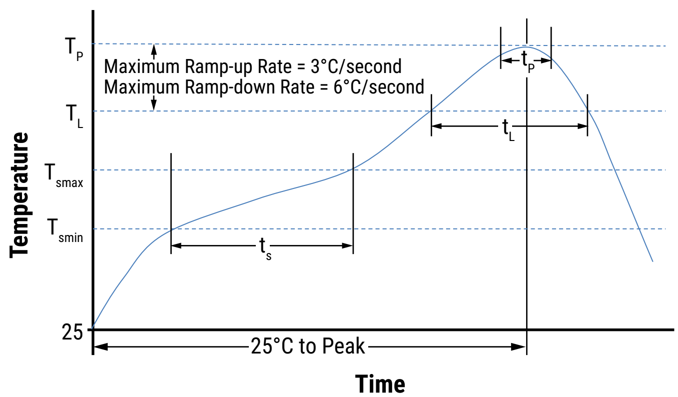


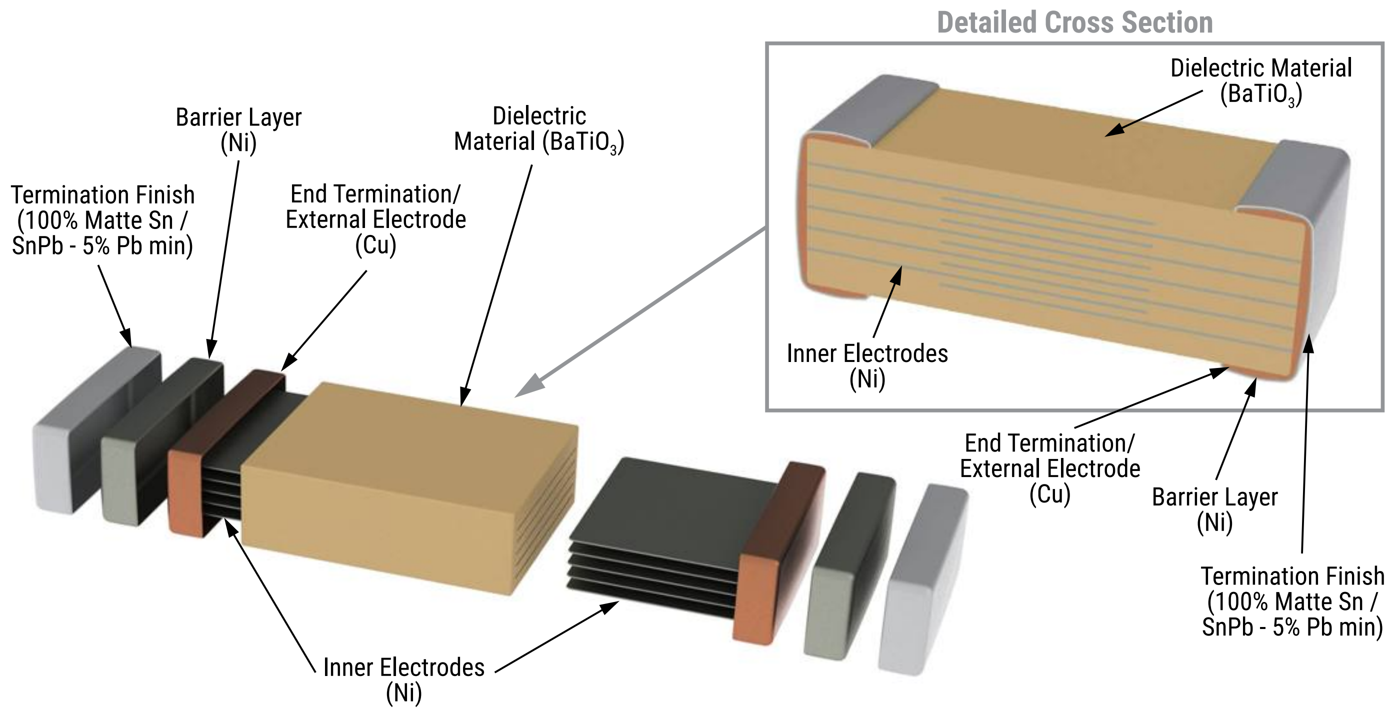
Table 4 – Performance & Reliability: Test Methods and Conditions

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 C0G. 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. 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 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.

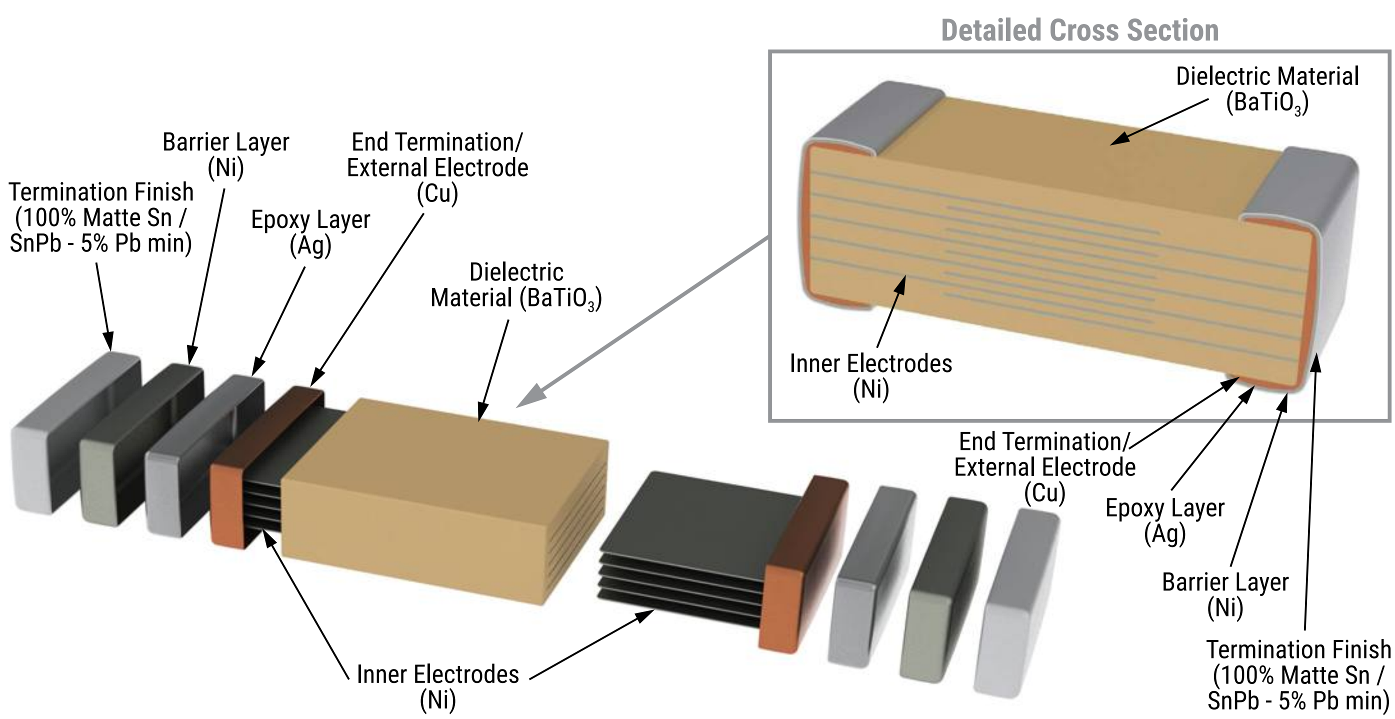
Storage and Handling

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 40ºC 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)

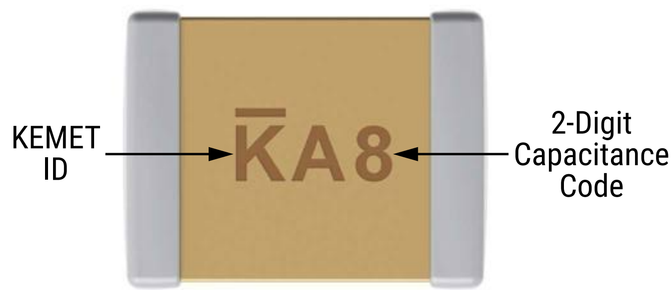
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic 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:

- C0G, 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 µF. Orientation of marking is vendor optional.

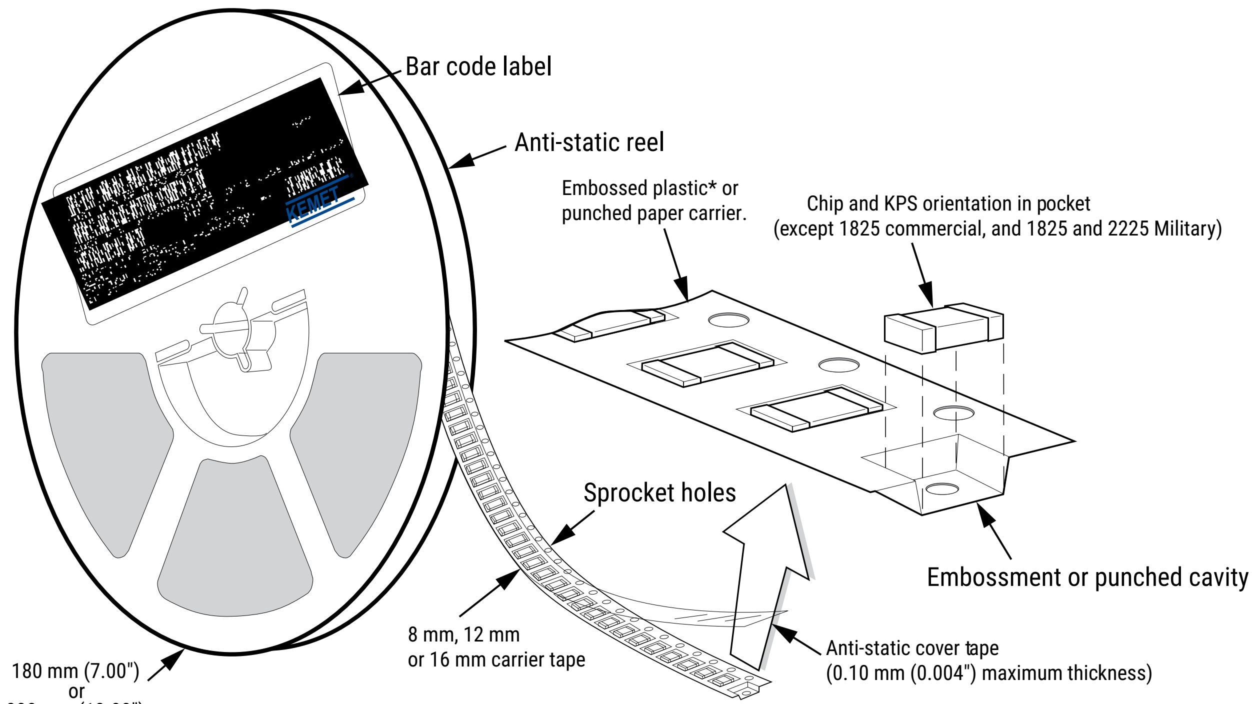


Capacitor Marking (Optional) cont.

Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.10	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

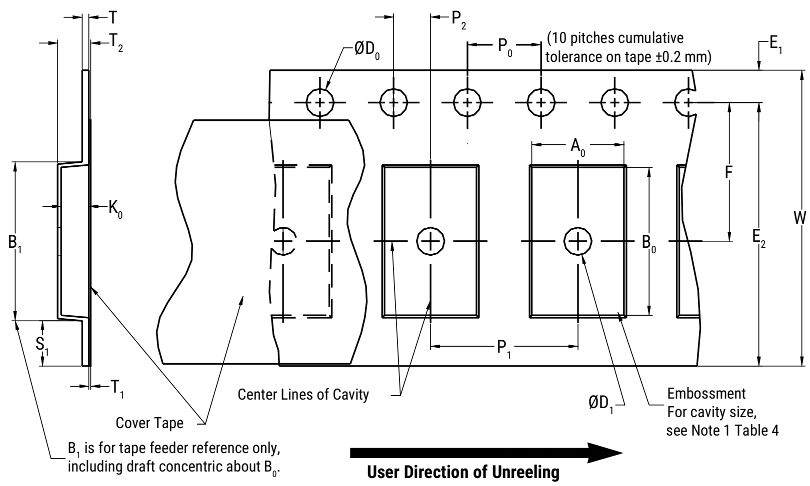


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +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)			
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)	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 S_1 < 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_0, B_0 and K_0 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

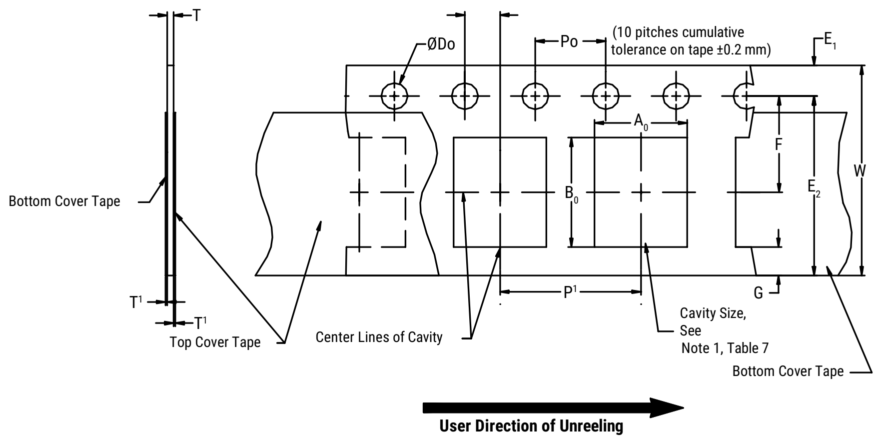


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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

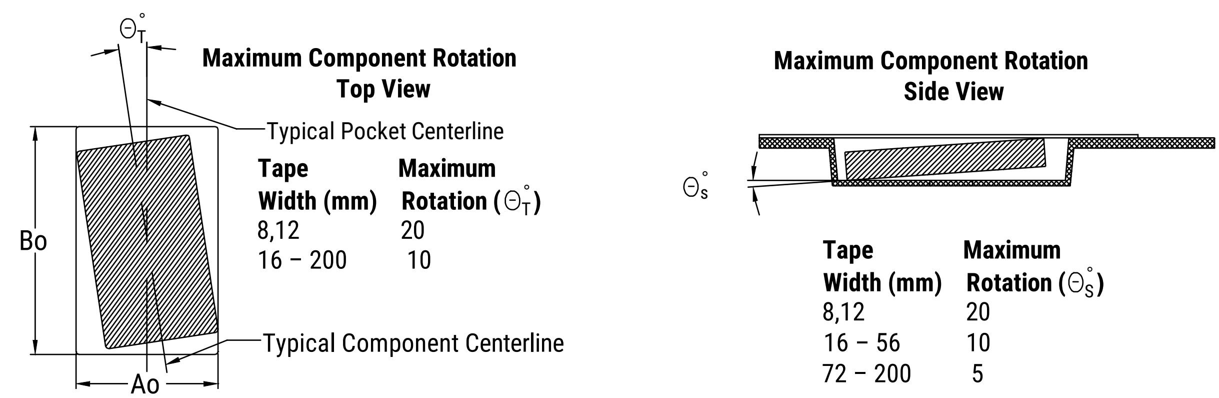


Figure 4 – Maximum Lateral Movement

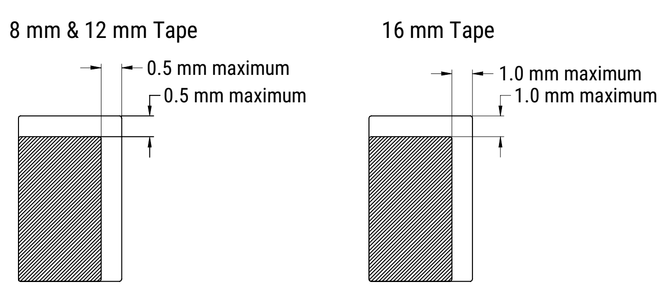


Figure 5 – Bending Radius

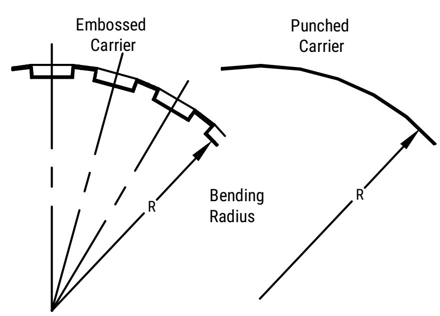
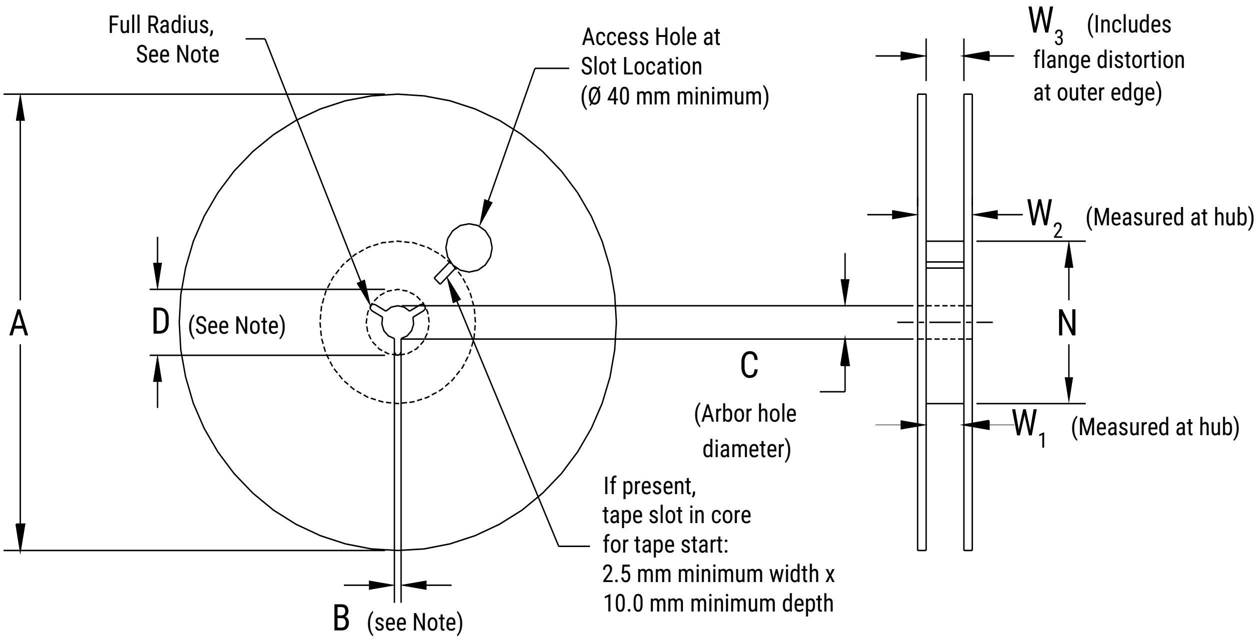


Figure 6 – Reel Dimensions



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	A	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	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)
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	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	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	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 7 – Tape Leader & Trailer Dimensions

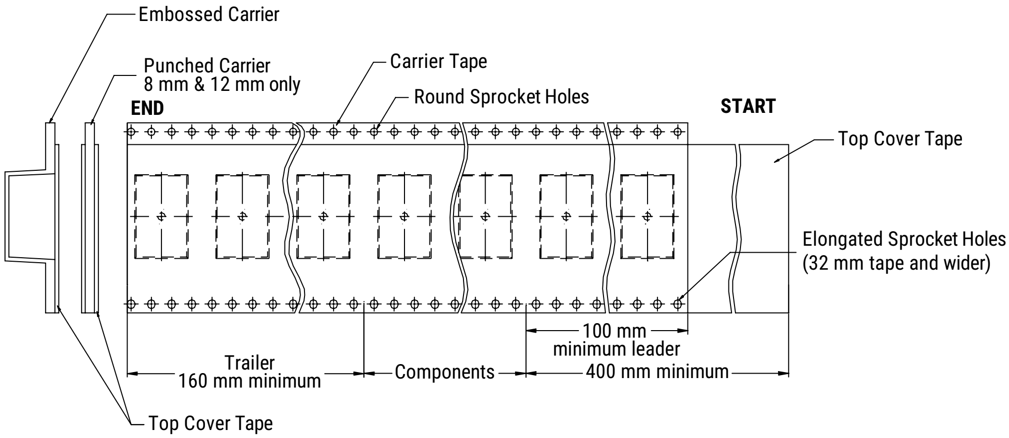
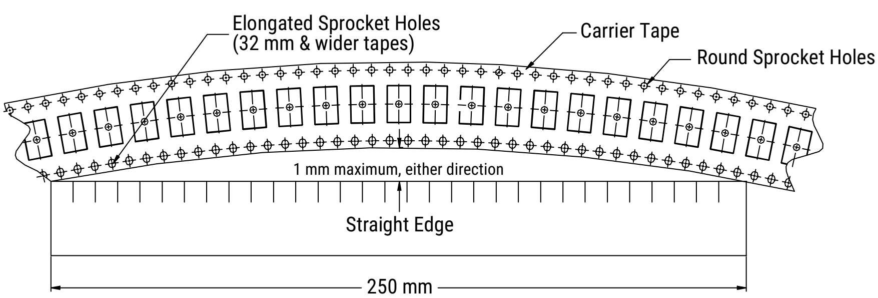


Figure 8 – Maximum Camber



Flexible Termination System (FT-CAP), X7R Dielectric, 6.3 – 250 VDC (Commercial Grade)

KEMET a YAGEO company

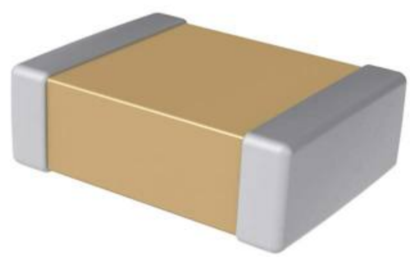
Overview

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 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 ±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

C	1206	X	106	K	4	R	A	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	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"

[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	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

[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."*

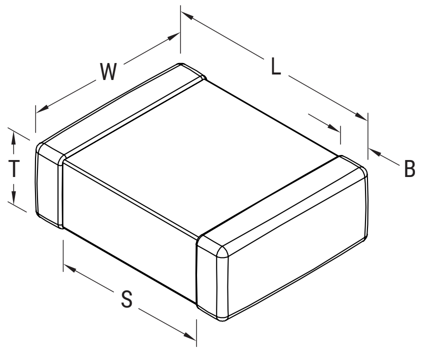
Benefits

- −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 μF
- 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)	See Table 2 for Thickness	0.45 (0.018) ±0.15 (0.006)	0.58 (0.023)	Solder wave or Solder reflow
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)	
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	
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)		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)		
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)		

[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 µF or ≥ 2.2 µF 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*

[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 ≤ 10 µF
120 Hz ± 10 Hz and 0.5 ± 0.1 V_{rms} if capacitance > 10 µF

[4] *To obtain IR limit, divide MΩ – µF value by the capacitance and compare to GΩ 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
0603	≤ 200 V	< 0.047 µF	≥ 0.047 µf < 0.47 µf	≥ 0.47 µf
	250 V	N/A	N/A	ALL
0805[1]	≤ 200 V	< 0.15 µF	≥ 0.15 µF < 2.2 µf	≥ 2.2 µf
	250 V	< .027 µF	N/A	≥ .027 µF
1206	≤ 200 V	< 0.47 µF	≥ 0.47 µF < 2.2 µf	≥ 2.2 µf
	250 V	< 0.12 µF	N/A	≥ 0.12 µF
1210[2]	≤ 200 V	< 0.39 µF	≥ 0.39 µF < 10 µf	≥ 10 µf
	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 %)
0603[1]	< 16	< 1.0 µF	5.0
	16/25		3.5
	> 25		2.5
	All	≥ 1.0 µF	10.0
0805[2]	< 16	< 4.7 µF	5.0
		≥ 4.7 µF	10.0
	16	< 4.7 µF	3.5
		≥ 4.7 µF	10.0
	25	< 2.2 µF	3.5
		≥ 2.2 µF	10.0
	> 25	<1.0 µF	2.5
		≥ 1.0 µF	10.0

EIA Case Size	Rated DC Voltage	Capacitance	Dissipation Factor (Maximum %)
1206[3]	< 16	All	5.0
	16/25	All	3.5
	> 25	All	2.5
1210[4]	< 16	All	5.0
	16	All	3.5
	25	< 10 µF	3.5
		≥ 10 µF	10.0
	> 25	All	2.5
	50	All	2.5
	> 50	All	2.5
1808 – 2225	< 16	All	5.0
	16/25	All	3.5
	> 25	All	2.5

[1] *For Capacitance values 0.22 µF (16 and 25 Volts) DF is 5% and for Capacitance value 4.7µF (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 ≥ 10 µF (≤ 16 V) DF is 10% and for Capacitance value 4.7 µF (50 V) DF is 5%.*

Post Environmental Limits

High Temperature Life, Biased Humidity, Moisture Resistance

EIA Case Size	Rated DC Voltage	Capacitance	Dissipation Factor (Maximum %)	Capacitance Shift	Insulation Resistance
0603[1]	< 16	< 1.0 µF	7.5	±20%	10% of Initial limit
	16/25		5.0		
	> 25		3.0		
	All	≥ 1.0 µF	20.0		
0805[2]	< 16	< 4.7 µF	7.5		
		≥ 4.7 µF	20.0		
	16	< 4.7 µF	5.0		
		≥ 4.7 µF	20.0		
	25	< 2.2 µF	5.0		
		≥ 2.2 µF	20.0		
	> 25	< 1.0 µF	3.0		
		≥ 1.0 µF	20.0		
1206[3]	< 16	All	7.5		
	16/25	All	5.0		
	> 25	All	3.0		
1210[4]	< 16	All	7.5		
	16	All	5.0		
	25	< 10µF	5.0		
		≥ 10µF	20.0		
	> 25	All	3.0		
	50	All	3.0		
	> 50	All	3.0		
1808 - 2225	< 16	All	7.5		
	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 ≥ 10 µF (≤ 16 V) DF is 20% and for Capacitance value 4.7 µF (50 V) DF is 7.5%

Table 1A – Capacitance Range/Selection Waterfall (0603 – 1210 Case Sizes)

Cap	Cap Code	Case Size/ Series			C0603X								C0805X								C1206X								C1210X							
		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
		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
		Cap Tolerance			Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions																															
180 pF	181	J	K	M	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	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	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	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	272	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
4,700 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	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	M	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
15,000 pF	153	J	K	M	CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DD	DR	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN	FN	FN	FN
18,000 pF	183	J	K	M	CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DD	DR	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN	FN	FN	FN
22,000 pF	223	J	K	M	CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DD	DR	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN	FN	FN	FN
27,000 pF	273	J	K	M	CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DD	DS	DG	EQ	EQ	EQ	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN	FN	FN	FN
33,000 pF	333	J	K	M	CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DD	DS	DG	EQ	EQ	EQ	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN	FN	FN	FN
39,000 pF	393	J	K	M	CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DD	DS	DG	EQ	EQ	EQ	EQ	EQ	ER	EQ	EQ	FN	FN	FN	FN	FN	FN	FN	FN
47,000 pF	473	J	K	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
Cap	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
		Case Size/ Series			C0603X								C0805X								C1206X								C1210X							

Table 1A – Capacitance Range/Selection Waterfall (0603 – 1210 Case Sizes) cont.

Cap	Cap Code	Case Size/ Series			C0603X								C0805X								C1206X								C1210X							
		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
		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
		Cap Tolerance			Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions																															
56,000 pF	563	J	K	M	CJ	CJ	CJ	CJ	CJ				DD	DD	DD	DD	DD	DS	DG	DG	EQ	EQ	EQ	EQ	EQ	EQ	ES	ES	FN	FN	FN	FN	FN	FN	FQ	FQ
68,000 pF	683	J	K	M	CJ	CJ	CJ	CJ	CJ				DD	DD	DD	DD	DD	DS	DG	DG	EQ	EQ	EQ	EQ	EQ	EQ	ES	ES	FN	FN	FN	FN	FN	FN	FQ	FQ
82,000 pF	823	J	K	M	CJ	CJ	CJ	CJ	CJ				DD	DD	DD	DD	DD	DS			EQ	EQ	EQ	EQ	EQ	EQ	ES	ES	FN	FN	FN	FN	FN	FQ	FA	FA
0.10 µF	104	J	K	M	CJ	CJ	CJ	CJ	CJ				DR	DR	DR	DR	DR	DS			EQ	EQ	EQ	EQ	EQ	EQ	EM	EM	FN	FN	FN	FN	FN	FX	FZ	FZ
0.12 µF	124	J	K	M	CJ	CJ	CJ	CJ	CJ				DR	DR	DR	DR	DD	DG			ER	ER	ER	ER	ER	ER	EU	EM	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			ER	ER	ER	ER	ER	ER	EU	EH	FQ	FQ	FQ	FQ	FQ	FX	FM	FM
0.18 µF	184	J	K	M	CJ	CJ	CJ	CJ					DR	DR	DR	DR	DG	DG			ER	ER	ER	ER	ER	ER	EM	EM	FQ	FQ	FQ	FQ	FQ	FX	FK	FK
0.22 µF	224	J	K	M	CJ	CJ	CJ	CJ	CJ				DR	DR	DR	DR	DG	DG			ER	ER	ER	ER	ER	ER	EH	EH	FQ	FQ	FQ	FQ	FQ	FX	FK	FK
0.27 µF	274	J	K	M	CJ	CJ	CJ						DD	DD	DD	DD	DD				EQ	EQ	EQ	EQ	ER	EM			FQ	FQ	FQ	FQ	FQ	FX	FP	FP
0.33 µF	334	J	K	M	CJ	CJ	CJ						DG	DG	DG	DG	DD				EQ	EQ	EQ	EQ	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				EQ	EQ	EQ	EQ	ER	EU			FX	FX	FX	FX	FX	FX	FK	FK
0.47 µF	474	J	K	M	CJ	CJ	CJ	CJ					DG	DG	DG	DG	DS				ER	ER	ER	ER	ER	EU			FX	FX	FX	FX	FX	FX	FS	FS
0.56 µF	564	J	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									DD	DD	DD	DG	DH				ET	ET	ET	ET	ES	EM			FX	FX	FX	FX	FX	FZ		
0.82 µF	824	J	K	M									DD	DD	DD	DG					EF	EF	EF	EF	ES	EU			FA	FA	FA	FA	FA	FL		
1.0 µF	105	J	K	M	CJ	CJ	CJ						DD	DD	DD	DG	DV				EF	EF	EF	EU	ES	EU			FU	FU	FU	FU	FU	FM		
1.2 µF	125	J	K	M									DS	DS	DS						ES	ES	ES	EU	EH				FU	FU	FU	FU	FZ	FH		
1.5 µF	155	J	K	M									DG	DG	DG						EF	EF	EF	EU	EH				FU	FU	FU	FU	FZ	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	J	K	M									DV	DV	DV	DV	DT				EA	EA	EA	EH	EH				FJ	FJ	FJ	FJ	FZ	FK		
2.7 µF	275	J	K	M																	EN	EN	EN	EH					FE	FE	FE	FZ	FU			
3.3 µF	335	J	K	M																	ES	ES	ES	EH					FA	FA	FA	FM	FM			
3.9 µF	395	J	K	M																	EF	EF	EF	EH					FZ	FZ	FZ	FZ	FK			
4.7 µF	475	J	K	M									DH	DH	DH	DH					EA	EA	EA	EA	EA				FQ	FQ	FQ	FZ	FS			
5.6 µF	565	J	K	M																	EH	EH	EH						FA	FA	FA	FU				
6.8 µF	685	J	K	M																	EH	EH	EH						FZ	FZ	FZ	FM				
8.2 µF	825	J	K	M																	EH	EH	EH						FU	FU	FU	FK				
10 µF	106	J	K	M									DT	DT							EA	EA	EA	EA					FS	FS	FS	FS				
22 µF	226	J	K	M																									FS	FS						
Cap	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
		Case Size/ Series			C0603X								C0805X								C1206X								C1210X							

Table 1B – Capacitance Range/Selection Waterfall (1808 – 2225 Case Sizes)

Cap	Cap Code	Case Size/ Series			C1808X				C1812X					C1825X				C2220X					C2225X			
		Voltage Code			5	1	2	A	3	5	1	2	A	5	1	2	A	3	5	1	2	A	5	1	2	A
		Rated Voltage (VDC)			50	100	200	250	25	50	100	200	250	50	100	200	250	25	50	100	200	250	50	100	200	250
		Cap Tolerance			Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions																					
4,700 pF	472	J	K	M	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	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB									
27,000 pF	273	J	K	M	LD	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB									
33,000 pF	333	J	K	M	LD	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB									
39,000 pF	393	J	K	M	LD	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB									
47,000 pF	473	J	K	M	LD	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB									
56,000 pF	563	J	K	M	LD	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB									
68,000 pF	683	J	K	M	LD				GB	GB	GB	GB	GB	HB	HB	HB	HB									
82,000 pF	823	J	K	M	LD				GB	GB	GB	GB	GB	HB	HB	HB	HB	JC	JC	JC	JC	JC				
0.10 µF	104	J	K	M	LD				GB	GB	GB	GB	GB	HB	HB	HB	HB	JC	JC	JC	JC	JC	KC	KC	KC	KC
0.12 µF	124	J	K	M	LD				GB	GB	GB	GB	GB	HB	HB	HB	HB	JC	JC	JC	JC	JC	KC	KC	KC	KC
0.15 µF	154	J	K	M	LD				GB	GB	GB	GE	GE	HB	HB	HB	HB	JC	JC	JC	JC	JC	KC	KC	KC	KC
0.18 µF	184	J	K	M	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	M					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			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			
1.8 µF	185	J	K	M					GE	GE	GE			HD				JD	JD				KD			
2.2 µF	225	J	K	M					GG	GG	GG			HF				JF	JF				KD			
2.7 µF	275	J	K	M					GJ	GJ	GJ															
3.3 µF	335	J	K	M					GL	GL	GL															
4.7 µF	475	J	K	M					GK	GK																
10 µF	106	J	K	M					GK									JF	JO							
15 µF	156	J	K	M														JO	JO							
22 µF	226	J	K	M														JO								
Cap	Cap Code	Rated Voltage (VDC)			50	100	200	250	25	50	100	200	250	50	100	200	250	25	50	100	200	250	50	100	200	250
		Voltage Code			5	1	2	A	3	5	1	2	A	5	1	2	A	3	5	1	2	A	5	1	2	A
		Case Size/ Series			C1808X				C1812X					C1825X				C2220X					C2225X			

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

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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
DH	0805	1.25 ±0.20	0	0	2,500	10,000
DT	0805	1.25 ± 0.25	0	0	2,500	10,000
DV	0805	1.25 ± 0.30	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
EN	1206	0.95 ±0.10	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
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
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
FS	1210	2.50 ±0.30	0	0	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
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
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 Code	Case Size1	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			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 2B – Bulk Packaging Quantities

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		Packaging Quantities (pieces/unit packaging)	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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.

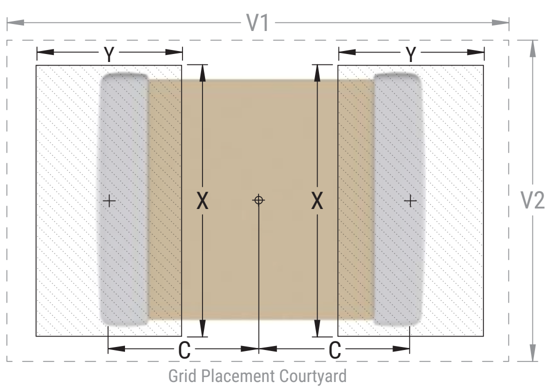
[2] A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding anti-static Bulk Bag and automotive grade products.) The 15th through 22nd character positions of the ordering code should be left blank. All products ordered without a packaging C-Spec will default to our standard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

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

EIA 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)				
		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	
	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.

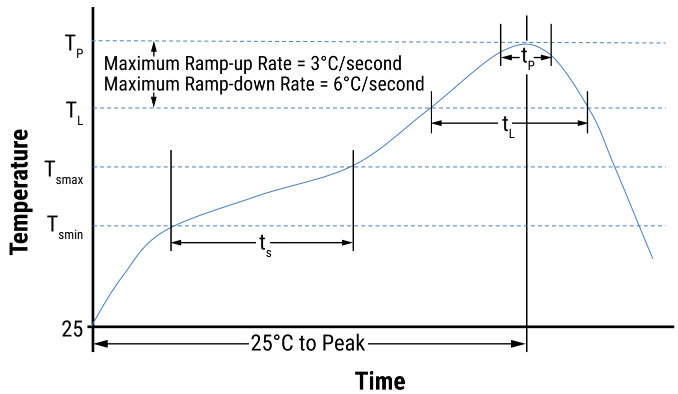


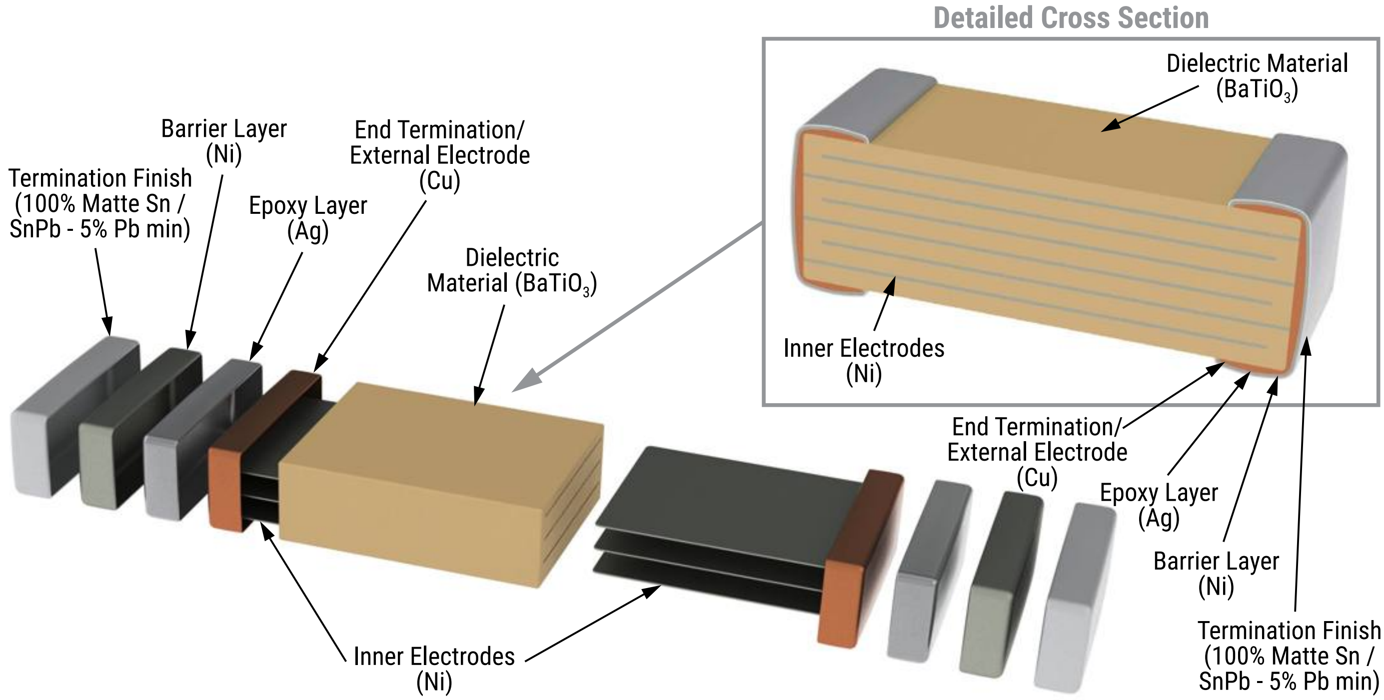
Table 4 – Performance & Reliability: Test Methods and Conditions

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 C0G. 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, 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.
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 40ºC 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)

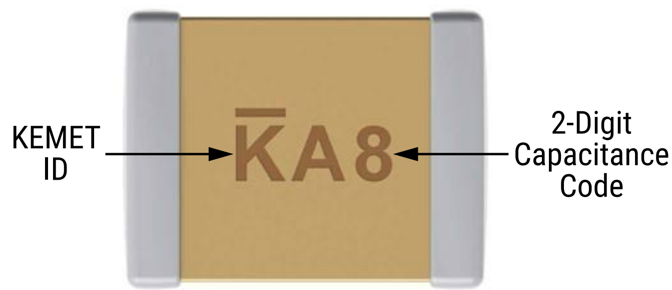
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic 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:

- C0G, 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 µF. Orientation of marking is vendor optional.

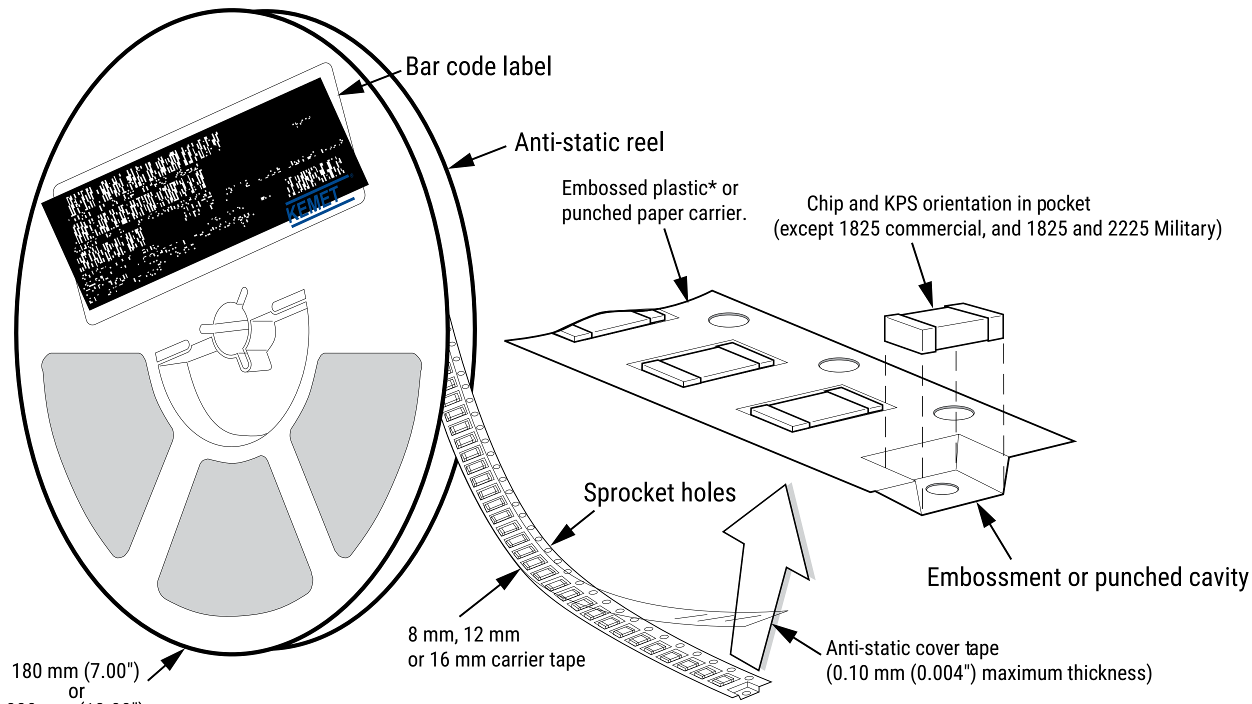


Capacitor Marking (Optional) cont.

Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.10	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

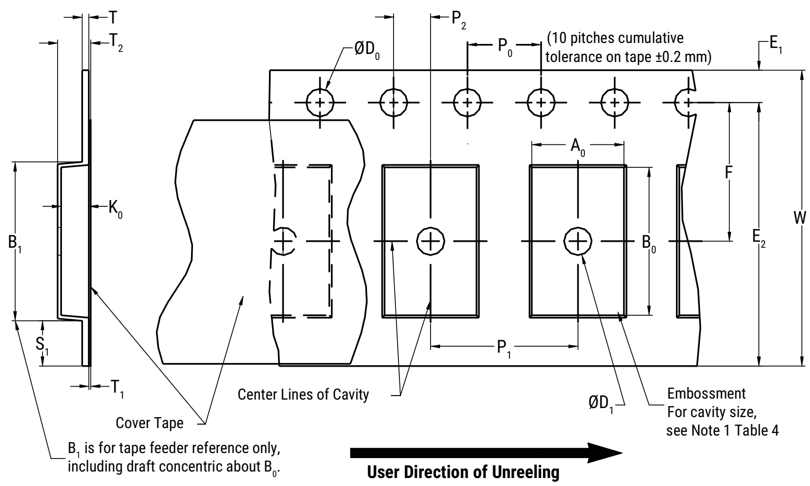


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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 (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)	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 S_1 < 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_0, B_0 and K_0 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

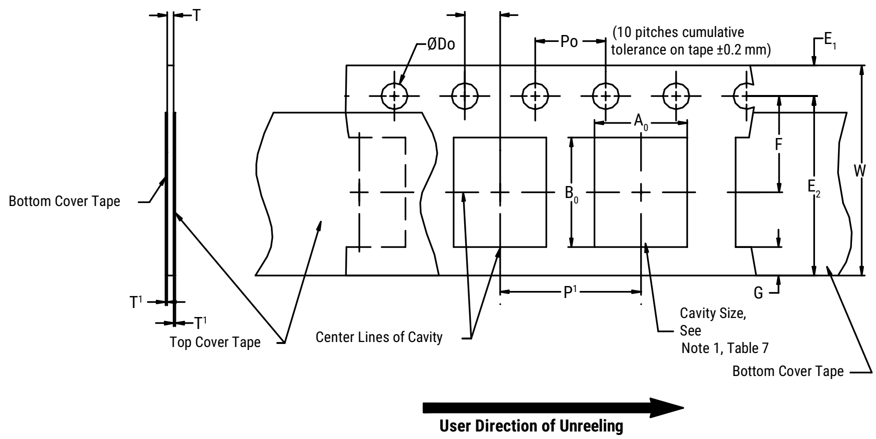


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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

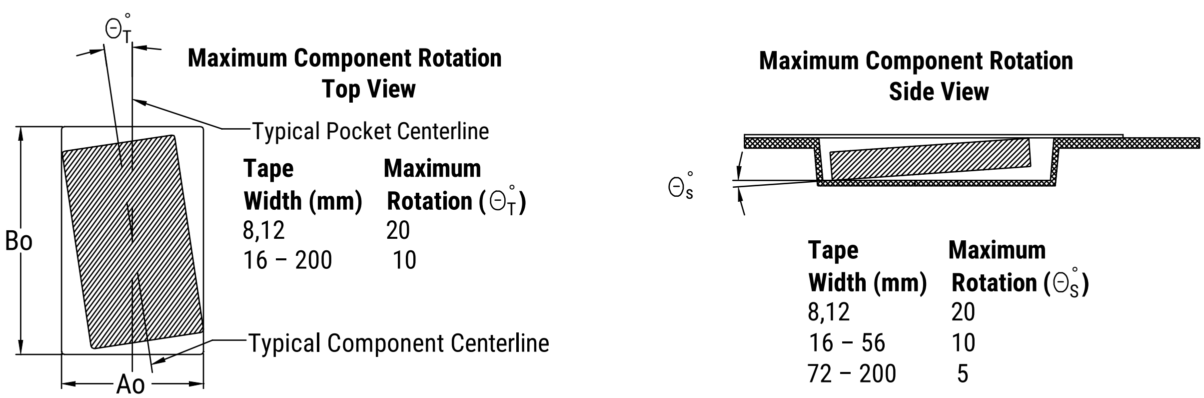


Figure 4 – Maximum Lateral Movement

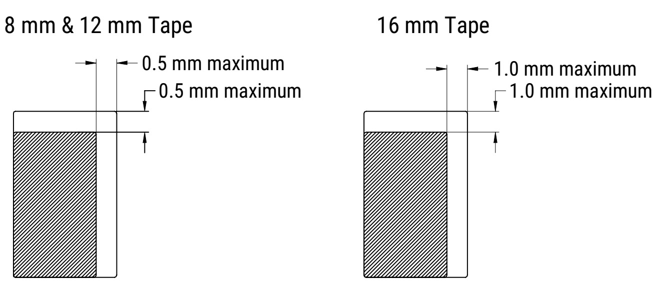


Figure 5 – Bending Radius

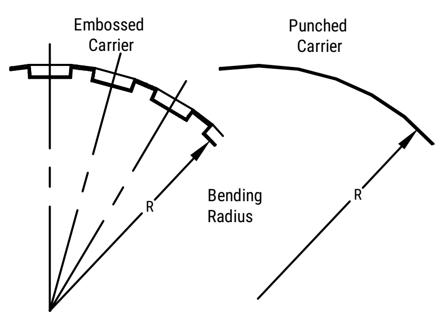
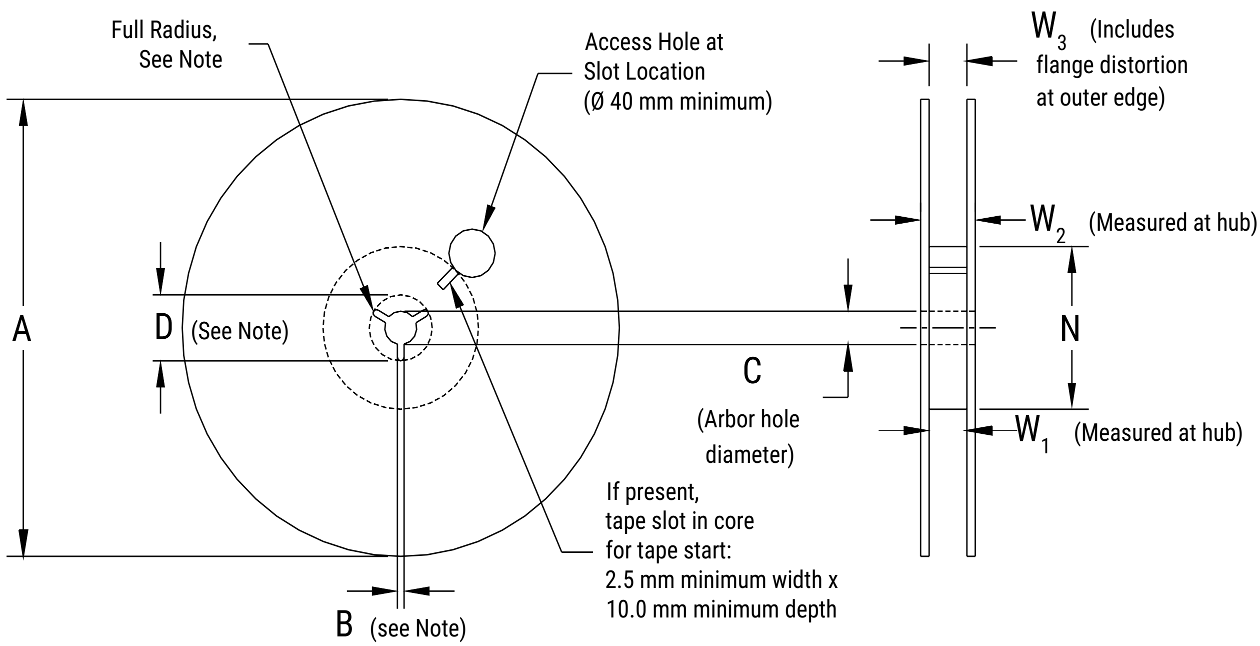


Figure 6 – Reel Dimensions



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	A	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

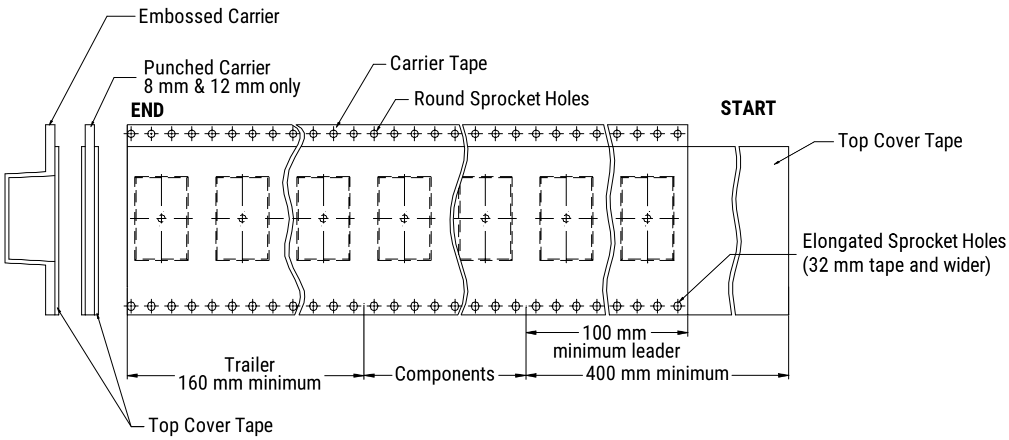
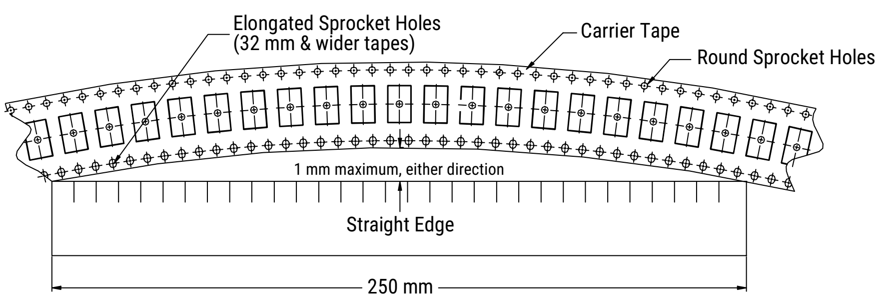


Figure 8 – Maximum Camber



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 ±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

C	0805	S	104	K	5	R	A	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.

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	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
Automotive 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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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:

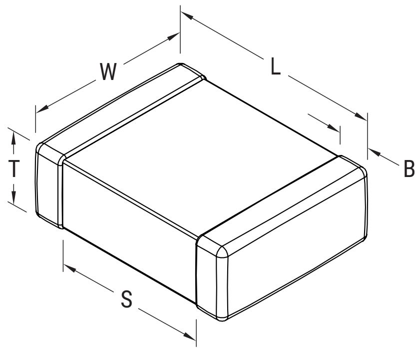
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

[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)	±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.*
[3] *Capacitance and dissipation factor (DF) measured under the following conditions:*
1kHz ± 50Hz and 1.0 ± 0.2 Vrms if capacitance ≤10µF
120Hz ± 10Hz and 0.5 ± 0.1 Vrms if capacitance >10µF
[4] *To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ 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	All	3.0	±20%	10% of Initial Limit
	16/25		5.0		
	< 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 (0402 – 0805 Case Sizes)

Capacitance	Cap Code	Case Size/ Series			C0402S					C0603S							C0805S							
		Voltage Code			9	8	4	3	5	9	8	4	3	5	1	2	9	8	4	3	5	1	2	A
		Rated Voltage (VDC)			6.3	10	16	25	50	6.3	10	16	25	50	100	200	6.3	10	16	25	50	100	200	250
		Capacitance Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																			
150 pF	151	J	K	M	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	M	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	M						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	M						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	M													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			
Capacitance	Cap Code	Rated Voltage (VDC)			6.3	10	16	25	50	6.3	10	16	25	50	100	200	6.3	10	16	25	50	100	200	250
		Voltage Code			9	8	4	3	5	9	8	4	3	5	1	2	9	8	4	3	5	1	2	A
		Case Size/ Series			C0402S					C0603S							C0805S							

Table 1B – Capacitance Range/Selection Waterfall (1206 – 1812 Case Sizes)

Capacitance	Cap Code	Case Size/ Series			C1206S								C1210S								C1812S				
		Voltage Code			9	8	4	3	5	1	2	A	9	8	4	3	5	1	2	A	3	5	1	2	A
		Rated Voltage (VDC)			6.3	10	16	25	50	100	200	250	6.3	10	16	25	50	100	200	250	25	50	100	200	250
		Capacitance Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																				
1,000 pF	102	J	K	M	EB	EB	EB	EB	EB	EB	EB	EB													
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	K	M	EB	EB	EB	EB	EB	EB	EB	EB													
2,200 pF	222	J	K	M	EB	EB	EB	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB	FB	FB	FB					
2,700 pF	272	J	K	M	EB	EB	EB	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB	FB	FB	FB					
3,300 pF	332	J	K	M	EB	EB	EB	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB	FB	FB	FB					
3,900 pF	392	J	K	M	EB	EB	EB	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB	FB	FB	FB					
4,700 pF	472	J	K	M	EB	EB	EB	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB	FB	FB	FB					
5,600 pF	562	J	K	M	EB	EB	EB	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB	FB	FB	FB					
6,800 pF	682	J	K	M	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	M	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	K	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	K	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	K	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	K	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	M	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
Capacitance	Cap Code	Rated Voltage (VDC)			6.3	10	16	25	50	100	200	250	6.3	10	16	25	50	100	200	250	25	50	100	200	250
		Voltage Code			9	8	4	3	5	1	2	A	9	8	4	3	5	1	2	A	3	5	1	2	A
		Case Size/ Series			C1206S								C1210S								C1812S				

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

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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 Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[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

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		Packaging Quantities (pieces/unit packaging)	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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 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)				
		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

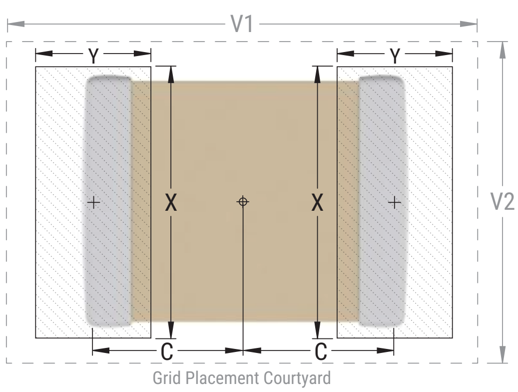
[1] *Only for capacitance values ≥ 22 µF*

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	
	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.

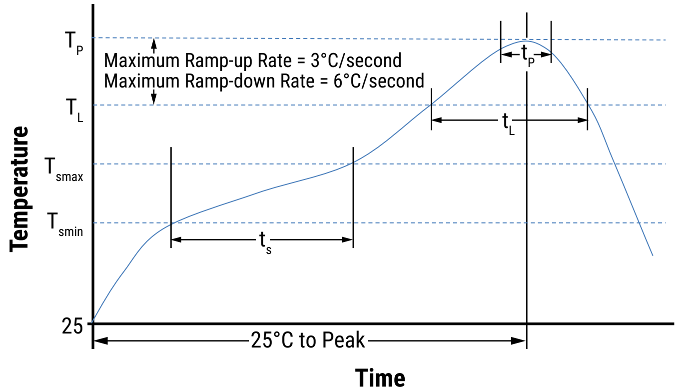


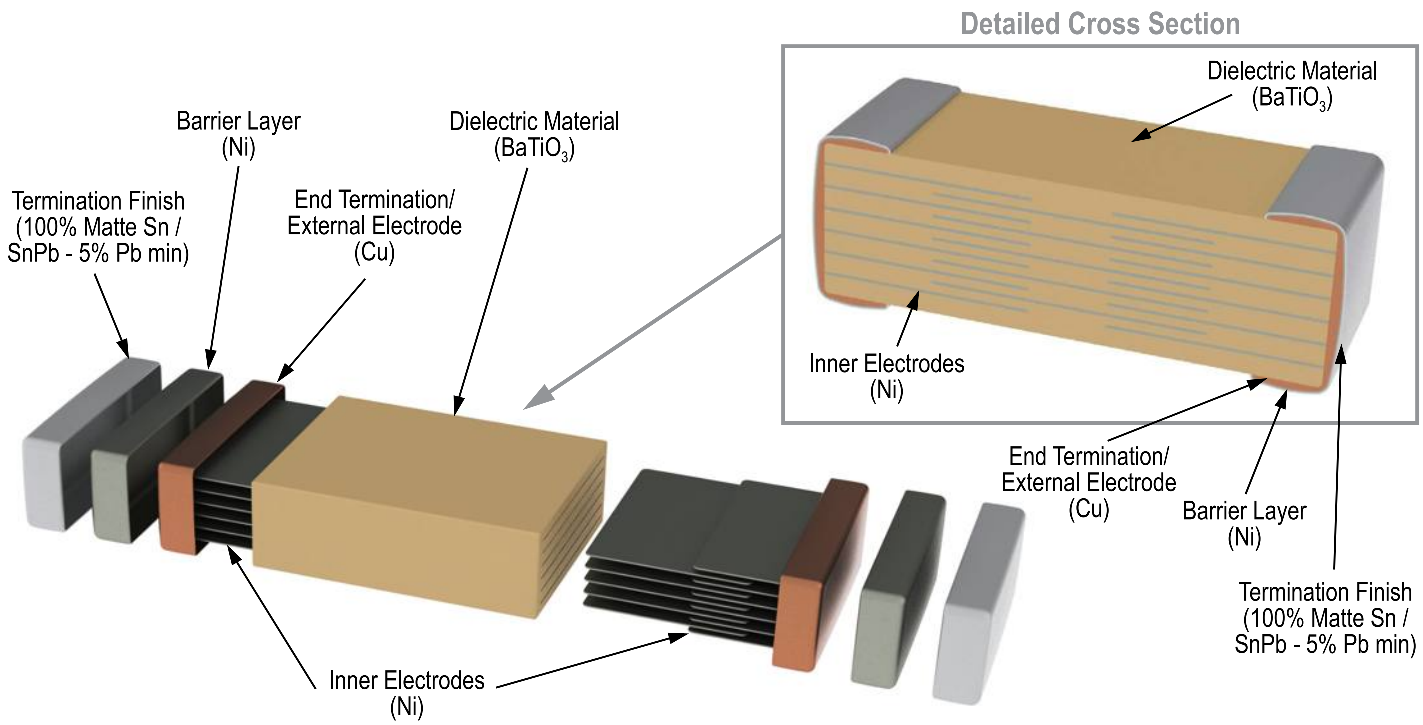
Table 4 – Performance & Reliability: Test Methods and Conditions

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 C0G. 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. 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 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 40ºC 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)

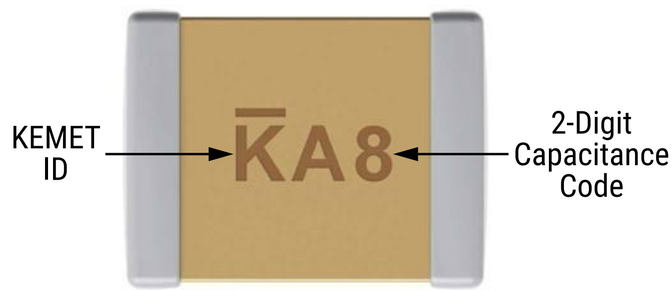
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic 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:

- C0G, 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 µF. Orientation of marking is vendor optional.

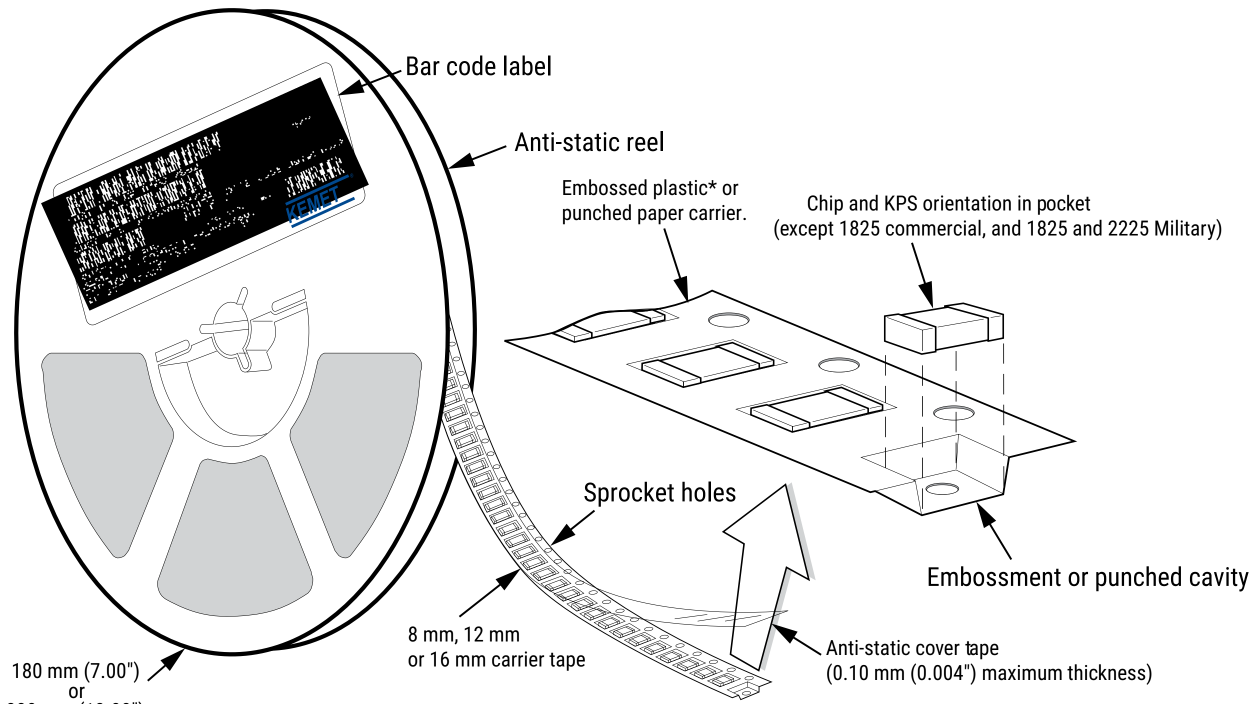


Capacitor Marking (Optional) cont.

Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.10	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

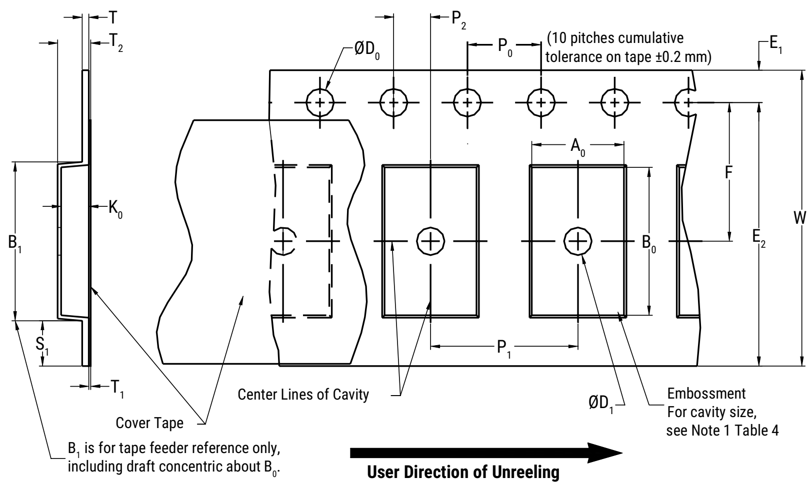


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +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)			
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)	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 S_1 < 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_0, B_0 and K_0 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

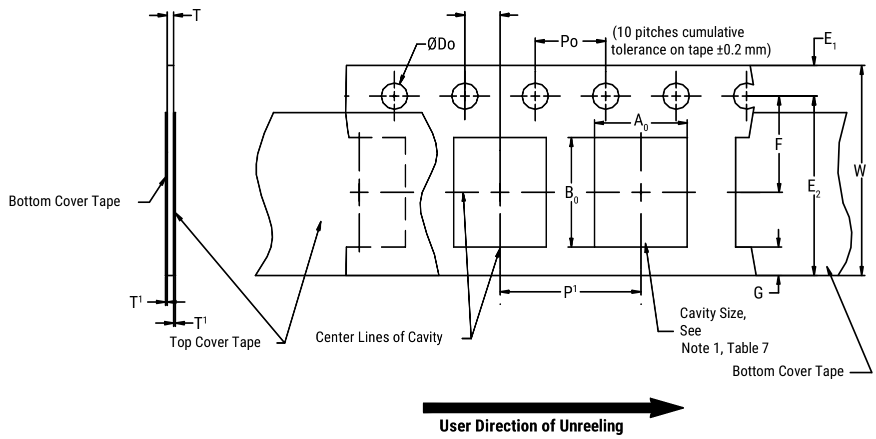


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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.)

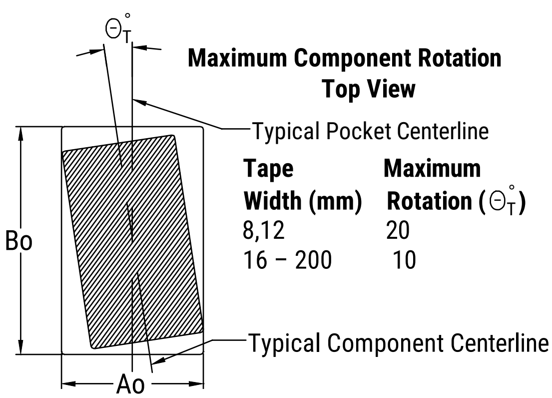
Packaging Information Performance Notes

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



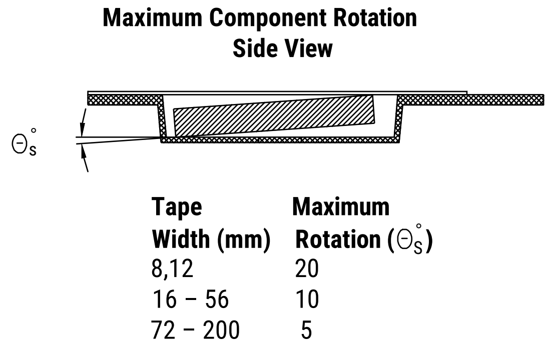


Figure 4 – Maximum Lateral Movement

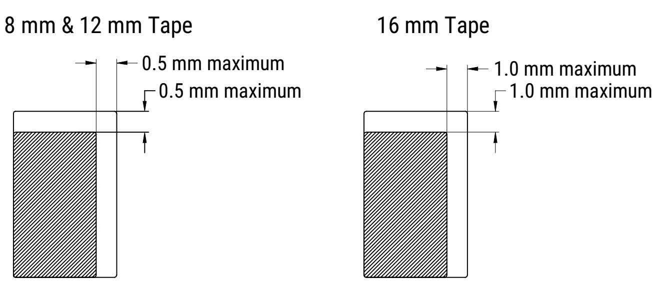


Figure 5 – Bending Radius

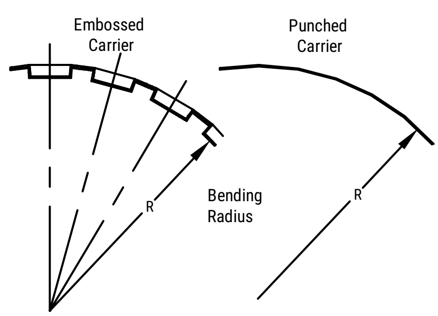
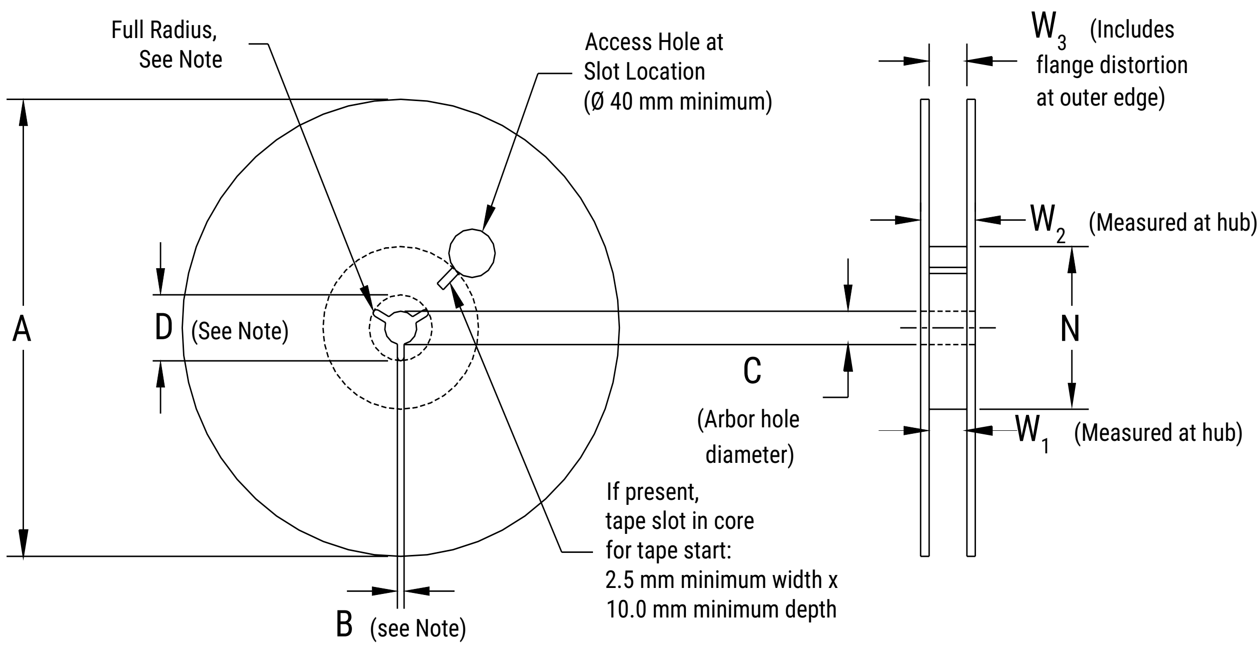


Figure 6 – Reel Dimensions



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	A	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

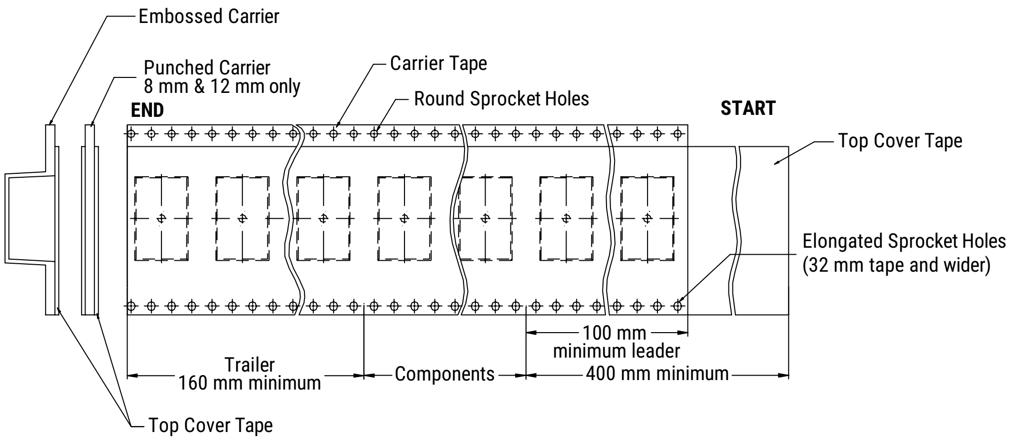
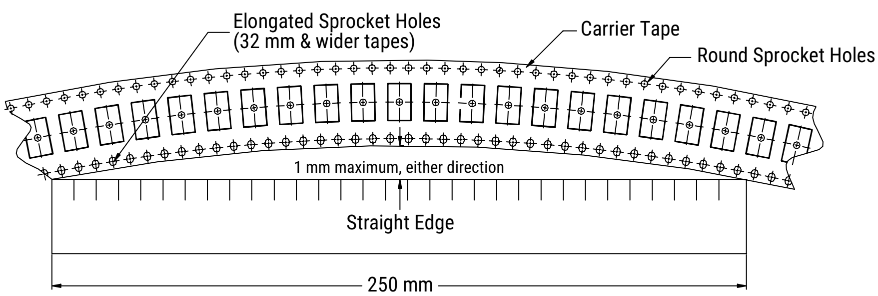


Figure 8 – Maximum Camber



Floating Electrode Design with Flexible Termination System (FF-CAP), X7R Dielectric, 6.3 – 250 VDC (Commercial & Automotive Grade)

KEMET a YAGEO company

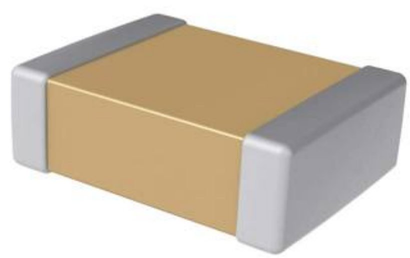
Overview

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 MLCCs– flex 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

C	0805	Y	104	K	5	R	A	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 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.*

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	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
Automotive 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
- 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 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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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:

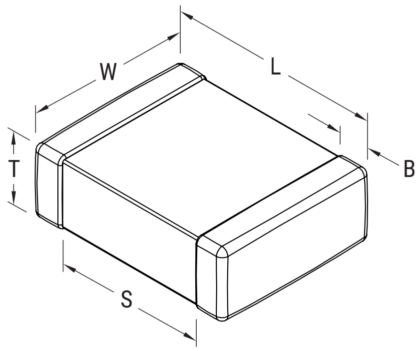
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

[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)	See Table 2 for Thickness	0.45 (0.018) ±0.15 (0.006)	0.58 (0.023)	Solder Wave or Solder Reflow
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)	
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	
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
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)		

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.*
[3] *Capacitance and dissipation factor (DF) measured under the following conditions:*
1kHz ± 50Hz and 1.0 ± 0.2 Vrms if capacitance ≤10μF
120Hz ± 10Hz and 0.5 ± 0.1 Vrms if capacitance >10μF
[4] *To obtain IR limit, divide MΩ-μF value by the capacitance and compare to GΩ 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	All	3.0	±20%	10% of Initial Limit
	16/25		5.0		
	< 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 (0603 – 0805 Case Sizes)

Capacitance	Capacitance Code	Case Size/ Series			C0603Y							C0805Y							
		Voltage Code			9	8	4	3	5	1	2	9	8	4	3	5	1	2	A
		Rated Voltage (VDC)			6.3	10	16	25	50	100	200	6.3	10	16	25	50	100	200	250
		Capacitance Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions														
180 pF	181	J	K	M	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	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	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	M	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	M	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	M								DR	DR	DR	DR	DR			
56,000 pF	563	J	K	M								DD	DD	DD	DD	DD			
68,000 pF	683	J	K	M								DD	DD	DD	DD	DD			
82,000 pF	823	J	K	M								DG	DG	DG	DG	DG			
0.10 µF	104	J	K	M								DG	DG	DG	DG	DG			
Capacitance	Capacitance Code	Rated Voltage (VDC)			6.3	10	16	25	50	100	200	6.3	10	16	25	50	100	200	250
		Voltage Code			9	8	4	3	5	1	2	9	8	4	3	5	1	2	A
		Case Size/Series			C0603Y							C0805Y							

Table 1B – Capacitance Range/Selection Waterfall (1206 – 1812 Case Sizes)

Capacitance	Cap Code	Case Size/ Series			C1206Y								C1210Y								C1812Y				
		Voltage Code			9	8	4	3	5	1	2	A	9	8	4	3	5	1	2	A	3	5	1	2	A
		Rated Voltage (VDC)			6.3	10	16	25	50	100	200	250	6.3	10	16	25	50	100	200	250	25	50	100	200	250
		Capacitance Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																				
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	M	EQ	EQ	EQ	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN	FN	FN	FN					
3,300 pF	332	J	K	M	EQ	EQ	EQ	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN	FN	FN	FN					
3,900 pF	392	J	K	M	EQ	EQ	EQ	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN	FN	FN	FN					
4,700 pF	472	J	K	M	EQ	EQ	EQ	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN	FN	FN	FN					
5,600 pF	562	J	K	M	EQ	EQ	EQ	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN	FN	FN	FN					
6,800 pF	682	J	K	M	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	M	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	M	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	M	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	M	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	M	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	M	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	M	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	K	M	EQ	EQ	EQ	EQ	EQ	EQ			FN	FN	FN	FN	FN	FN	FN	FN	GB	GB	GB	GB	GB
39,000 pF	393	J	K	M	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	M	EQ	EQ	EQ	EQ	EQ	ER			FN	FN	FN	FN	FN	FN	FQ	FQ	GB	GB	GB	GB	GB
56,000 pF	563	J	K	M	EQ	EQ	EQ	EQ	EQ	EQ			FN	FN	FN	FN	FN	FN	FQ	FQ	GB	GB	GB	GB	GB
68,000 pF	683	J	K	M	EQ	EQ	EQ	EQ	EQ				FN	FN	FN	FN	FN	FN			GB	GB	GB	GB	GB
82,000 pF	823	J	K	M	EQ	EQ	EQ	EQ	EQ				FN	FN	FN	FN	FN	FQ			GB	GB	GB	GB	GB
0.10 µF	104	J	K	M	EQ	EQ	EQ	EQ	EQ				FN	FN	FN	FN	FN	FX			GB	GB	GB	GB	GB
0.12 µF	124	J	K	M	ER	ER	ER	ER	ER				FN	FN	FN	FN	FN				GB	GB	GB	GB	GB
0.15 µF	154	J	K	M									FQ	FQ	FQ	FQ	FQ				GB	GB	GB	GB	GB
0.18 µF	184	J	K	M									FQ	FQ	FQ	FQ	FQ				GB	GB	GB	GB	GB
0.22 µF	224	J	K	M									FQ	FQ	FQ	FQ	FQ				GB	GB	GB	GB	GB
Capacitance	Cap Code	Rated Voltage (VDC)			6.3	10	16	25	50	100	200	250	6.3	10	16	25	50	100	200	250	25	50	100	200	250
		Voltage Code			9	8	4	3	5	1	2	A	9	8	4	3	5	1	2	A	3	5	1	2	A
		Case Size/ Series			C1206Y								C1210Y								C1812Y				

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

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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 Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[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

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		Packaging Quantities (pieces/unit packaging)	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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.*

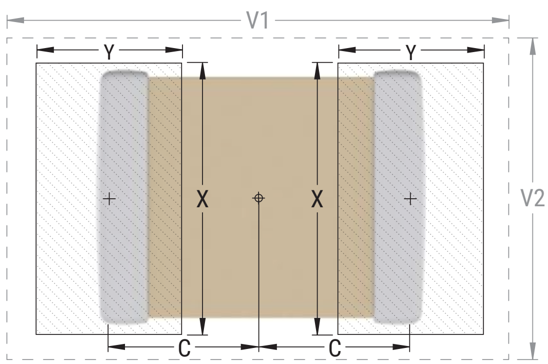
[2] *A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard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

Table 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)				
		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.



Grid Placement Courtyard

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	
	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.

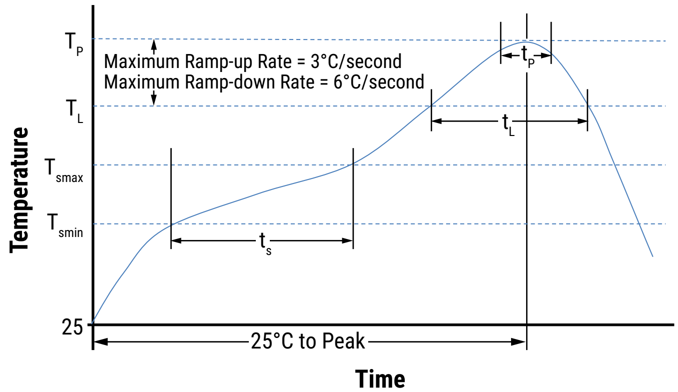


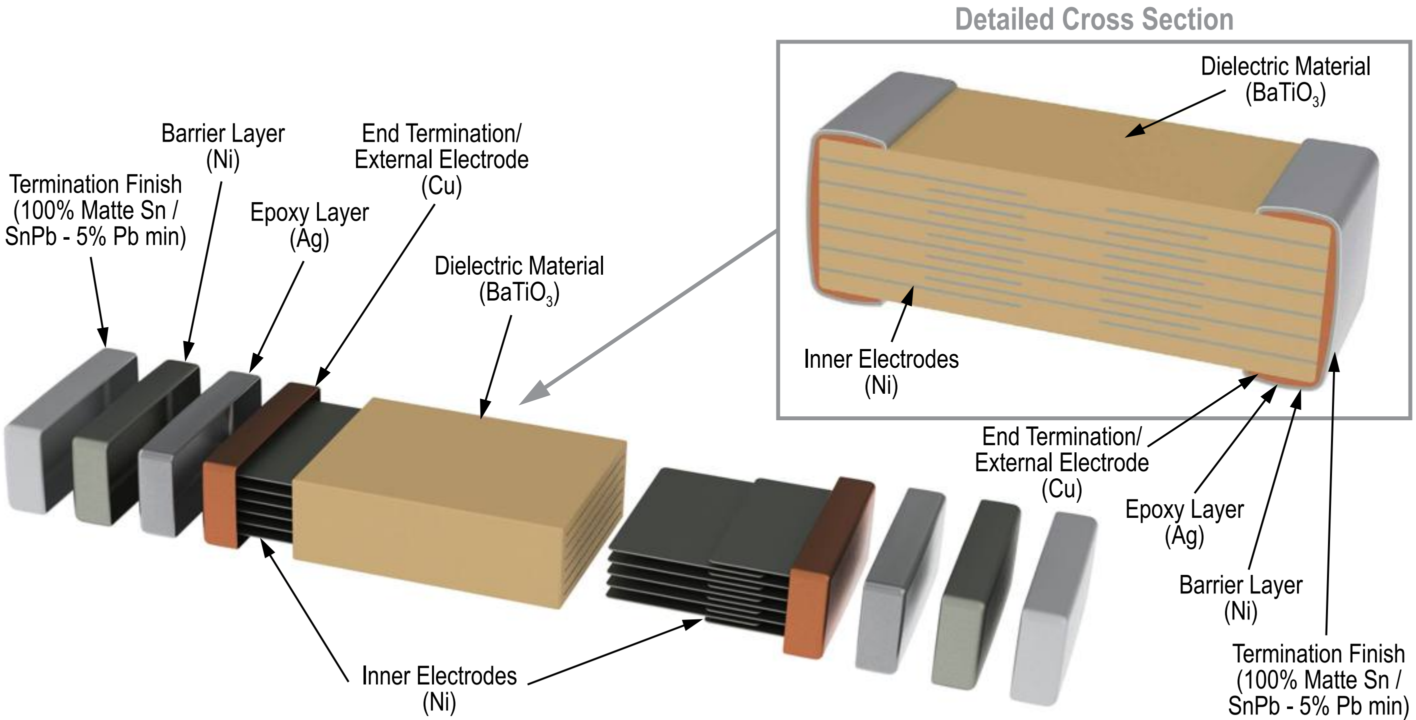
Table 4 – Performance & Reliability: Test Methods and Conditions

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 C0G. 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. 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 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 40ºC 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)

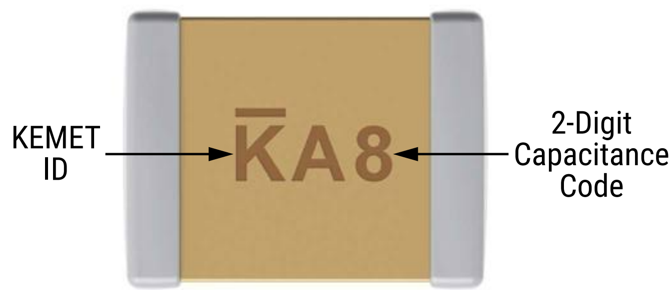
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic 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:

- C0G, 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 µF. Orientation of marking is vendor optional.

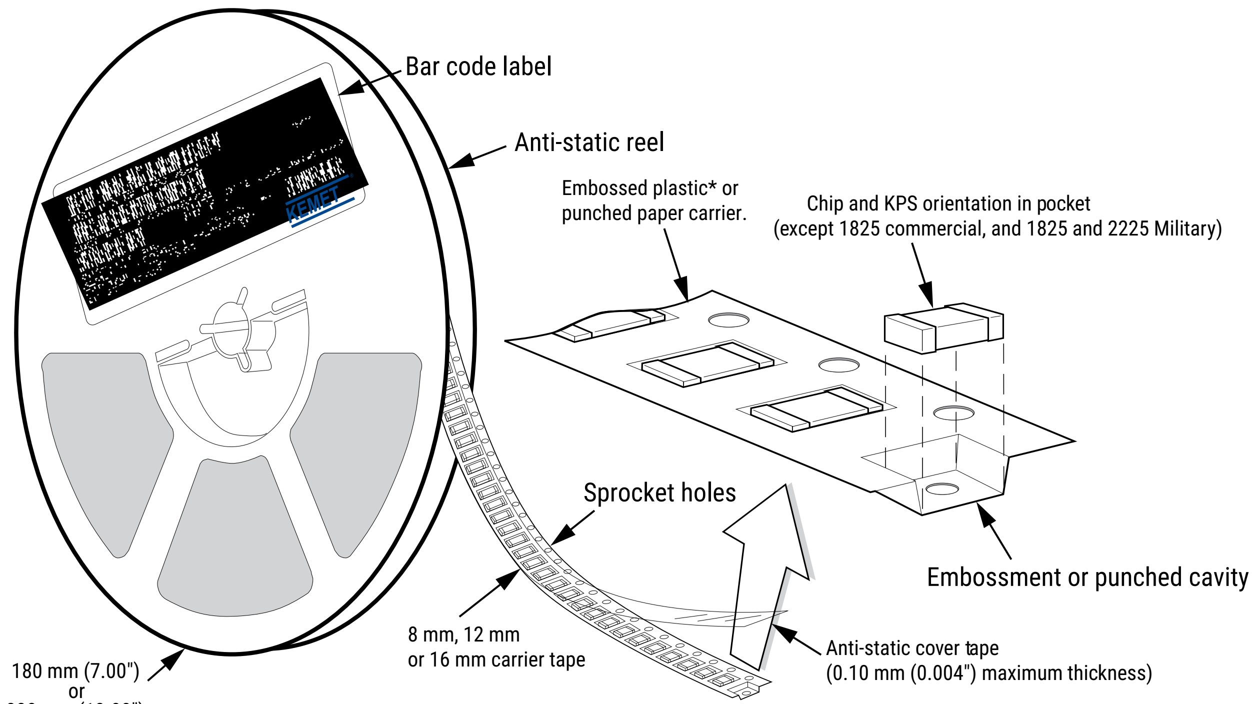


Capacitor Marking (Optional) cont.

Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.10	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

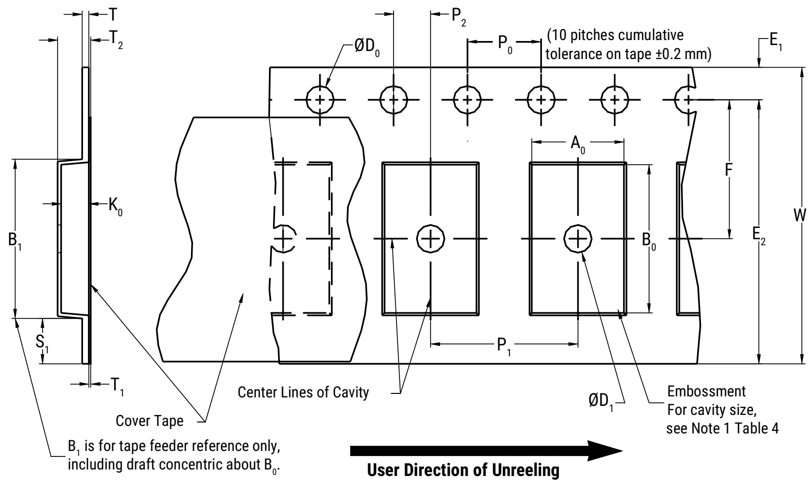


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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 (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)	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 S_1 < 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_0, B_0 and K_0 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

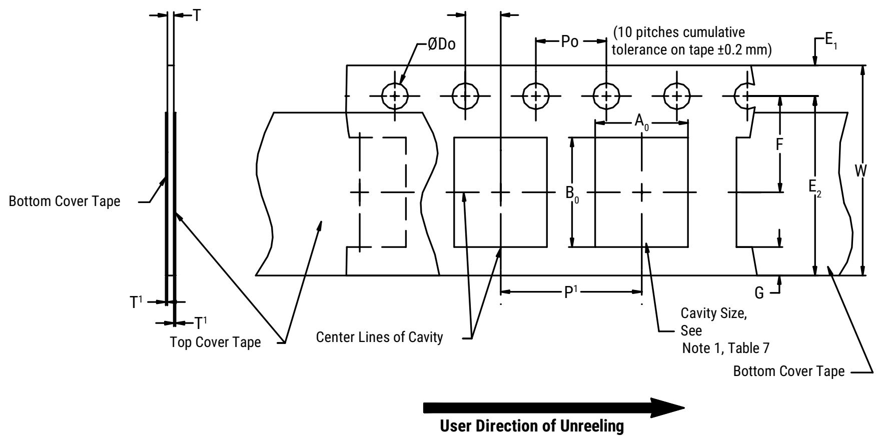


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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

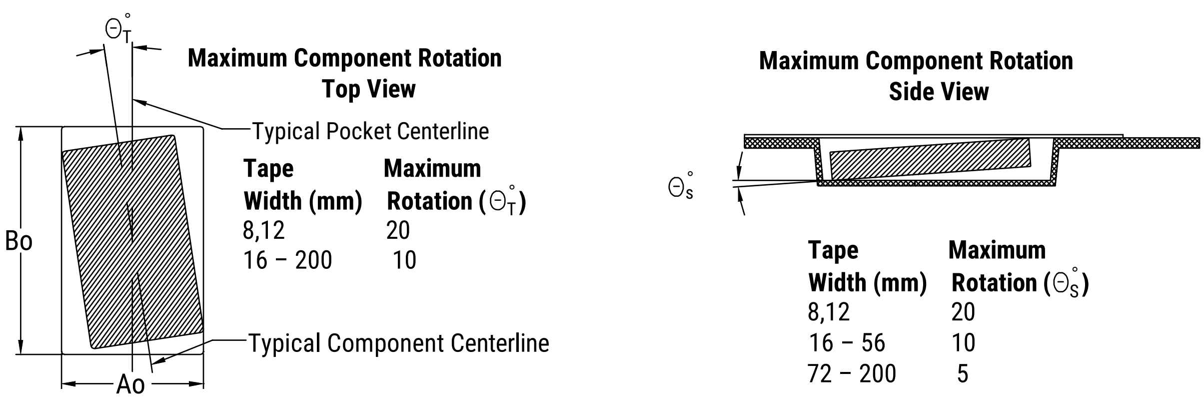


Figure 4 – Maximum Lateral Movement

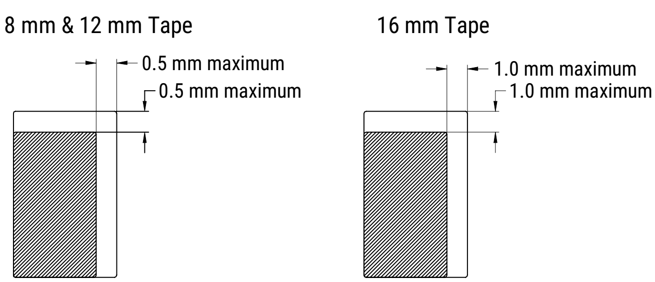


Figure 5 – Bending Radius

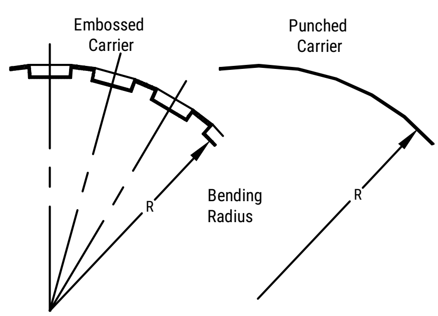
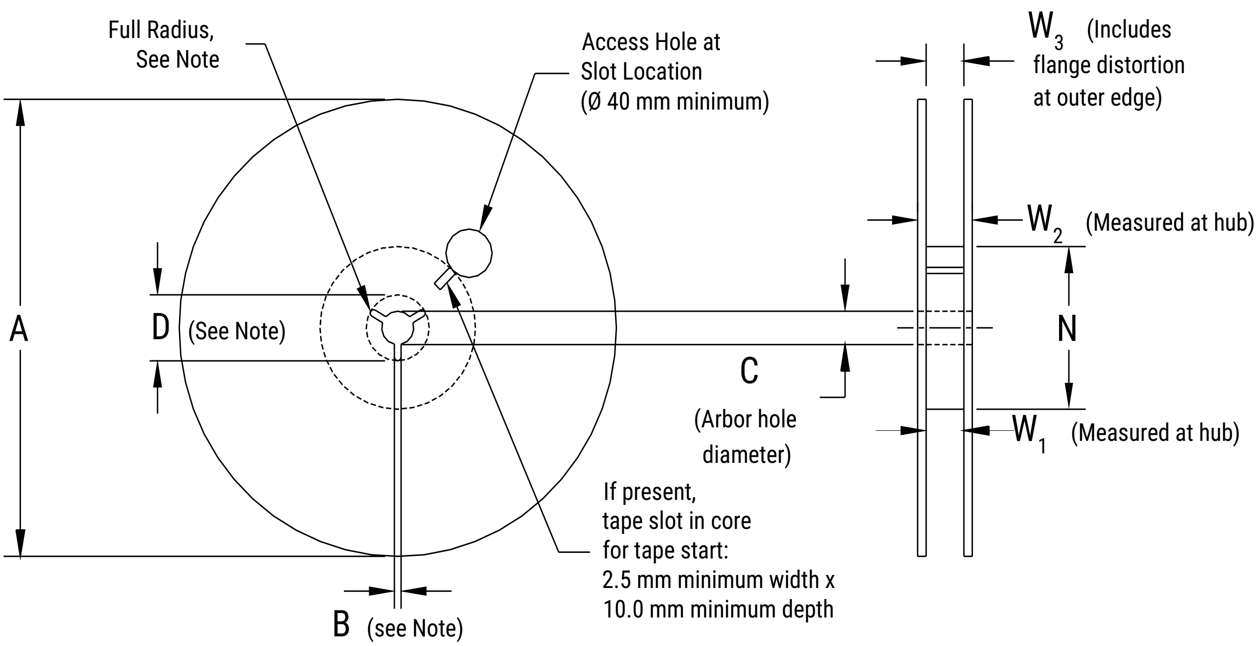


Figure 6 – Reel Dimensions



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	A	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

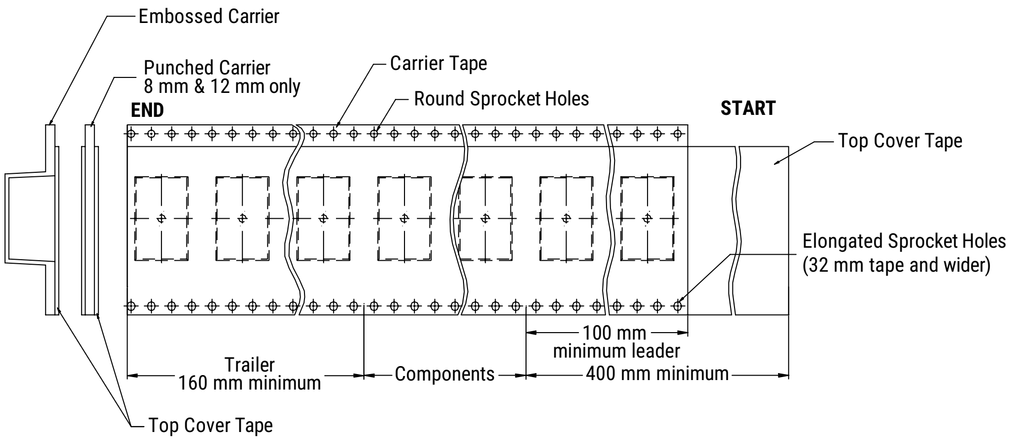
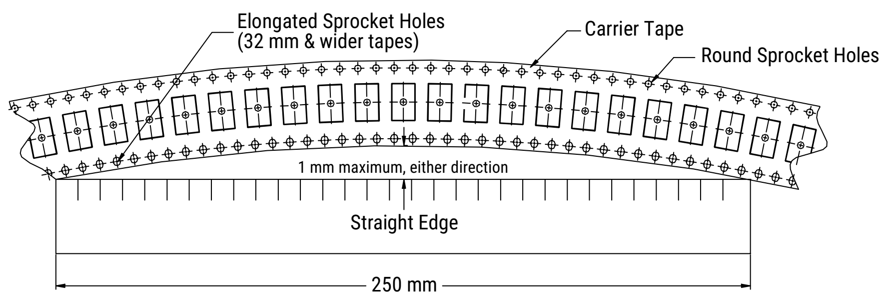


Figure 8 – Maximum Camber



Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs)

Capacitor Array, C0G Dielectric, 10 – 200 VDC (Commercial & Automotive Grade)

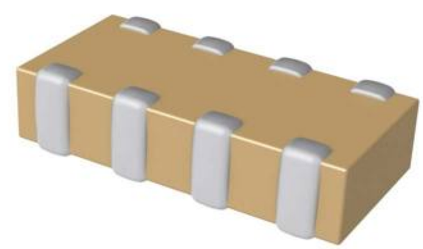
Overview

KEMET's Ceramic Chip Capacitor Array in C0G 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 C0G dielectric features a 125°C maximum operating temperature and is considered "stable." The Electronics Industries Alliance (EIA) characterizes C0G 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. C0G 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	A	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 = C0G	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)
Commercial Grade[1]	
Bulk Bag	Not Required (Blank)
7" Reel/Unmarked	TU
13" Reel/Unmarked	7210
Automotive Grade[2]	
7" Reel	AUTO
13" Reel/Unmarked	AUTO7210

[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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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.

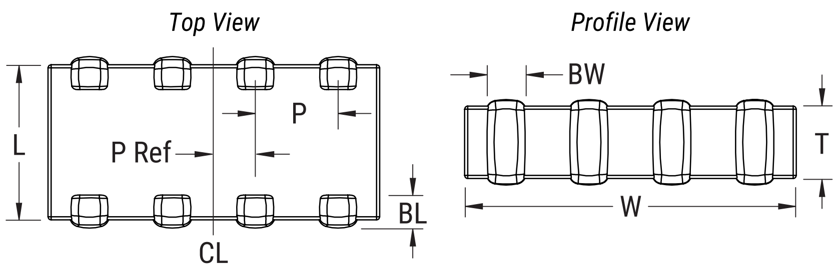
KEMET Automotive C-Spec	PPAP (Product Part Approval Process) Level				
	1	2	3	4	5
KEMET assigned[1]	●	●	●	●	●
AUTO			○		

[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)

0612 (4-CAP)



EIA Size Code	Metric Size Code	L Length	W Width	BW Bandwidth	BL Bandlength	T Thickness	P Pitch	P 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 ≤ 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 MΩ-µF value by the capacitance and compare to GΩ 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
C0G	All	All	0.5	0.3% or ±0.25 pF	10% of Initial Limit

Table 1 – Capacitance Range/Selection Waterfall (0612 Case Size)

Capacitance	Capacitance Code	Case Size/ Series			C0612X (CA064X 4-Cap Case Size)					
		Voltage Code			8	4	3	5	1	2
		Rated Voltage (VDC)			10	16	25	50	100	200
		Capacitance Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions					
10 pF	100	J	K	M	MA	MA	MA	MA	MA	MA
12 pF	120	J	K	M	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	M	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	M	MA	MA	MA	MA		
470 pF	471	J	K	M	MA	MA	MA	MA		
Capacitance	Capacitance Code	Rated Voltage (VDC)			10	16	25	50	100	200
		Voltage Code			8	4	3	5	1	2
		Case Size/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 Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
MA	0612	0.80 ±0.10	4,000	10,000	0	0

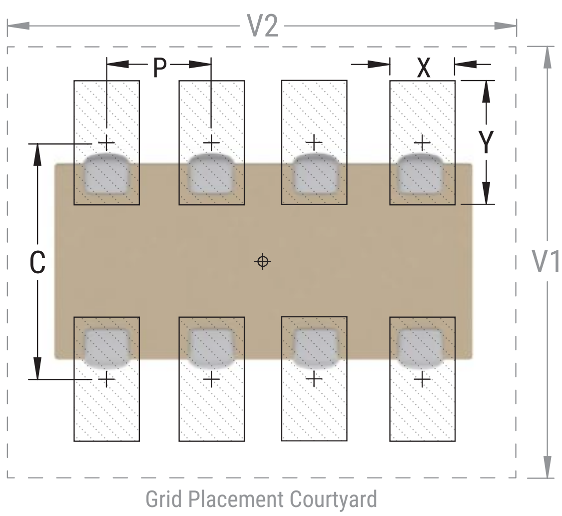
Package quantity based on finished chip thickness specifications.

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

EIA SIZE CODE	METRIC SIZE 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)					
		C	Y	X	P	V1	V2	C	Y	X	P	V1	V2	C	Y	X	P	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	Termination Finish	
	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.

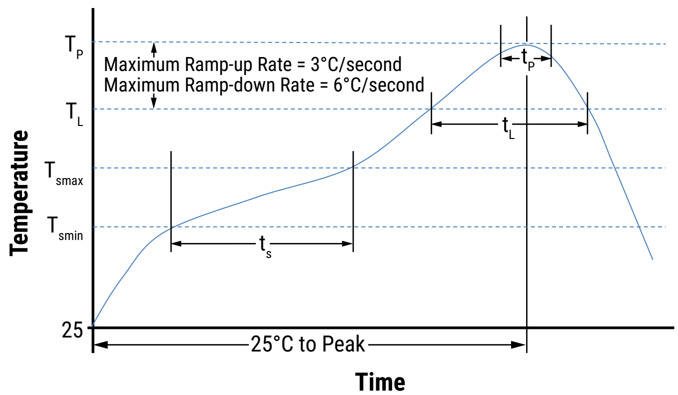


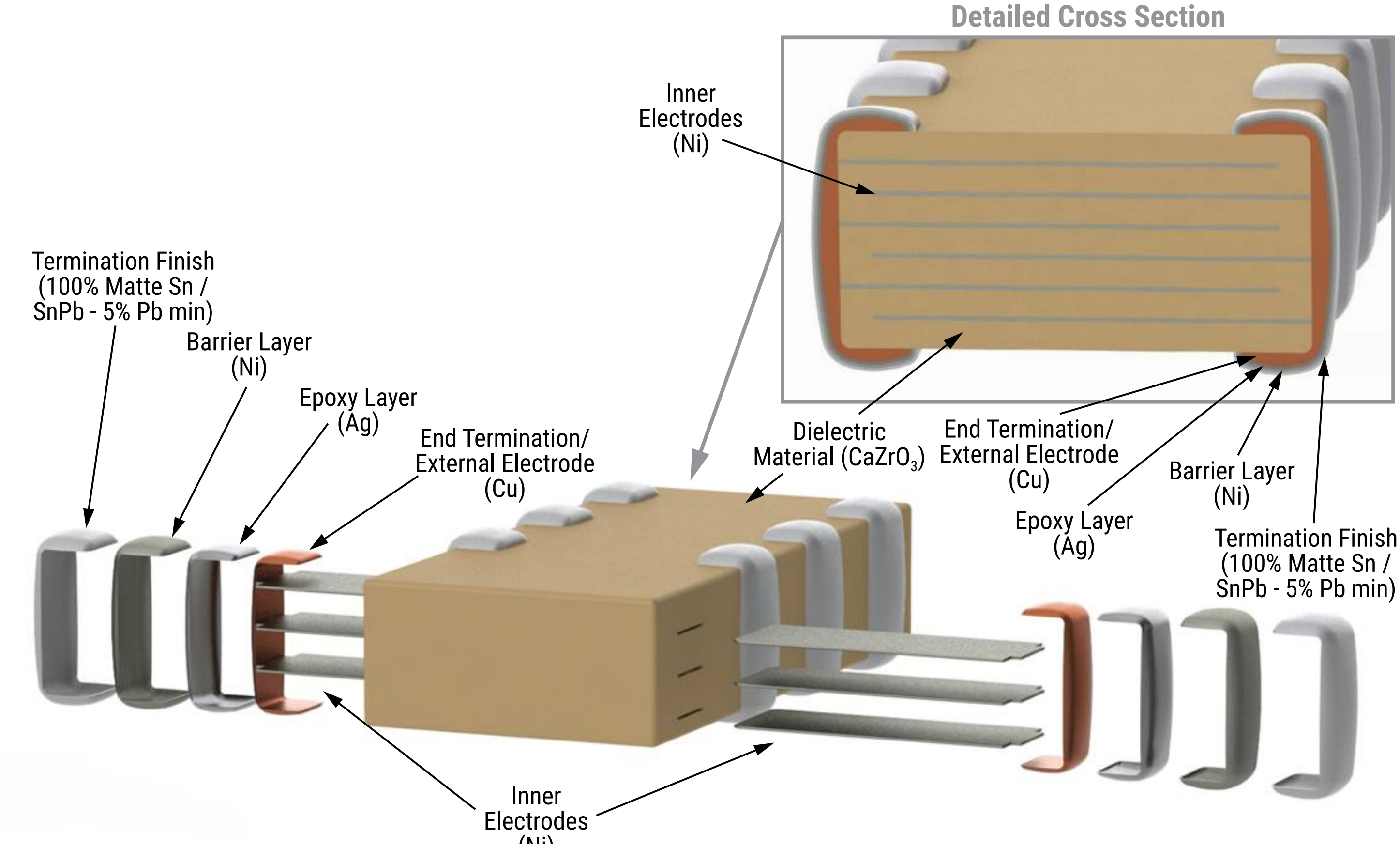
Table 4 – Performance & Reliability: Test Methods & Conditions

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 C0G. 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. 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):

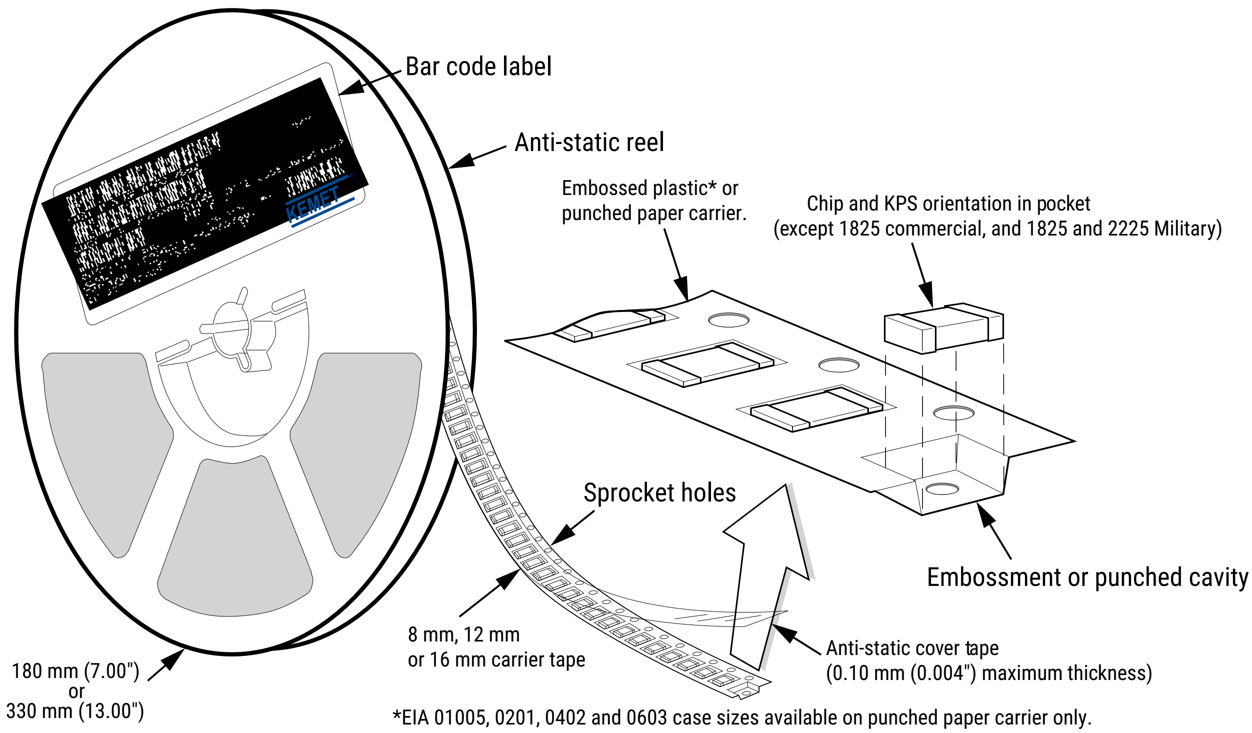
Laser marking option is not available on:

- C0G, 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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

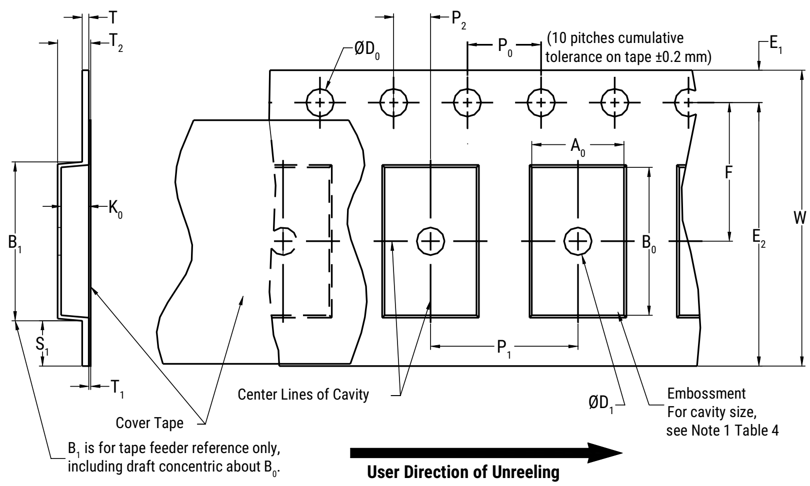


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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 (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)	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 S_1 < 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_0, B_0 and K_0 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

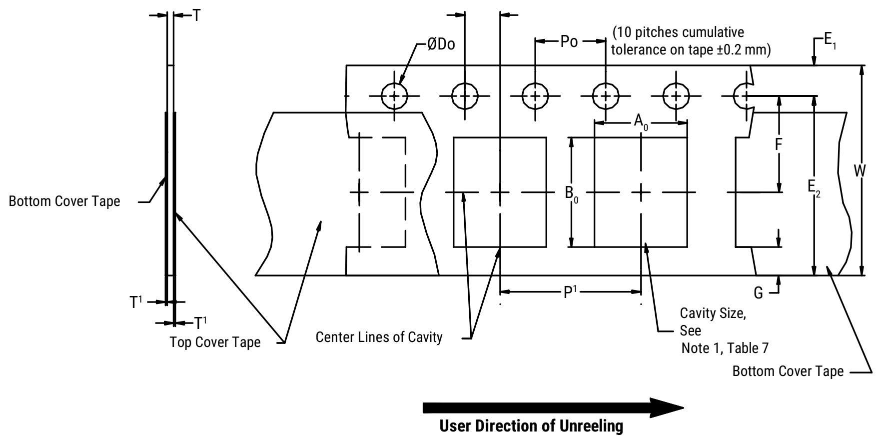


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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

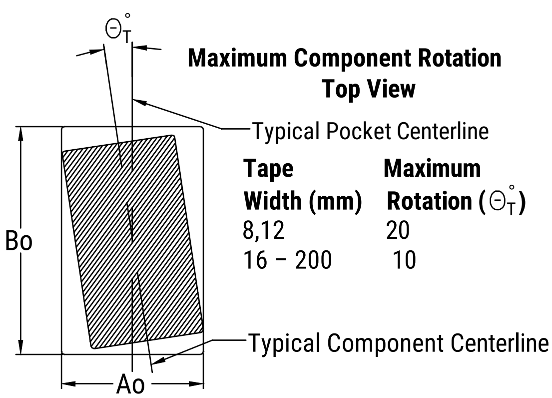
1. Cover Tape Break Force: 1.0 kg minimum.
2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

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



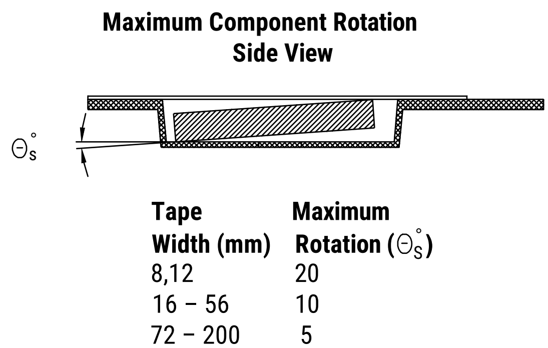


Figure 4 – Maximum Lateral Movement

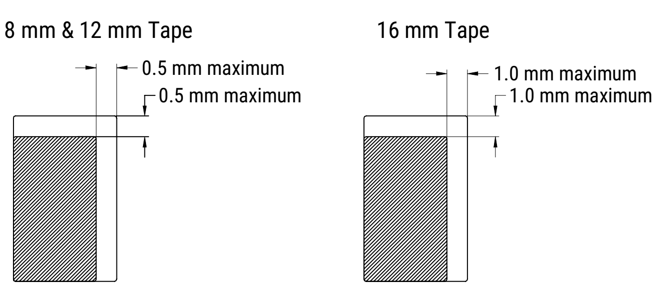


Figure 5 – Bending Radius

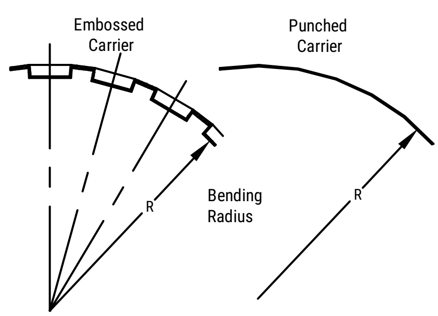
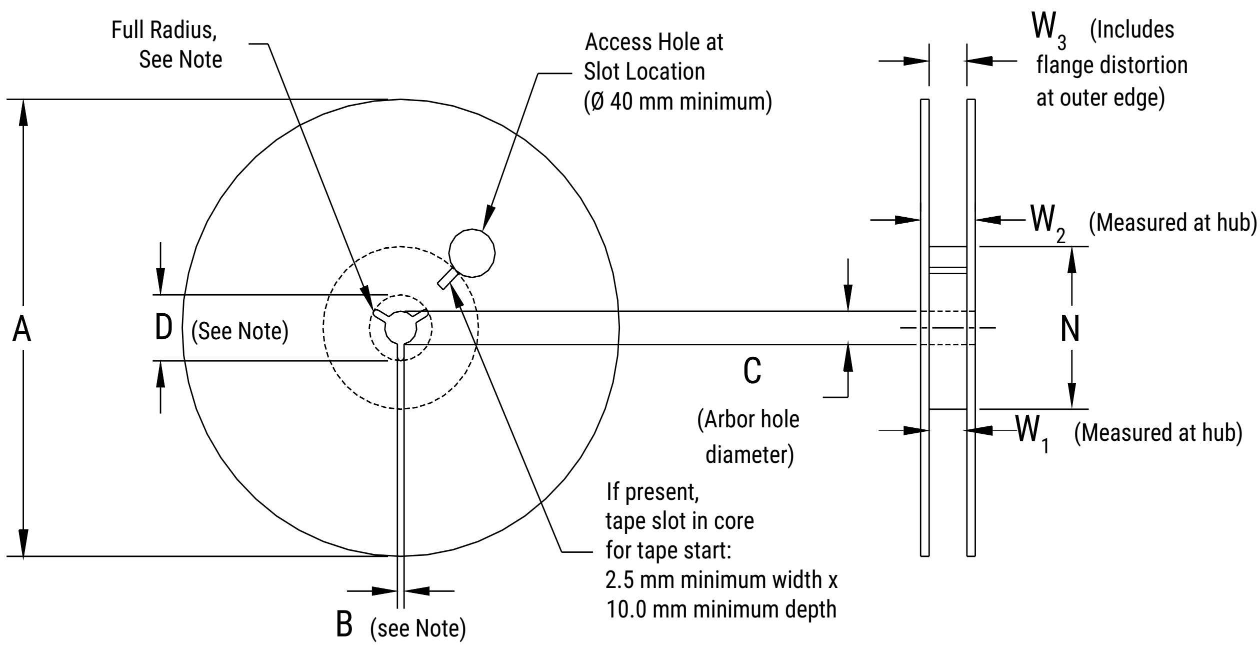


Figure 6 – Reel Dimensions



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	A	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

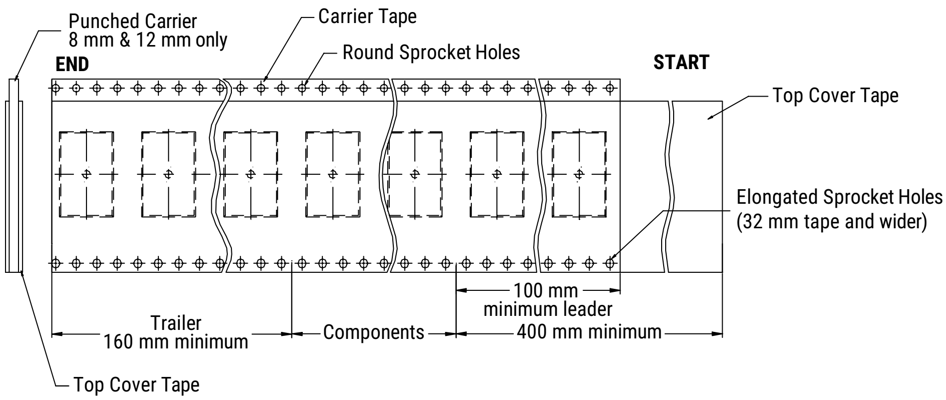
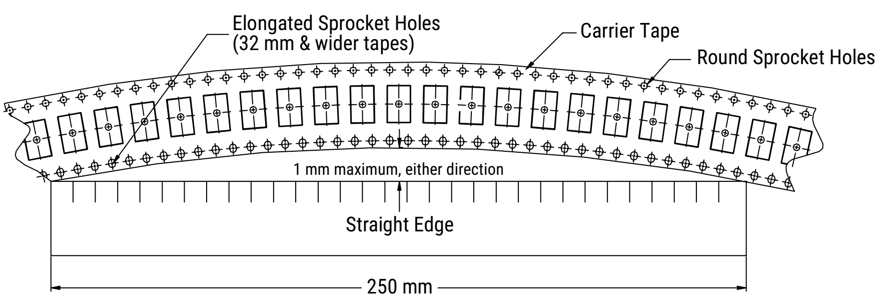


Figure 8 – Maximum Camber



Capacitor Array, X7R Dielectric, 10 – 200 VDC (Commercial & Automotive Grade)

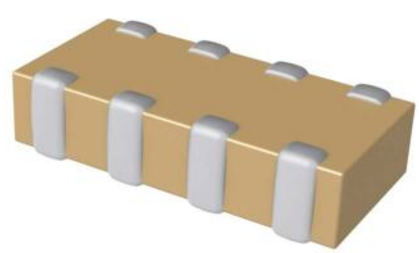
Overview

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 ±15% 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	R	A	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)
Commercial Grade[1]	
Bulk Bag	Not Required (Blank)
7" Reel/Unmarked	TU
13" Reel/Unmarked	7210
Automotive Grade[2]	
7" Reel	AUTO
13" Reel/Unmarked	AUTO7210

[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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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			○		

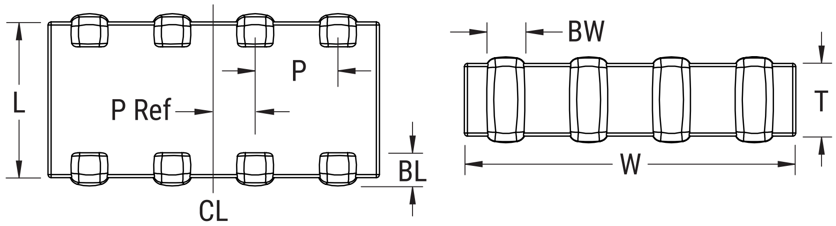
[1] *KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.*

● Part number specific PPAP available
○ Product family PPAP only

Dimensions – Millimeters (Inches)

0612 (4-CAP)

Top View *Profile View*



EIA Size Code	Metric Size Code	L Length	W Width	BW Bandwidth	BL Bandlength	T Thickness	P Pitch	P 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
[4]Insulation 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_{rms} if capacitance ≤ 10 µF
120 Hz ±10Hz and 0.5 ±0.1 V_{rms} if capacitance > 10 µF
[4] *To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ 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
X7R	< 16	All	7.5	±20%	10% of Initial Limit
	16/25	All	5.0		
	50	≤ 0.02 µF	3.0		
		> 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
	> 0.022 µF	3.5
> 50	All	2.5

Table 1 – Capacitance Range/Selection Waterfall (0612 Case Size)

Capacitance	Capacitance Code	Case Size/Series			C0612C/X (CA064C/X 4-Cap Case Size)					
		Voltage Code			8	4	3	5	1	2
		Rated Voltage (VDC)			10	16	25	50	100	200
		Capacitance Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions					
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	M	MA	MA	MA	MA	MA	MA
2,200 pF	222	J	K	M	MA	MA	MA	MA	MA	MA
2,700 pF	272	J	K	M	MA	MA	MA	MA	MA	MA
3,300 pF	332	J	K	M	MA	MA	MA	MA	MA	MA
3,900 pF	392	J	K	M	MA	MA	MA	MA	MA	MA
4,700 pF	472	J	K	M	MA	MA	MA	MA	MA	MA
5,600 pF	562	J	K	M	MA	MA	MA	MA	MA	MA
6,800 pF	682	J	K	M	MA	MA	MA	MA	MA	MA
8,200 pF	822	J	K	M	MA	MA	MA	MA	MA	MA
10,000 pF	103	J	K	M	MA	MA	MA	MA	MA	MA
12,000 pF	123	J	K	M	MA	MA	MA	MA	MA	
15,000 pF	153	J	K	M	MA	MA	MA	MA	MA	
18,000 pF	183	J	K	M	MA	MA	MA	MA	MA	
22,000 pF	223	J	K	M	MA	MA	MA	MA	MA	
27,000 pF	273	J	K	M	MA	MA	MA	MA		
33,000 pF	333	J	K	M	MA	MA	MA	MA		
39,000 pF	393	J	K	M	MA	MA	MA	MA		
47,000 pF	473	J	K	M	MA	MA	MA	MA		
56,000 pF	563	J	K	M	MA	MA	MA			
68,000 pF	683	J	K	M	MA	MA				
82,000 pF	823	J	K	M	MA	MA				
0.10 µF	104	J	K	M	MA	MA				
Capacitance	Capacitance Code	Rated Voltage (VDC)			10	16	25	50	100	200
		Voltage Code			8	4	3	5	1	2
		Case Size/Series			C0612C/X (CA064C/X 4-Cap Case Size)					

Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
MA	0612	0.80 ±0.10	4,000	10,000	0	0

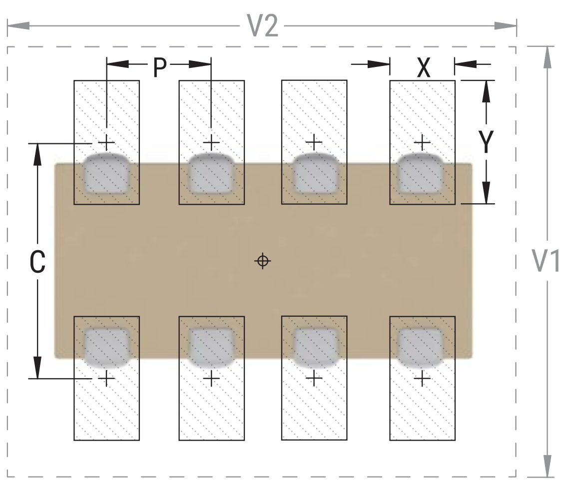
Package quantity based on finished chip thickness specifications.

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

EIA SIZE CODE	METRIC SIZE 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)					
		C	Y	X	P	V1	V2	C	Y	X	P	V1	V2	C	Y	X	P	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.



Grid Placement Courtyard

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	Termination Finish	
	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.

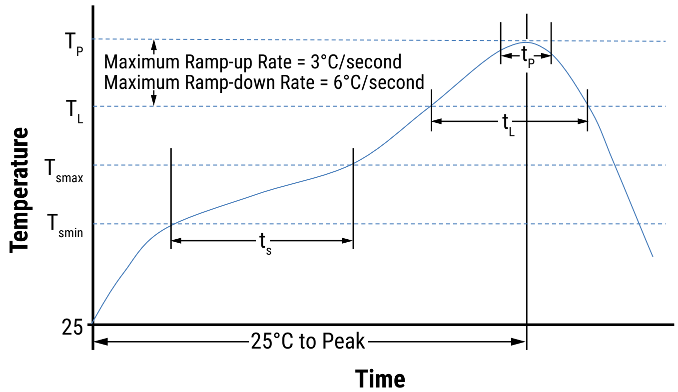


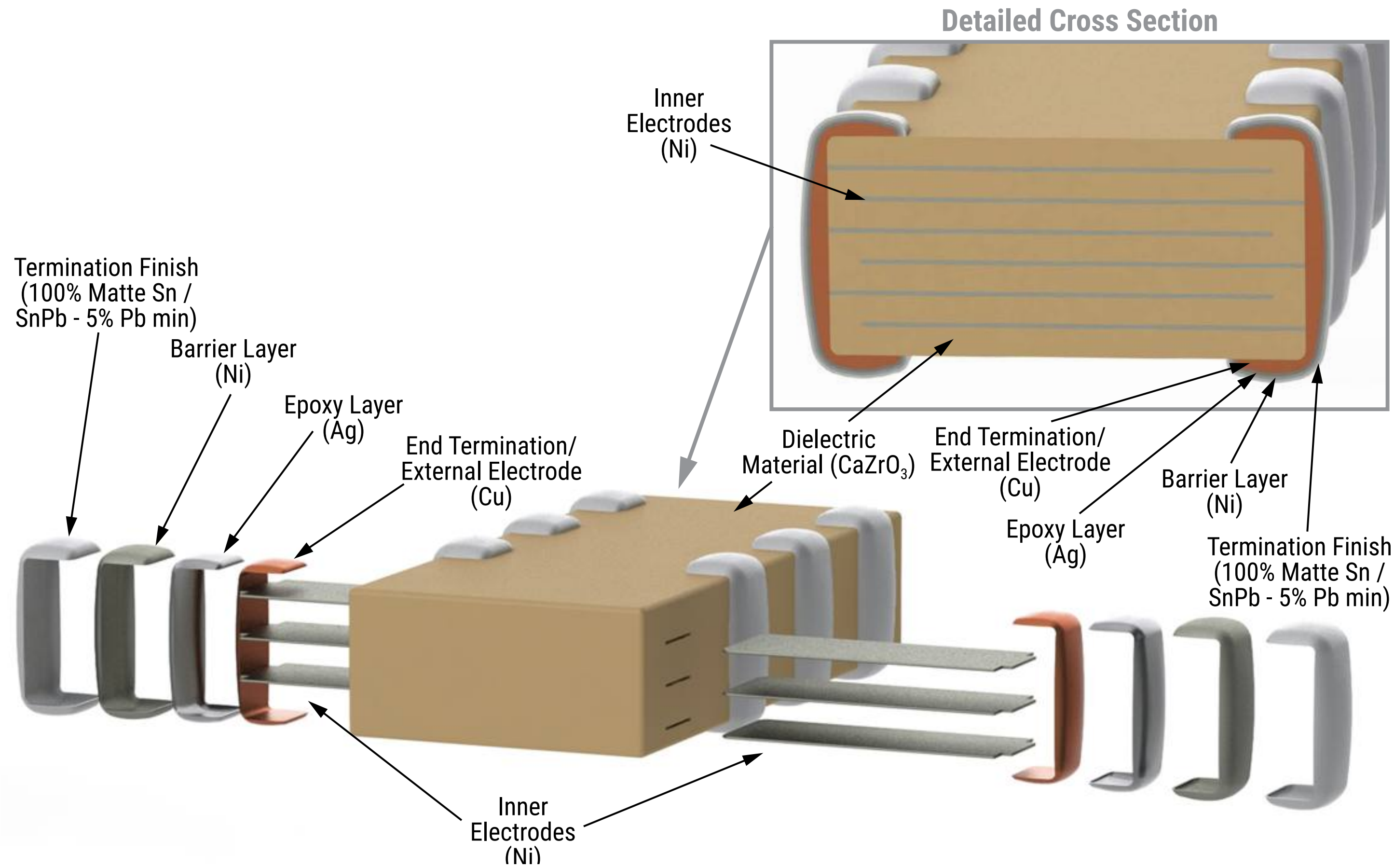
Table 4 – Performance & Reliability: Test Methods and Conditions

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 C0G. 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. 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 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 40ºC 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)

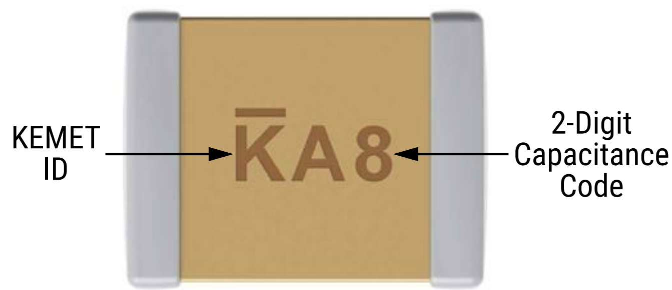
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic 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 <u>not</u> available on:

- C0G, 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 µF. Orientation of marking is vendor optional.

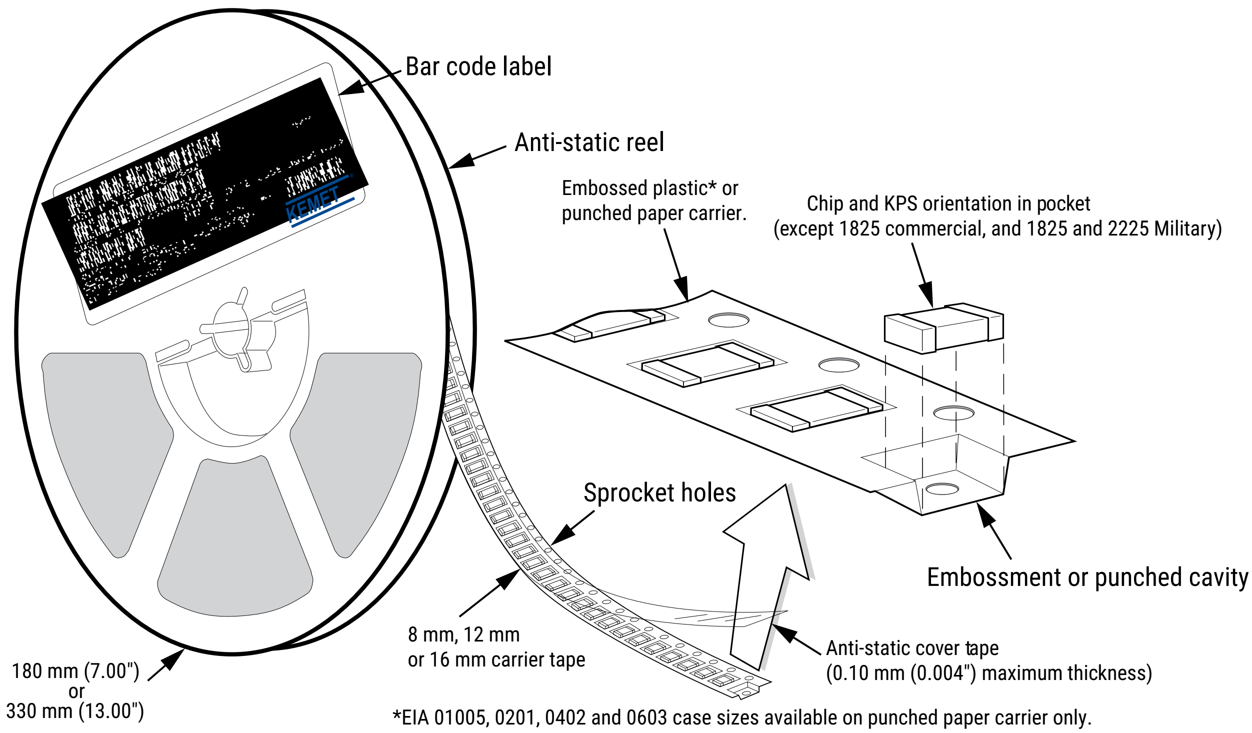


Capacitor Marking (Optional) cont.

Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.10	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

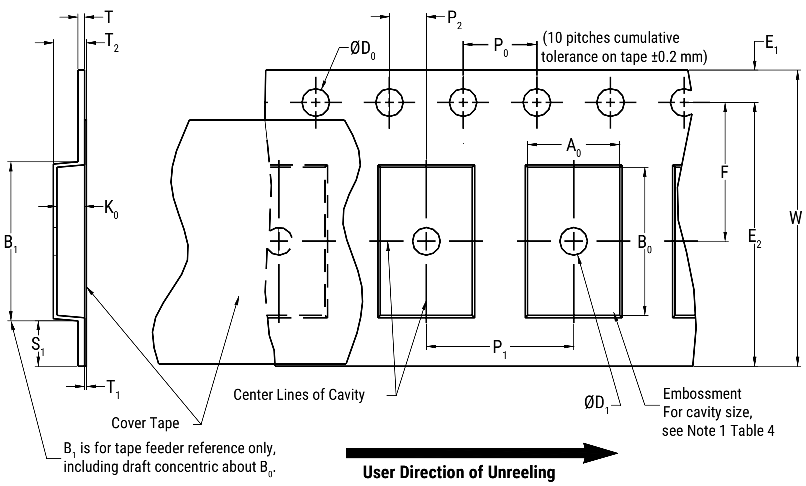


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +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)			
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)	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 S_1 < 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_0, B_0 and K_0 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

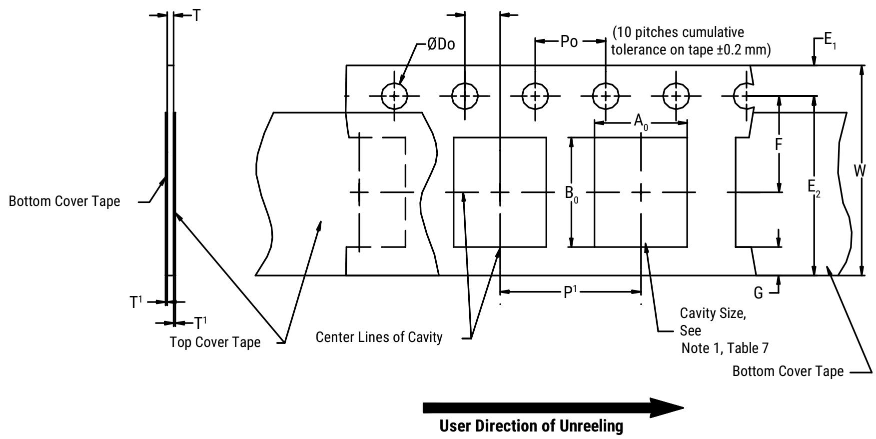


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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

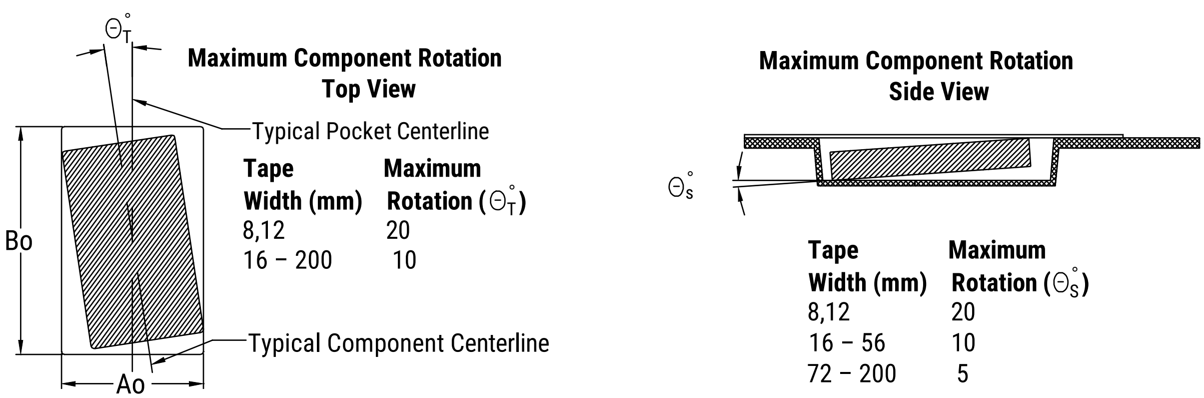


Figure 4 – Maximum Lateral Movement

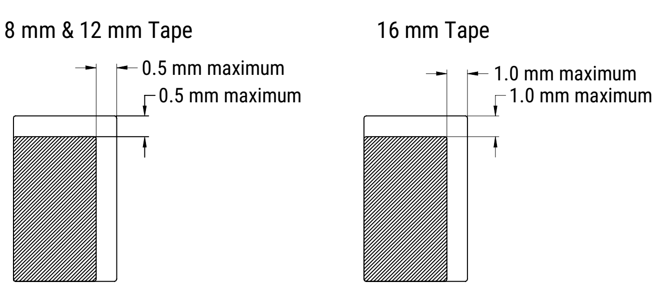


Figure 5 – Bending Radius

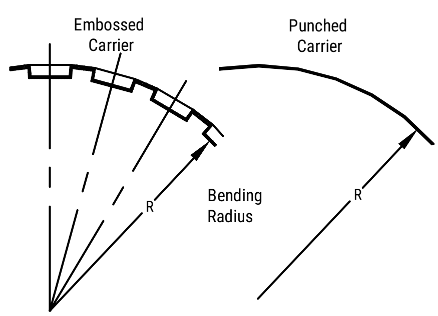
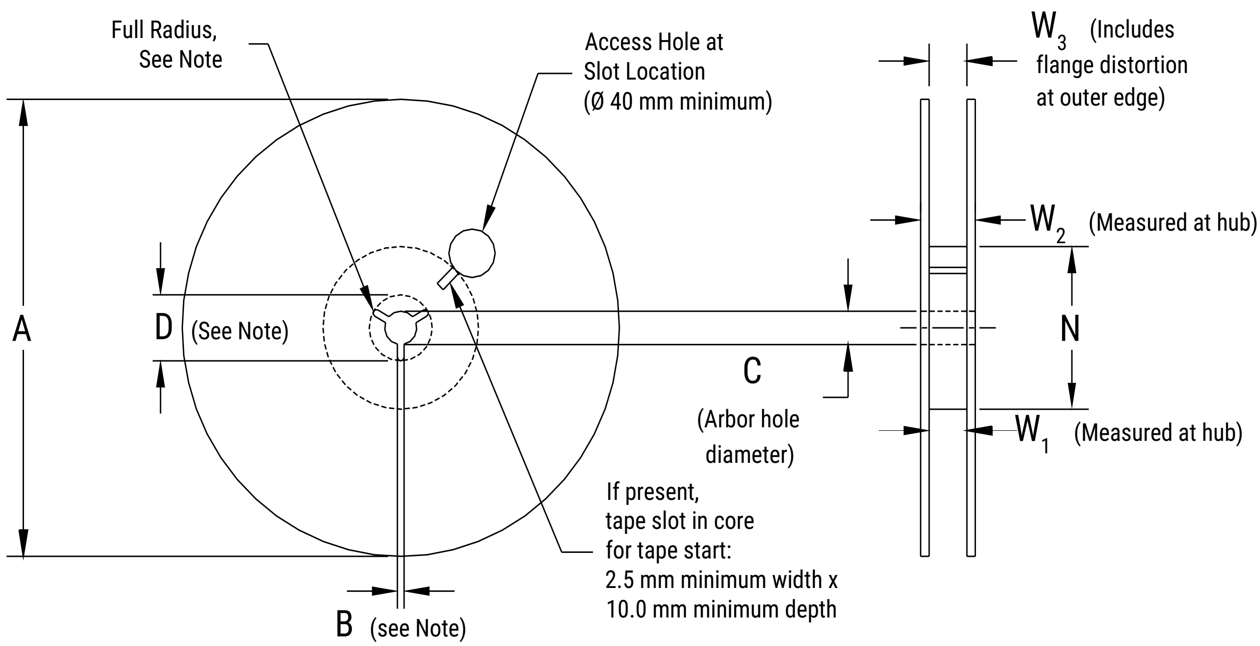


Figure 6 – Reel Dimensions



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	A	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

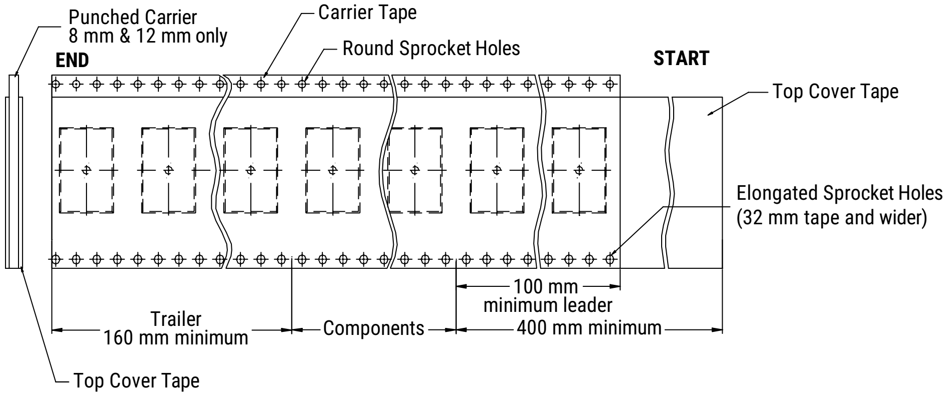
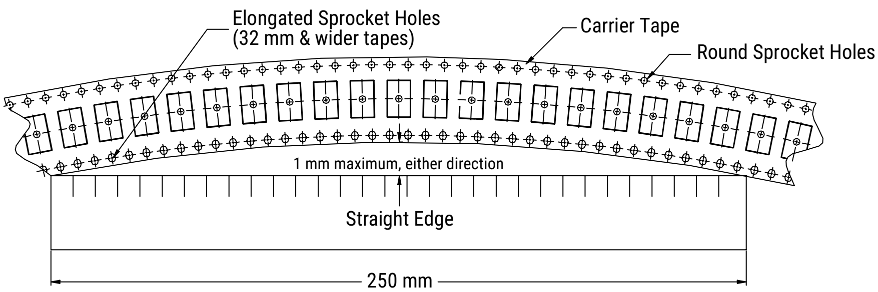


Figure 8 – Maximum Camber



Commercial "L", SnPb Termination, X7R Dielectric 6.3 – 250 VDC (Commercial Grade)

KEMET a YAGEO company

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 ±15% from −55°C to +125°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 μF
- 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

C	1210	C	226	K	8	R	A	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

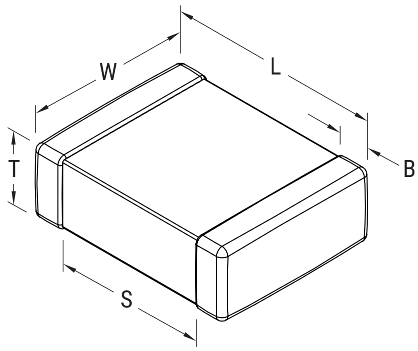
Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)
Bulk Bag/Unmarked	Not required (Blank)
7" Reel/Unmarked	TU
13" Reel/Unmarked	7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes)
7" Reel/Marked	TM
13" Reel/Marked	7040 (EIA 0603) 7215 (EIA 0805 and larger case sizes)
7"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

[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)	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[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)		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)		
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 ≥ 2.2 µF 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 ≤ 10 µF
120 Hz ±10 Hz and 0.5 ±0.1 V_{rms} if capacitance > 10 µF
[4] To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ 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
X7R	> 25	All	3.0	±20%	10% of Initial limit
	16/25		5.0		
	< 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
0603	≤ 200 V	< .047 µF	≥ .047 µF	N/A
	250 V	N/A	N/A	ALL
0805	≤ 200 V	< 0.15 µF	≥ 0.15 µF	N/A
	250 V	< .027 µF	N/A	≥ .027 µF
1206	≤200 V	< 0.47 µF	≥ 0.47 µF	N/A
	250 V	< 0.12 µF	N/A	≥ 0.12 µF
1210	≤200 V	< 0.39 µF	≥ 0.39 µF	N/A
	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)

Cap	Cap Code	Case Size/ Series			C0402C					C0603C								C0805C									C1206C								
		Voltage Code			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
		Rated Voltage (VDC)			6.3	10	16	25	50	6.3	10	16	25	50	100	200	250	6.3	10	16	25	35	50	100	200	250	6.3	10	16	25	35	50	100	200	250
		Capacitance Tolerance			Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions																														
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	DN		EB	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	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	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
1200 pF	122	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
1500 pF	152	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
1800 pF	182	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
2200 pF	222	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
2700 pF	272	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
3300 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	DN	EB	EB	EB	EB	EB	EB	EB	EB	EB
3900 pF	392	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
4700 pF	472	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
5600 pF	562	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
6800 pF	682	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
8200 pF	822	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
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	K	M	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	M	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
18000 pF	183	J	K	M	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	M	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
27000 pF	273	J	K	M	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	M	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	M	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	EC	EB	EB
47000 pF	473	J	K	M	BB	BB	BB	BB		CF	CF	CF	CF	CF	CF			DN	DN	DN	DN	DN	DN	DE	DG	DG	EB	EB	EB	EB	EB	EB	EC	ED	ED
56000 pF	563	J	K	M	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
68000 pF	683	J	K	M	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	M	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	M	BB	BB	BB			CF	CF	CF	CF	CF				DN	DN	DN	DN	DN	DN	DE			EB	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	DP	DG			EC	EC	EC	EC	EC	EC	EC	EG	EM
0.15 µF	154	J	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	K	M						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	DG			EC	EC	EC	EC	EC	EC	EC	EG	EG
0.27 µF	274	J	K	M						CF	CF	CF						DP	DP	DP	DP	DP	DP				EB	EB	EB	EB	EC	EC	EM		
0.33 µF	334	J	K	M						CF	CF	CF						DG	DG	DG	DG	DP	DP				EB	EB	EB	EB	EC	EC	EG		
0.39 µF	394	J	K	M						CF	CF	CF						DG	DG	DG	DG	DE	DE				EB	EB	EB	EB	EC	EC	EG		
0.47 µF	474	J	K	M						CF	CF	CF						DG	DG	DG	DG	DE	DE				EC	EC	EC	EC	EC	EC	EG		
0.56 µF	564	J	K	M														DP	DP	DP	DG	DH	DH				ED	ED	ED	ED	EC	EC	EM		
0.68 µF	684	J	K	M														DP	DP	DP	DG	DH	DH				EE	EE	EE	EE	ED	ED	EM		
0.82 µF	824	J	K	M														DP	DP	DP	DG						EF	EF	EF	EF	ED	ED	EH		
1 µF	105	J	K	M														DP	DP	DP	DG						EF	EF	EF	EH	ED	ED	EH		
1.2 µF	125	J	K	M														DE	DE	DE							ED	ED	ED	EG	EH	EH			
1.5 µF	155	J	K	M														DG	DG	DG							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	K	M														DG	DG	DG							ED	ED	ED	EF	EH	EH			
2.7 µF	275	J	K	M																							EN	EN	EN	EH					
3.3 µF	335	J	K	M																							ED	ED	ED	EH					
3.9 µF	395	J	K	M																							EF	EF	EF	EH					
4.7 µF	475	J	K	M																							EF	EF	EF	EH					
5.6 µF	565	J	K	M																							EH	EH	EH						
6.8 µF	685	J	K	M																							EH	EH	EH						
8.2 µF	825	J	K	M																							EH	EH	EH						
10 µF	106	J	K	M																							EH	EH	EH						
Cap	Cap Code	Rated Voltage (VDC)			6.3	10	16	25	50	6.3	10	16	25	50	100	200	250	6.3	10	16	25	35	50	100	200	250	6.3	10	16	25	35	50	100	200	250
		Voltage Code			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
		Case Size/ Series			C0402C					C0603C								C0805C									C1206C								

**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)

Cap	Cap Code	Case Size/ Series			C1210C								C1805C			C1808C			C1812C				
		Voltage Code			9	8	4	3	5	1	2	A	5	1	2	5	1	2	3	5	1	2	A
		Rated Voltage (VDC)			6.3	10	16	25	50	100	200	250	50	100	200	50	100	200	25	50	100	200	250
		Capacitance Tolerance			Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions																		
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 pF	471	J	K	M	FB	FB	FB	FB	FB	FB	FB		NC	NC	NC	LF	LF	LF	GB	GB	GB	GB	
560 pF	561	J	K	M	FB	FB	FB	FB	FB	FB	FB		NC	NC	NC	LF	LF	LF	GB	GB	GB	GB	
680 pF	681	J	K	M	FB	FB	FB	FB	FB	FB	FB		NC	NC	NC	LF	LF	LF	GB	GB	GB	GB	
820 pF	821	J	K	M	FB	FB	FB	FB	FB	FB	FB		NC	NC	NC	LF	LF	LF	GB	GB	GB	GB	
1,000 pF	102	J	K	M	FB	FB	FB	FB	FB	FB	FB		NC	NC	NC	LF	LF	LF	GB	GB	GB	GB	
1,200 pF	122	J	K	M	FB	FB	FB	FB	FB	FB	FB		NC	NC		LF	LF	LF	GB	GB	GB	GB	
1,500 pF	152	J	K	M	FB	FB	FB	FB	FB	FB	FE		NC	NC		LF	LF	LF	GB	GB	GB	GB	
1,800 pF	182	J	K	M	FB	FB	FB	FB	FB	FB	FE		NC	NC		LF	LF	LF	GB	GB	GB	GB	
2,200 pF	222	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NC	NC		LF	LF	LF	GB	GB	GB	GB	
2,700 pF	272	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA	NA	LF	LF	LF	GB	GB	GB	GB	
3,300 pF	332	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA	NA	LF	LF		GB	GB	GB	GB	
3,900 pF	392	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA	NA	LF	LF		GB	GB	GB	GB	
4,700 pF	472	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA	NA	LD	LD	LD	GB	GB	GB	GD	
5,600 pF	562	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA	NA	LD	LD	LD	GB	GB	GB	GH	
6,800 pF	682	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA		LD	LD	LD	GB	GB	GB	GB	GB
8,200 pF	822	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA		LD	LD	LD	GB	GB	GB	GB	GB
10,000 pF	103	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA		LD	LD	LD	GB	GB	GB	GB	GB
12,000 pF	123	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA		LD	LD	LD	GB	GB	GB	GB	GB
15,000 pF	153	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA		LD	LD	LD	GB	GB	GB	GB	GB
18,000 pF	183	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA		LD	LD	LD	GB	GB	GB	GB	GB
22,000 pF	223	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA		LD	LD		GB	GB	GB	GB	GB
27,000 pF	273	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA		LD	LD		GB	GB	GB	GB	GB
33,000 pF	333	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA			LD	LD		GB	GB	GB	GB	GB
39,000 pF	393	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA			LD	LD		GB	GB	GB	GB	GB
47,000 pF	473	J	K	M	FB	FB	FB	FB	FB	FB	FC	FC	NA			LD	LD		GB	GB	GB	GB	GB
56,000 pF	563	J	K	M	FB	FB	FB	FB	FB	FB	FC	FC	NA			LD	LD		GB	GB	GB	GB	GB
68,000 pF	683	J	K	M	FB	FB	FB	FB	FB	FB	FC	FC	NA			LD			GB	GB	GB	GB	GB
82,000 pF	823	J	K	M	FB	FB	FB	FB	FB	FC	FF	FF	NA			LD			GB	GB	GB	GB	GB
0.10 µF	104	J	K	M	FB	FB	FB	FB	FB	FD	FG	FG	NA			LD			GB	GB	GB	GB	GB
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
		Voltage Code			9	8	4	3	5	1	2	A	5	1	2	5	1	2	3	5	1	2	A
		Case Size/ Series			C1210C								C1805C			C1808C			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.

Cap	Cap Code	Case Size/ Series			C1210C								C1805C			C1808C			C1812C				
		Voltage Code			9	8	4	3	5	1	2	A	5	1	2	5	1	2	3	5	1	2	A
		Rated Voltage (VDC)			6.3	10	16	25	50	100	200	250	50	100	200	50	100	200	25	50	100	200	250
		Capacitance Tolerance			Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions																		
0.12 µF	124	J	K	M	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	K	M	FC	FC	FC	FC	FC	FD	FK	FK							GB	GB	GB	GG	GG
0.27 µF	274	J	K	M	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	M	FF	FF	FF	FF	FF	FL									GE	GE	GG		
1.0 µF	105	J	K	M	FH	FH	FH	FH	FH	FM									GE	GE	GG		
1.2 µF	125	J	K	M	FH	FH	FH	FH	FG	FH									GB	GB	GB		
1.5 µF	155	J	K	M	FH	FH	FH	FH	FG	FM									GC	GC	GC		
1.8 µF	185	J	K	M	FH	FH	FH	FH	FG	FJ									GE	GE	GE		
2.2 µF	225	J	K	M	FJ	FJ	FJ	FJ	FG	FK									GO	GO	GG		
2.7 µF	275	J	K	M	FE	FE	FE	FG	FH										GJ	GJ	GJ		
3.3 µF	335	J	K	M	FF	FF	FF	FM	FM										GL	GL	GL		
3.9 µF	395	J	K	M	FG	FG	FG	FG	FK										GK	GK			
4.7 µF	475	J	K	M	FC	FC	FC	FG	FS										GK	GK			
5.6 µF	565	J	K	M	FF	FF	FF	FH															
6.8 µF	685	J	K	M	FG	FG	FG	FM															
8.2 µF	825	J	K	M	FH	FH	FH	FK															
10 µF	106	J	K	M	FH[1]	FH[1]	FH[1]	FS											GK				
15 µF	156	J	K	M	FM	FM																	
22 µF	226	J	K	M	FS	FS																	
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
		Voltage Code			9	8	4	3	5	1	2	A	5	1	2	5	1	2	3	5	1	2	A
		Case Size/ Series			C1210C								C1805C			C1808C			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 1C – Capacitance Range/Selection Waterfall (1825 – 2225 Case Sizes)

Cap	Cap Code	Case Size/ Series			C1825C				C2220C					C2225C			
		Voltage Code			5	1	2	A	3	5	1	2	A	5	1	2	A
		Rated Voltage (VDC)			50	100	200	250	25	50	100	200	250	50	100	200	250
		Capacitance Tolerance			Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions												
3,900 pF	392	J	K	M	HB	HB	HB										
4,700 pF	472	J	K	M	HB	HB	HB							KE	KE	KE	
5,600 pF	562	J	K	M	HB	HB	HB							KE	KE	KE	
6,800 pF	682	J	K	M	HB	HB	HB		JE	JE	JE			KE	KE	KE	
8,200 pF	822	J	K	M	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	M	HB	HB	HB	HB	JE	JE	JE			KE	KE		
33,000 pF	333	J	K	M	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	M	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	M	HB	HB	HB	HB	JB	JB	JB						
82,000 pF	823	J	K	M	HB	HB	HB	HB	JC	JC	JC	JC	JC				
0.10 µF	104	J	K	M	HB	HB	HB	HB	JC	JC	JC	JC	JC	KC	KC	KC	KC
0.12 µF	124	J	K	M	HB	HB	HB	HB	JC	JC	JC	JC	JC	KC	KC	KC	KC
0.15 µF	154	J	K	M	HB	HB	HB	HB	JC	JC	JC	JC	JC	KC	KC	KC	KC
0.18 µF	184	J	K	M	HB	HB	HB	HB	JC	JC	JC	JC	JC	KC	KC	KC	KC
0.22 µF	224	J	K	M	HB	HB	HB	HB	JC	JC	JC	JC	JC	KC	KC	KC	KC
0.27 µF	274	J	K	M	HB	HB	HB	HB	JC	JC	JC	JC	JC	KB	KC	KC	KC
0.33 µF	334	J	K	M	HB	HB	HB	HB	JC	JC	JC	JC	JC	KB	KC	KC	KC
0.39 µF	394	J	K	M	HB	HB	HD	HD	JC	JC	JC	JC	JC	KB	KC	KC	KC
0.47 µF	474	J	K	M	HB	HB	HD	HD	JC	JC	JC	JC	JC	KB	KC	KD	KD
0.56 µF	564	J	K	M	HB	HD	HD	HD	JC	JC	JC	JD	JD	KB	KC	KD	KD
0.68 µF	684	J	K	M	HB	HD	HD	HD	JC	JC	JD	JD	JD	KB	KC	KD	KD
0.82 µF	824	J	K	M	HB	HF	HF	HF	JC	JC	JF	JF	JF	KB	KC	KE	KE
1.0 µF	105	J	K	M	HB	HF	HF	HF	JC	JC	JF	JF	JF	KB	KD	KE	KE
1.2 µF	125	J	K	M	HB				JC	JC				KB	KE	KE	KE
1.5 µF	155	J	K	M	HC				JC	JC				KC			
1.8 µF	185	J	K	M	HD				JD	JD				KD			
2.2 µF	225	J	K	M	HF				JF	JF				KD			
4.7 µF	475								JF	JF							
10 µF	106								JF	JO							
15 µF	156								JO	JO							
22 µF	226								JO								
Cap	Cap Code	Rated Voltage (VDC)			50	100	200	250	25	50	100	200	250	50	100	200	250
		Voltage Code			5	1	2	A	3	5	1	2	A	5	1	2	A
		Case Size/ Series			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).
**Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68 and 82).

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

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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 Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[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 2A – Chip Thickness/Tape & Reel Packaging Quantities cont.

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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 Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[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

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		**Packaging Quantities (pieces/unit packaging)**	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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.*

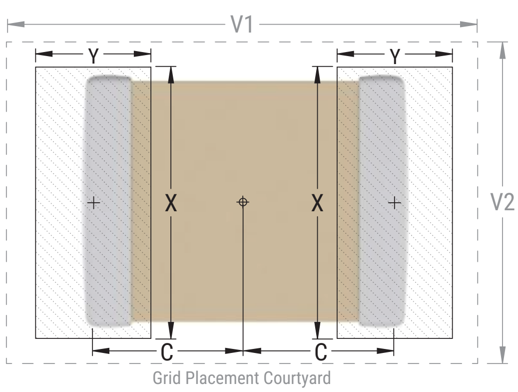
[2] *A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding anti-static Bulk Bag and automotive grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard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

Table 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)				
		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 ≥ 22 µF*
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	Termination Finish	
	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.

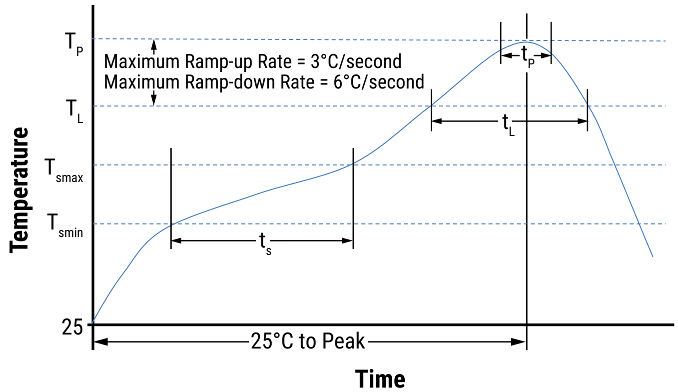


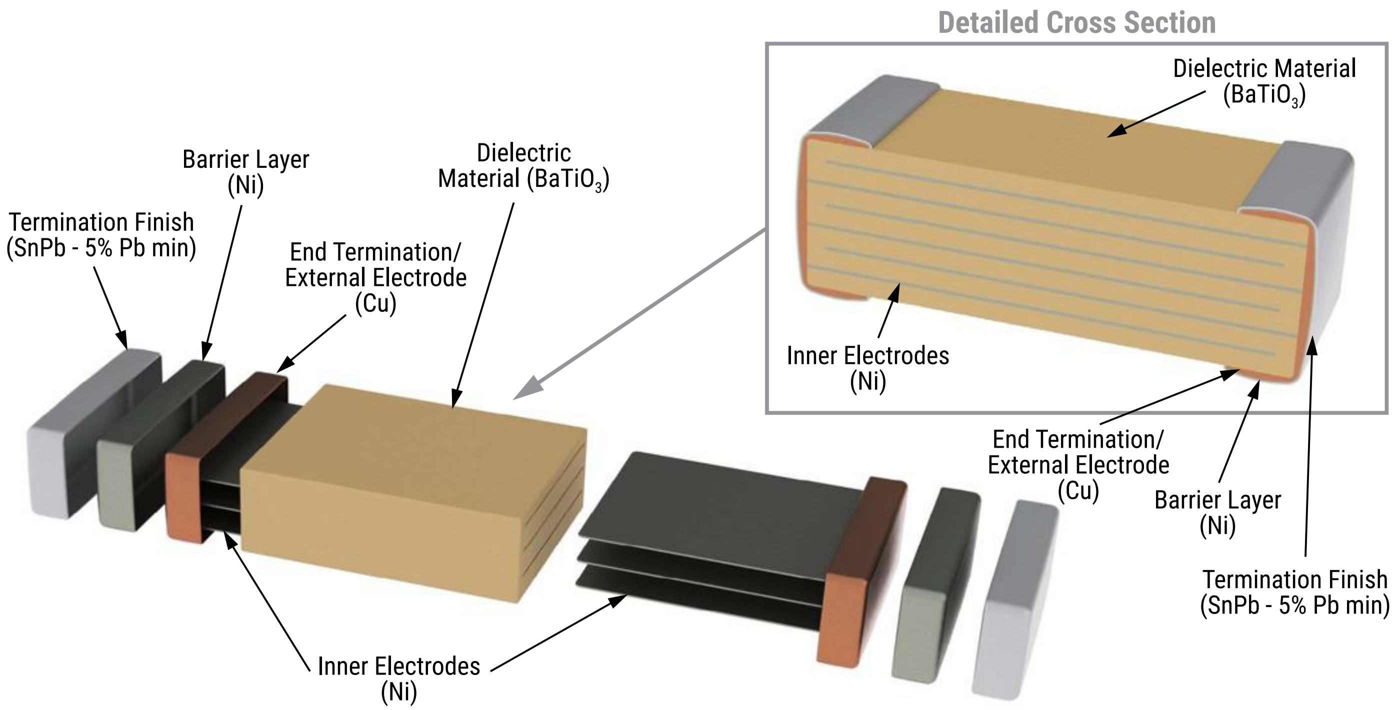
Table 4 – Performance & Reliability: Test Methods and Conditions

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 C0G. 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, 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.
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)

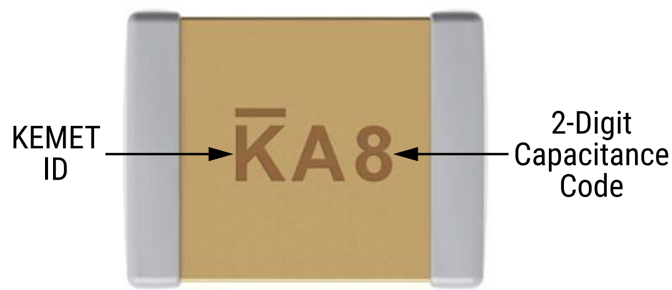
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic 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:

- C0G, 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 μF. Orientation of marking is vendor optional.

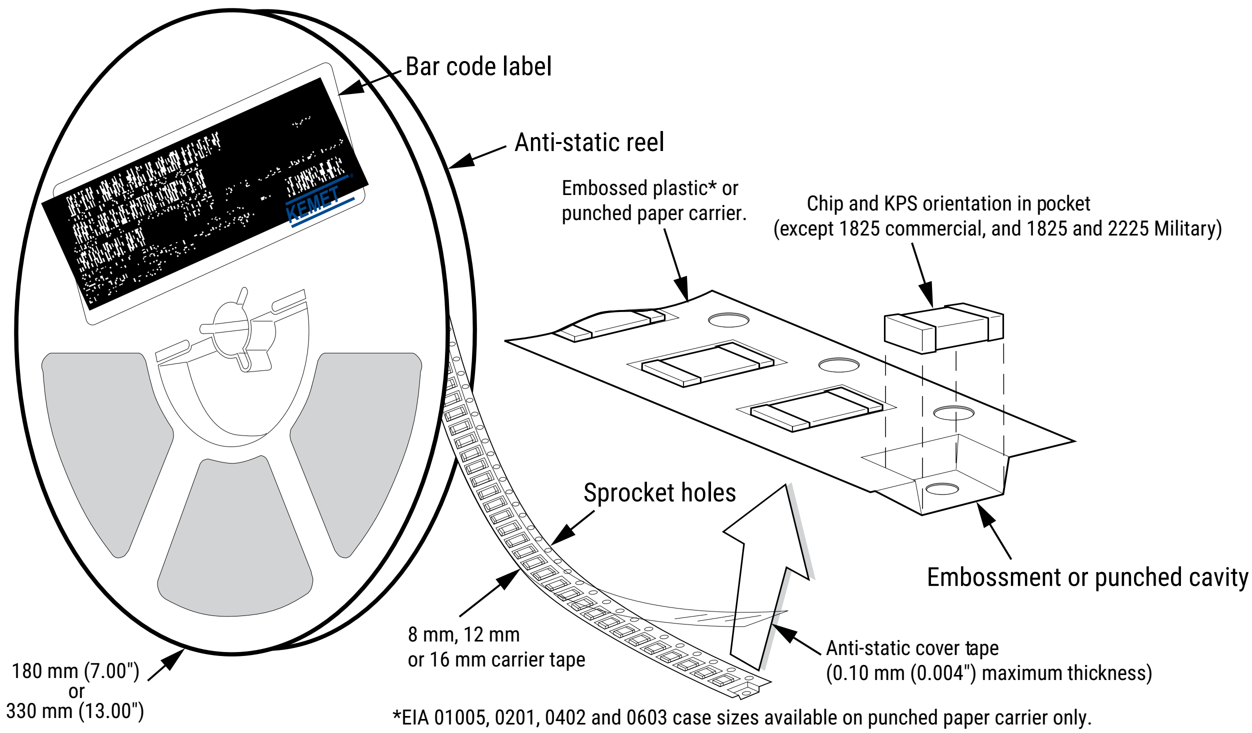


Capacitor Marking (Optional) cont.

Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.10	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

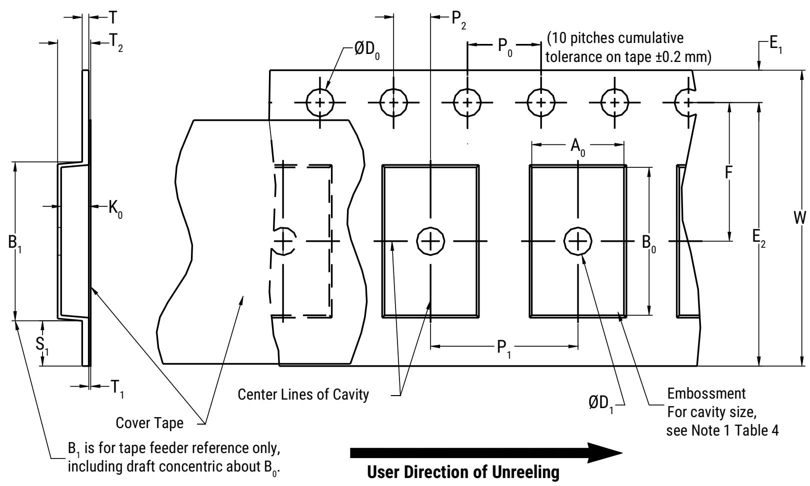


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +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)			
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)	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 S_1 < 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_0, B_0 and K_0 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

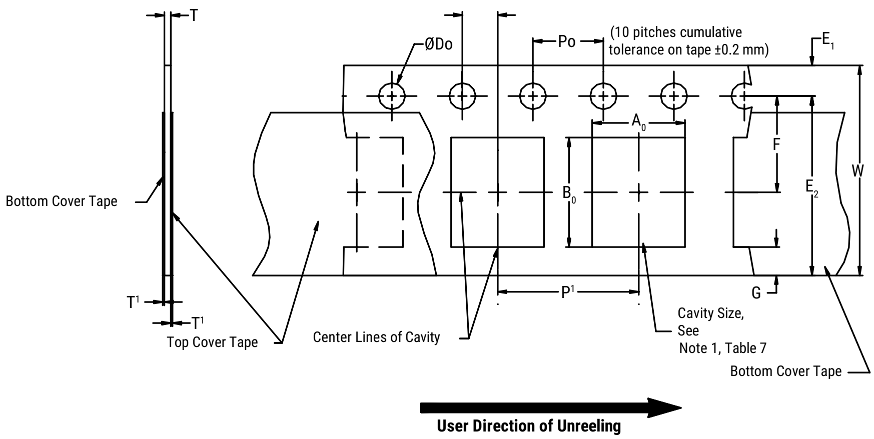


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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.)

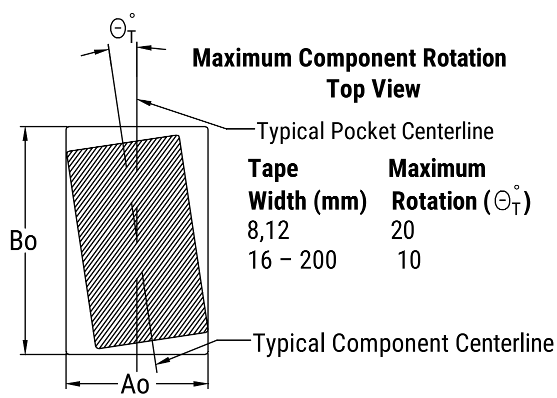
Packaging Information Performance Notes

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



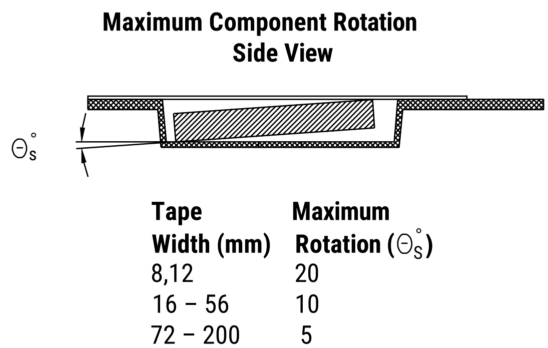


Figure 4 – Maximum Lateral Movement

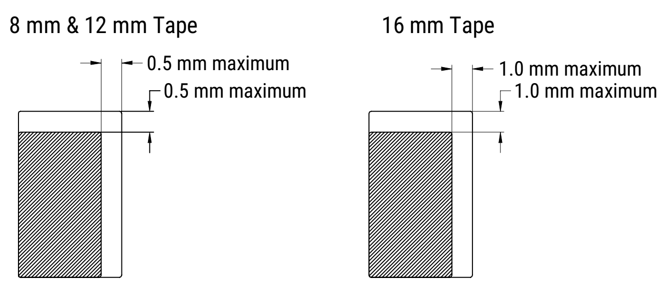


Figure 5 – Bending Radius

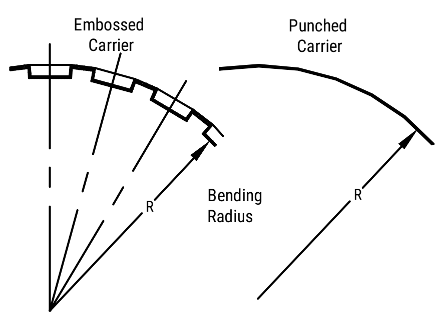
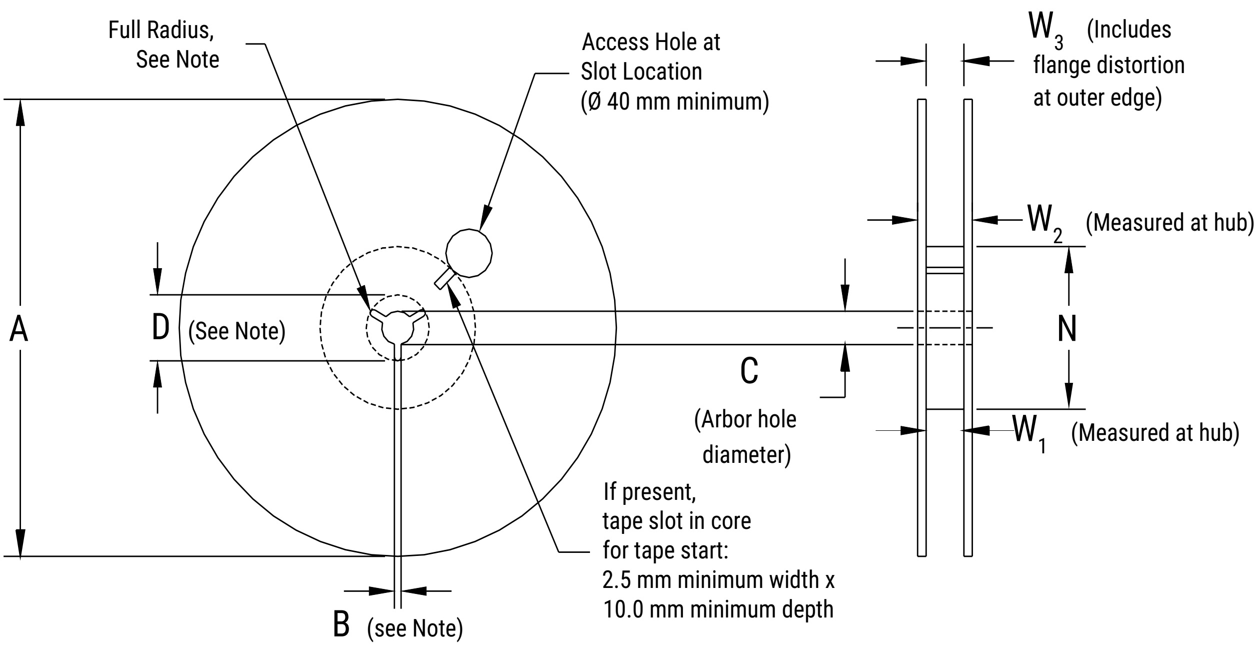


Figure 6 – Reel Dimensions



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	A	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

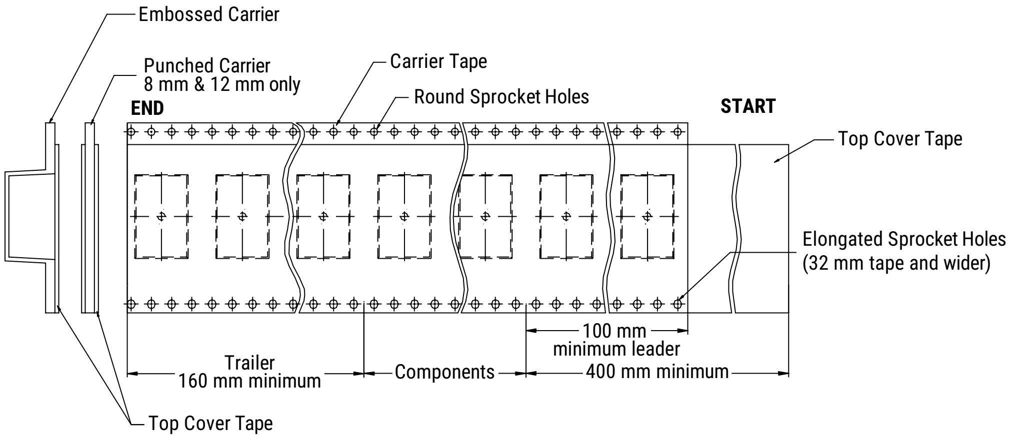
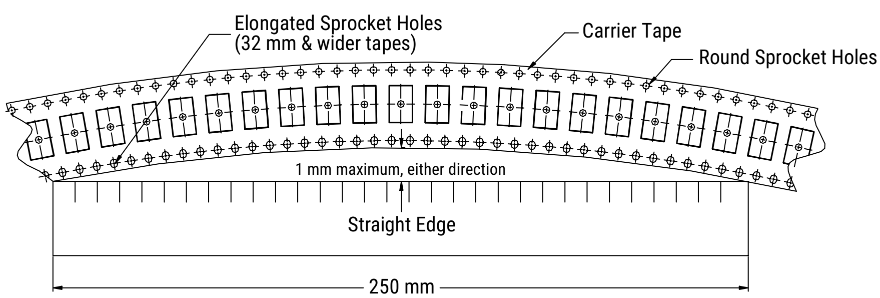


Figure 8 – Maximum Camber



Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs)

Commercial "L" Series, SnPb Termination, C0G Dielectric 10 – 250 VDC (Commercial Grade)

Overview

KEMET's Commercial "L" Series with Tin/Lead Termination surface mount capacitors in C0G 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.

KEMET's C0G dielectric features a 125°C maximum operating temperature and is considered "stable." The Electronics Components, Assemblies & Materials Association (EIA) characterizes C0G 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. C0G 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/ºC from −55°C to +125°C.

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

C	1206	C	104	J	3	G	A	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 = ±0.10 pF C = ±0.25 pF D = ±0.5 pF F = ±1% G = ±2% J = ±5% K = ±10% M = ±20%	8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 2 = 200 A = 250	G = C0G	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*

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".*

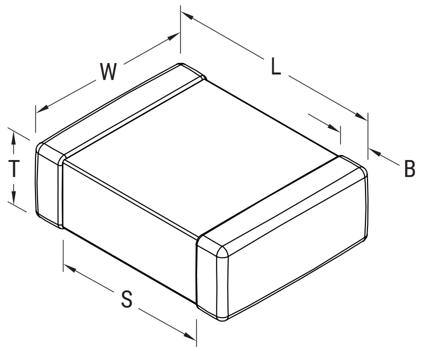
Benefits cont.

- No piezoelectric noise
- Extremely low ESR and ESL
- High thermal stability
- High ripple current capability
- Preferred capacitance solution at line frequencies and into the MHz range
- Negligible capacitance change with respect to temperature 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
- 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.

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)	See Table 2 for Thickness	0.15 (0.006) ±0.05 (0.002)	N/A	Solder Reflow Only
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)	
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
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)		
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 ≤ 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 MΩ-µF value by the capacitance and compare to GΩ 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
C0G	All	All	0.5	0.3% or ±0.25 pF	10% of Initial Limit

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

Cap	Cap Code	Case Size/ Series								C0402C							C0603C							C0805C							C1206C						
		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
		Rated Voltage (VDC)								10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250
		Capacitance Tolerance								Product Availability and Chip Thickness Codes – See Table 2 for Chip 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							
1.0 – 9.1 pF*	109 – 919*	B	C	D						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
10 – 20 pF*	100 – 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				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
24 – 91 pF*	240 – 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	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	M	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	K	M	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	M	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	K	M	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	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
390 pF	391				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
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
750 pF	751				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
820 pF	821				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
910 pF	911				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
1,000 pF	102				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
1,100 pF	112				F	G	J	K	M	BB	BB	BB	BB				CF	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	BB	BB	BB	BB				CF	CF	CF	CF	CF	CH	CH	DN	DN	DN	DN	DN	DN	DN	EB	EB	EB	EB	EB	EB	EB
1,300 pF	132				F	G	J	K	M	BB	BB	BB	BB				CF	CF	CF	CF	CF	CH	CH	DP	DP	DP	DP	DP	DN	DN	EB	EB	EB	EB	EC	EC	EC
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	EB	EB	EB	EB	ED	EC	EC
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	EB	EB	EB	EB	ED	ED	ED
1,800 pF	182				F	G	J	K	M	BB	BB	BB					CF	CF	CF	CF	CF	CH	CH	DP	DP	DP	DP	DP	DN	DN	EB	EB	EB	EB	ED	ED	ED
Cap	Cap Code	Rated Voltage (VDC)								10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250
		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								C0402C							C0603C							C0805C							C1206C						

**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 – 1206 Case Sizes) cont.

Cap	Cap Code	Case Size/ Series	C0402C							C0603C							C0805C							C1206C						
		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
		Rated Voltage (VDC)	10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250
		Capacitance Tolerance	Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions																											
2,000 pF	202	F G J K M	BB	BB	BB					CF	CF	CF	CF	CF	CH	CH	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	CH	CH	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	F G J K M								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	F G J K M								CF	CF	CF	CF	CF			DE	DE	DE	DE	DN	DP	DP	EC	EC	EC	EC	EF	EB	EB
4,300 pF	432	F G J K M								CF	CF	CF	CF	CF			DE	DE	DE	DE	DN	DP	DP	EC	EC	EC	EC	EC	EB	EB
4,700 pF	472	F G J K M								CF	CF	CF	CF	CF			DE	DE	DE	DE	DN	DP	DP	EC	EC	EC	EC	EC	EB	EB
5,100 pF	512	F G J K M								CF	CF	CF	CF				DE	DE	DE	DE	DN	DP	DP	ED	ED	ED	ED	ED	EB	EB
5,600 pF	562	F G J K M								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 K M								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 K M								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 K M								CF	CF	CF					DN	DN	DN	DN	DN	DG	DG	EB	EB	EB	EB	EB	EB	EB
8,200 pF	822	F G J K M								CF	CF	CF					DN	DN	DN	DN	DN	DG	DG	EC	EC	EC	EC	EB	EC	EC
9,100 pF	912	F G J K M								CF	CF	CF					DN	DN	DN	DN	DN			EC	EC	EC	EC	EB	EC	EC
10,000 pF	103	F G J K M								CF	CF	CF					DN	DN	DN	DN	DP			ED	ED	ED	ED	EB	EC	EC
12,000 pF	123	F G J K M								CF	CF	CF					DN	DN	DN	DN	DE			EB	EB	EB	EB	EB	ED	ED
15,000 pF	153	F G J K M								CF	CF	CF					DN	DN	DN	DP	DG			EB	EB	EB	EB	EB	EF	EF
18,000 pF	183	F G J K M															DN	DN	DN	DP				EB	EB	EB	EB	EB	EH	EH
22,000 pF	223	F G J K M															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	F G J K M															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																						EH	EH	EH				
Cap	Cap Code	Rated Voltage (VDC)	10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250
		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	C0402C							C0603C							C0805C							C1206C						

**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)*
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Table 1B – Capacitance Range/Selection Waterfall (1210 – 1812 Case Sizes)

Cap	Cap Code	Case Size/Series								C1210C							C1805C			C1808C				C1812C			
		Voltage Code								8	4	3	5	1	2	A	5	1	2	5	1	2	A	5	1	2	A
		Rated Voltage (VDC)								10	16	25	50	100	200	250	50	100	200	50	100	200	250	50	100	200	250
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																	
1.0 - 9.1 pF*	109 - 919*	B	C	D						FB	FB	FB	FB	FB	FB	FB											
10 - 91 pF*	100 - 910*				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB											
100 - 300 pF*	101 - 201*				F	G	J	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	K	M	FB	FB	FB	FB	FB	FB	FB	NC	NC	NC								
270 pF	271				F	G	J	K	M	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	LF	LF	LF	LF				
470 - 910 pF*	471 - 911*				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB	NC	NC	NC	LF	LF	LF	LF	GB	GB	GB	GB
1,000 pF	102				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB	NC	NC	NC	LF	LF	LF	LF	GB	GB	GB	GB
1,100 pF	112				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB	NC	NC		LF	LF	LF	LF	GB	GB	GB	GB
1,200 pF	122				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB	NC	NC		LF	LF	LF	LF	GB	GB	GB	GB
1,300 pF	132				F	G	J	K	M	FB	FB	FB	FB	FB	FC	FC	NC	NC		LF	LF	LF	LF	GB	GB	GB	GB
1,500 pF	152				F	G	J	K	M	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	LF	LF	GB	GB	GB	GB
1,800 pF	182				F	G	J	K	M	FB	FB	FB	FB	FB	FE	FE	NC	NC		LF	LF	LF	LF	GB	GB	GB	GB
2,000 pF	202				F	G	J	K	M	FB	FB	FB	FB	FC	FE	FE	NC	NC		LF	LF	LF	LF	GB	GB	GB	GB
2,200 pF	222				F	G	J	K	M	FB	FB	FB	FB	FC	FG	FG	NC	NC		LF	LF	LF	LF	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				
2,700 pF	272				F	G	J	K	M	FB	FB	FB	FB	FC	FC	FC	NC	NC		LF	LF	LF	LF	GB	GB	GB	GB
3,000 pF	302				F	G	J	K	M	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				LF	LF			GB	GB	GB	GB
3,600 pF	362				F	G	J	K	M	FB	FB	FB	FB	FF	FF	FF				LF	LF						
3,900 pF	392				F	G	J	K	M	FB	FB	FB	FB	FF	FF	FF				LF	LF			GB	GB	GB	GB
4,300 pF	432				F	G	J	K	M	FB	FB	FB	FB	FF	FF	FF				LF	LF						
4,700 pF	472				F	G	J	K	M	FF	FF	FF	FF	FG	FG	FG				LF	LF			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											
6,800 pF	682				F	G	J	K	M	FB	FB	FB	FB	FG	FB	FB								GB	GB	GJ	GJ
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
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
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	K	M	FG	FG	FG	FG	FB	FC	FC								GB	GB	GB	GB
18,000 pF	183				F	G	J	K	M	FB	FB	FB	FB	FB	FC	FC								GB	GB	GB	GB
22,000 pF	223				F	G	J	K	M	FB	FB	FB	FB	FB	FF	FF								GB	GB	GB	GB
27,000 pF	273				F	G	J	K	M	FB	FB	FB	FB	FB	FG	FG								GB	GB	GB	GB
33,000 pF	333				F	G	J	K	M	FB	FB	FB	FB	FB	FH	FH								GB	GB	GB	GB
39,000 pF	393				F	G	J	K	M	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	563				F	G	J	K	M	FB	FB	FB	FB	FF										GB	GB	GD	GD
68,000 pF	683				F	G	J	K	M	FB	FB	FB	FC	FG										GB	GB	GK	GK
82,000 pF	823				F	G	J	K	M	FC	FC	FC	FF	FH										GB	GB	GM	GM
0.10 µF	104				F	G	J	K	M	FE	FE	FE	FG	FM										GB	GD	GM	GM
0.12 µF	124				F	G	J	K	M	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												GH			
0.22 µF	224				F	G	J	K	M	FK	FK	FK												GK			
0.27 µF	274				F	G	J	K	M																		
0.33 µF	334				F	G	J	K	M																		
0.39 µF	394				F	G	J	K	M																		
0.47 µF	474				F	G	J	K	M																		
Cap	Cap Code	Rated Voltage (VDC)								10	16	25	50	100	200	250	50	100	200	50	100	200	250	50	100	200	250
		Voltage Code								8	4	3	5	1	2	A	5	1	2	5	1	2	A	5	1	2	A
		Case Size/Series								C1210C							C1805C			C1808C				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)*
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 (1825 – 2225 Case Sizes)

Cap	Cap Code	Case Size/Series					C1825C				C2220C				C2225C			
		Voltage Code					5	1	2	A	5	1	2	A	5	1	2	A
		Rated Voltage (VDC)					50	100	200	250	50	100	200	250	50	100	200	250
		Capacitance Tolerance					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions											
3,900 pF	392	F	G	J	K	M	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	M									KE	KE	KE	KE
8,200 pF	822	F	G	J	K	M	HB	HB	HB	HB	JE	JE	JB		KE	KE	KE	KE
9,100 pF	912	F	G	J	K	M									KE	KE	KE	KE
10,000 pF	103	F	G	J	K	M	HB	HB	HE	HE	JE	JE	JB		KE	KE	KE	KE
12,000 pF	123	F	G	J	K	M	HB	HB	HE	HE	JE	JE	JB		KE	KE	KE	KE
15,000 pF	153	F	G	J	K	M	HB	HB			JE	JE	JB		KE	KE	KE	KE
18,000 pF	183	F	G	J	K	M	HB	HE			JE	JE	JB		KE	KE		
22,000 pF	223	F	G	J	K	M	HB	HE			JE	JB	JB		KE	KE		
27,000 pF	273	F	G	J	K	M	HB	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	K	M					JB	JB	JB					
47,000 pF	473	F	G	J	K	M					JB	JB	JB					
56,000 pF	563	F	G	J	K	M					JB	JB	JB					
68,000 pF	683	F	G	J	K	M					JB	JB	JB					
82,000 pF	823	F	G	J	K	M					JB	JB	JB					
0.10 µF	104	F	G	J	K	M					JB	JB	JD					
0.12 µF	124	F	G	J	K	M					JB	JB	JD					
0.15 µF	154	F	G	J	K	M					JB	JB	JG					
0.18 µF	184	F	G	J	K	M					JB	JD	JG					
0.22 µF	224	F	G	J	K	M					JB	JD	JL					
0.27 µF	274	F	G	J	K	M					JB	JF						
0.33 µF	334	F	G	J	K	M					JD	JG						
0.39 µF	394	F	G	J	K	M					JG							
0.47 µF	474	F	G	J	K	M					JG							
Cap	Cap Code	Rated Voltage (VDC)					50	100	200	250	50	100	200	250	50	100	200	250
		Voltage Code					5	1	2	A	5	1	2	A	5	1	2	A
		Case Size/Series					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.

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

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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	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
FK	1210	2.10 ± 0.20	0	0	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	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
JL	2220	2.00 ± 0.20	0	0	500	2,000
KE	2225	1.40 ± 0.15	0	0	1,000	4,000
Thickness Code	**Case Size[1]**	**Thickness ± Range (mm)**	**7" Reel**	**13" Reel**	**7" Reel**	**13" Reel**
			Paper Quantity[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

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		Packaging Quantities (pieces/unit packaging)	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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.

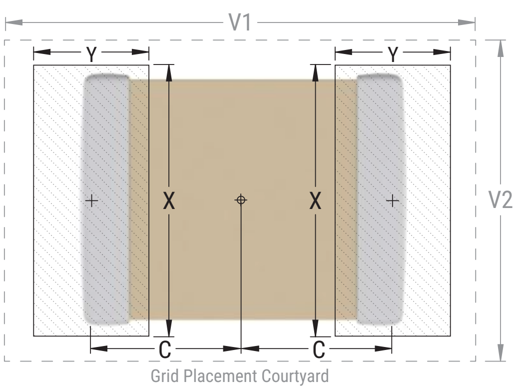
[2] A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard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

Table 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)				
		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 ≥ 22 µF*
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	
	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.

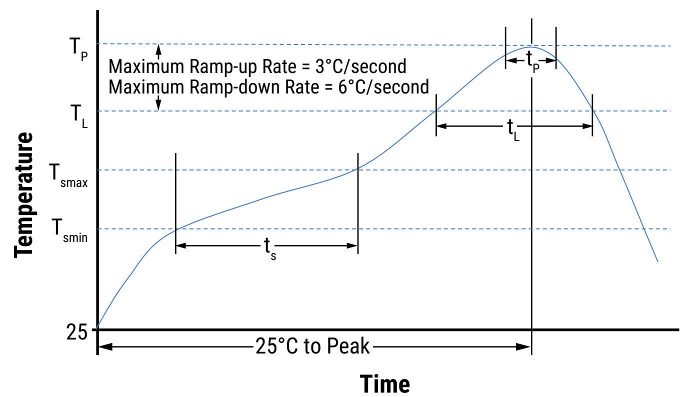


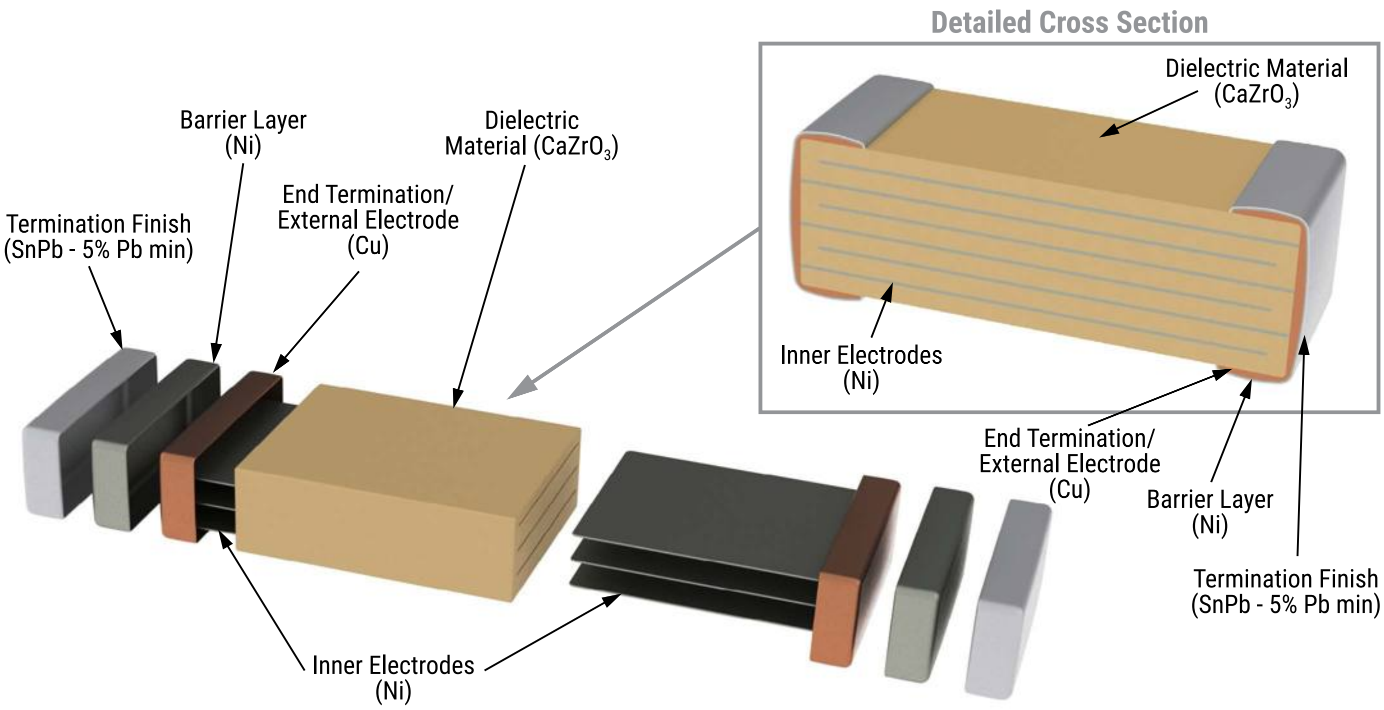
Table 4 – Performance & Reliability: Test Methods and Conditions

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 C0G. 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. 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 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 40ºC 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)

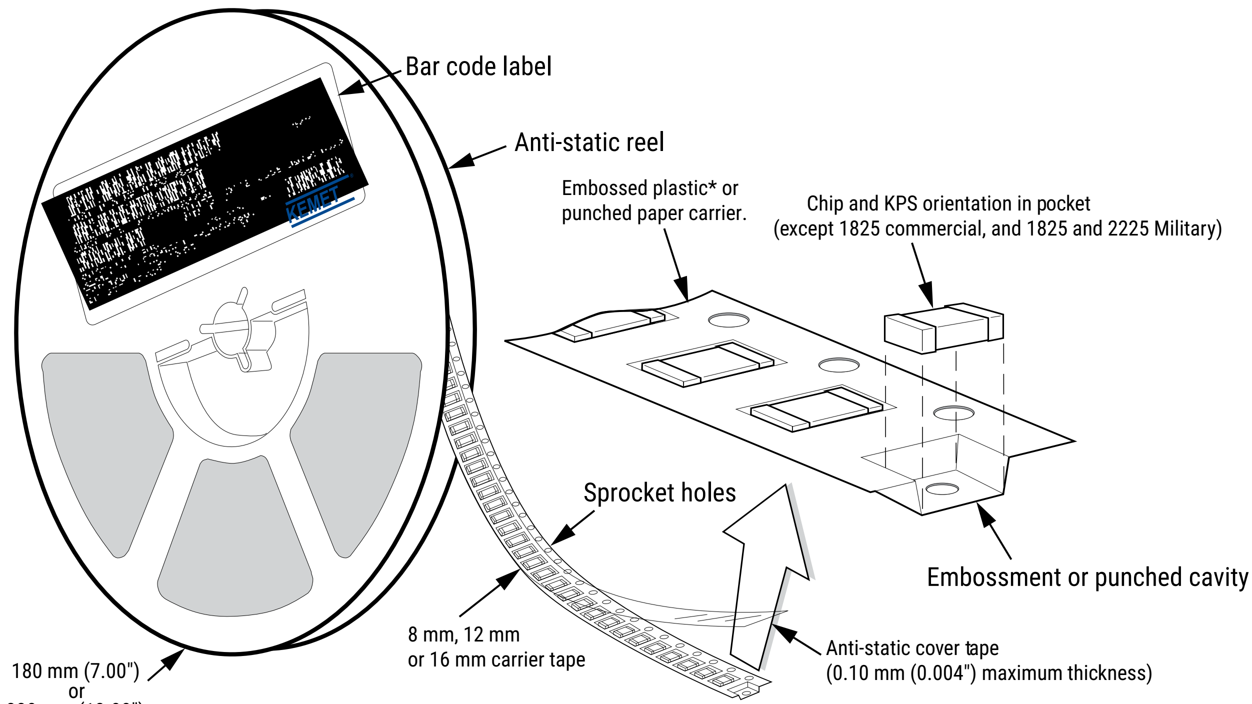
Laser marking option is not available on:

- C0G, 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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

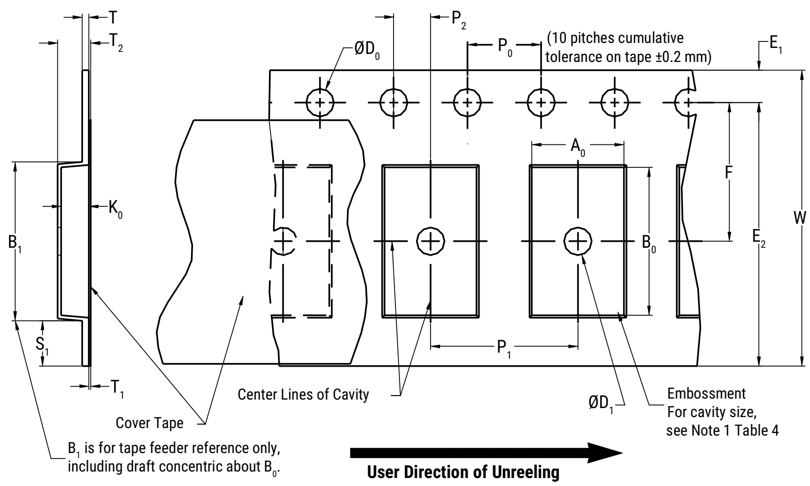


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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 (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)	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 S_1 < 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_0, B_0 and K_0 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

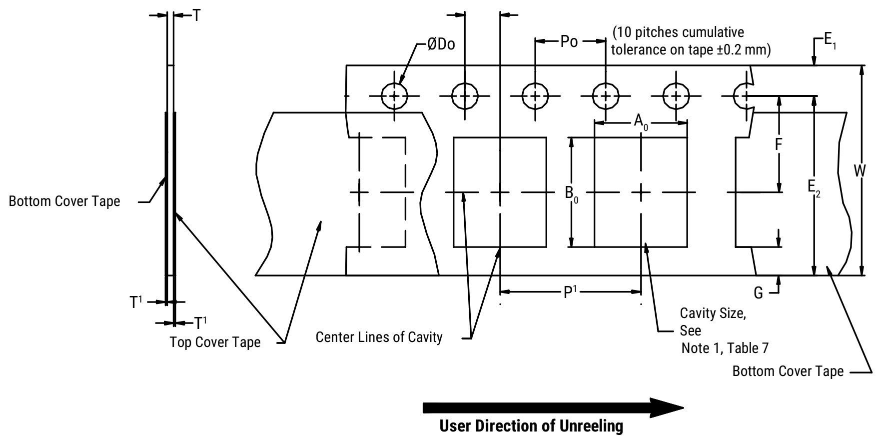


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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.)

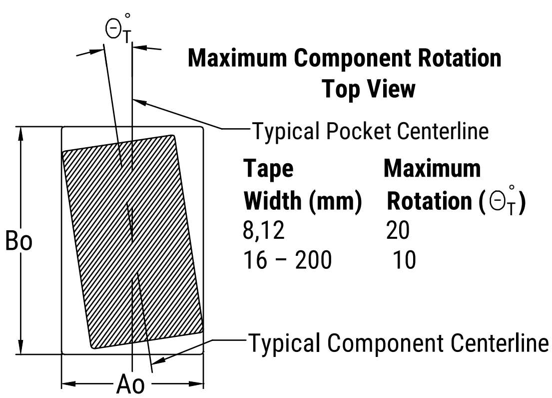
Packaging Information Performance Notes

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



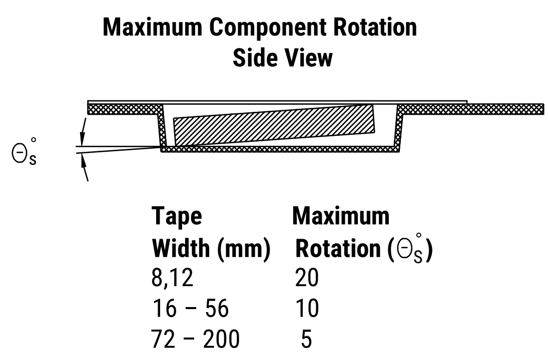


Figure 4 – Maximum Lateral Movement

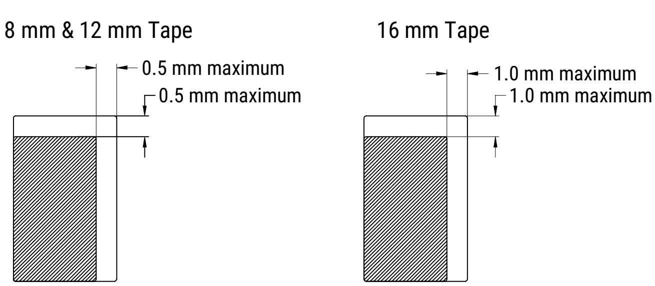


Figure 5 – Bending Radius

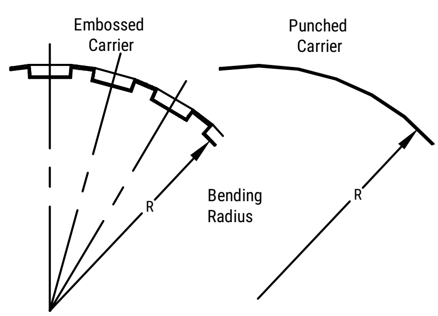
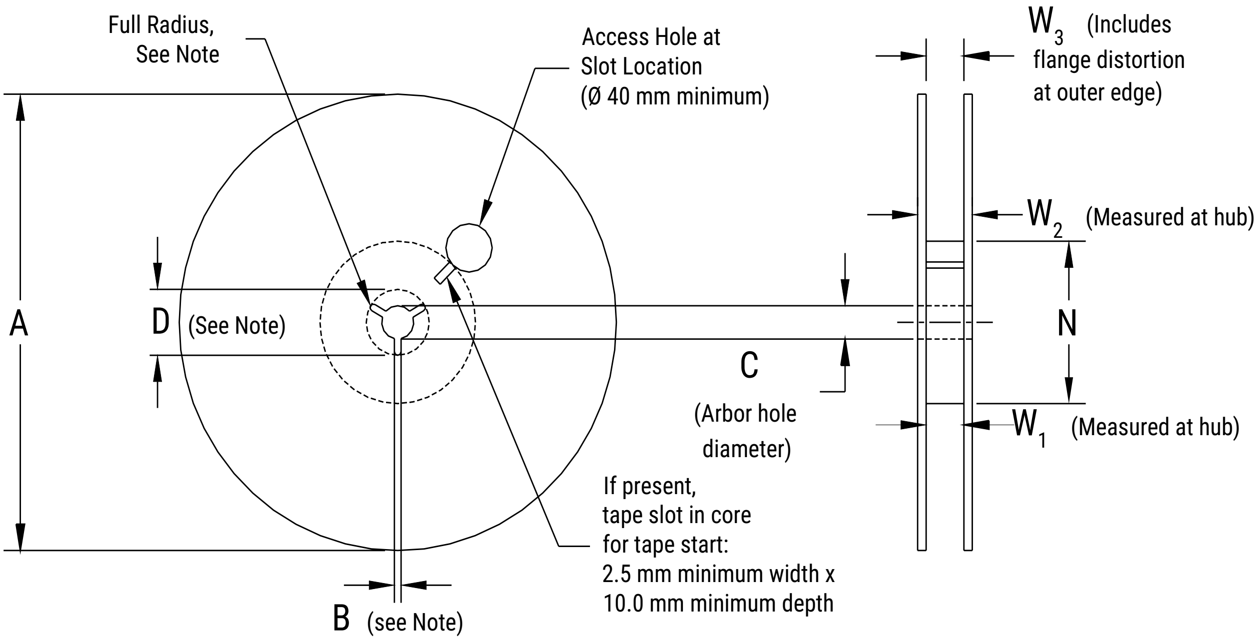


Figure 6 – Reel Dimensions



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	A	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

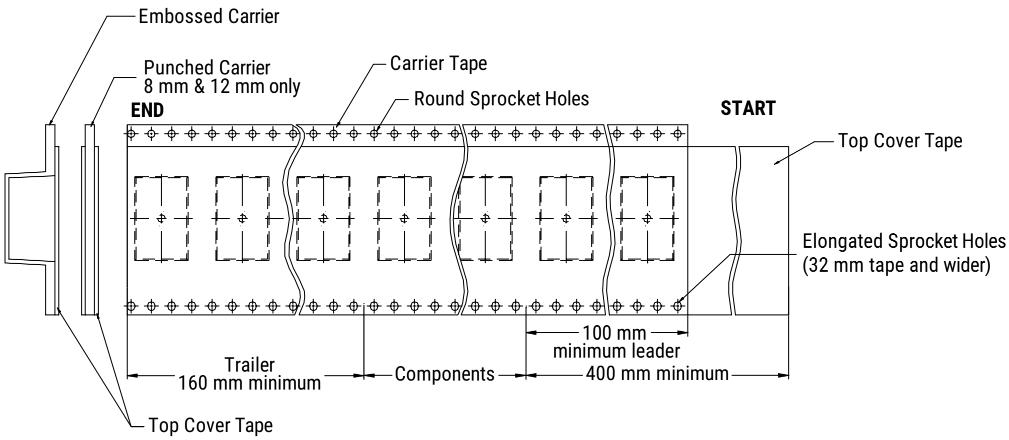
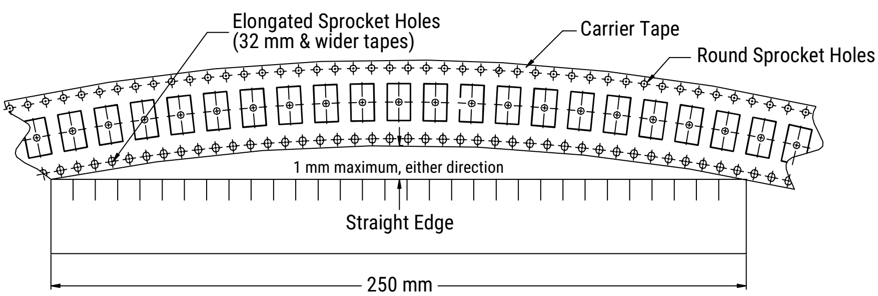


Figure 8 – Maximum Camber



KPS, X7R Dielectric, 10 – 250 VDC (Commercial Grade)

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 ±15% from −55°C to +125°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

C	2220	C	106	M	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

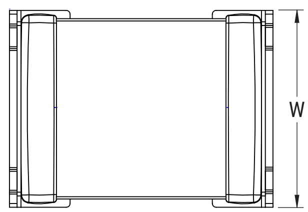
Commercial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance & Reliability.

Environmental Compliance

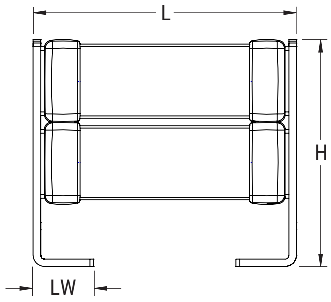
Lead (Pb)-free, RoHS, and REACH compliant without exemptions.

Dimensions – Millimeters (Inches)

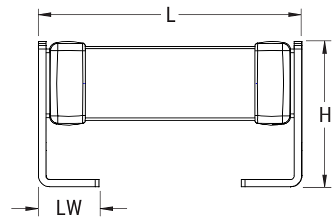
Single or Double Chip Stack



Double Chip Stack



Single Chip Stack



Number of Chips	EIA Size Code	Metric Size Code	L Length	W Width	H Height	LW Lead Width	Mounting Technique
Single	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)	Solder Reflow Only
	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)	
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)	
	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 ≤ 10 µF
120 Hz ±10 Hz and 0.5 ±0.1 Vrms if capacitance > 10 µF

[4] *To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ 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

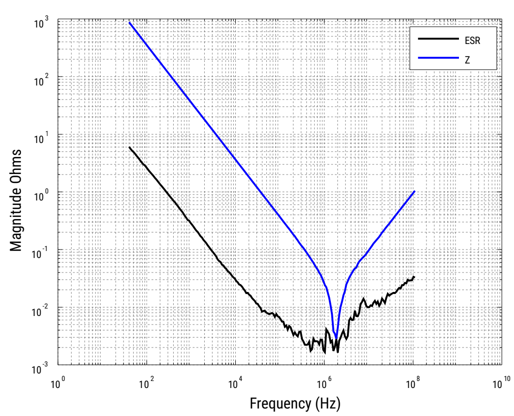
High Temperature Life, Biased Humidity, Moisture Resistance					
Dielectric	Rated DC Voltage	Capacitance Value	Dissipation Factor (Maximum %)	Capacitance Shift	Insulation Resistance
X7R	> 25	All	3.0	±20%	10% of Initial Limit
	16/25		5.0		
	< 16		7.5		

Insulation Resistance Limit Table

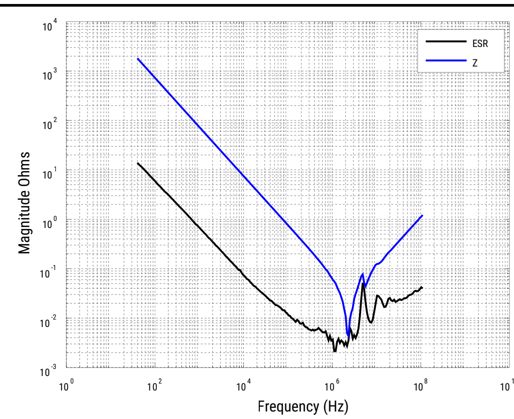
EIA Case Size	1,000 Megohm Microfarads or 100 GΩ	500 Megohm Microfarads or 10 GΩ
1210	< 0.39 µF	≥ 0.39 µF
1812	< 2.2 µF	≥ 2.2 µF
2220	< 10 µF	≥ 10 µF

Electrical Characteristics

Z and ESR C1210C475M5R1C

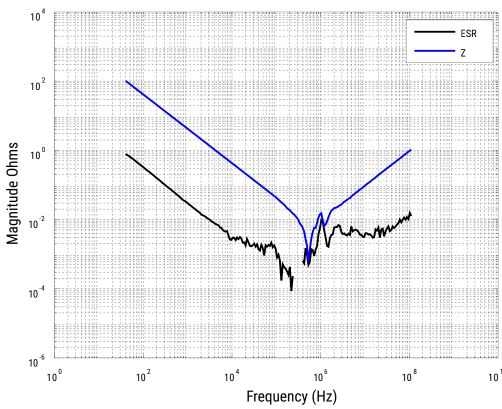


Z and ESR C2220C225MAR2C

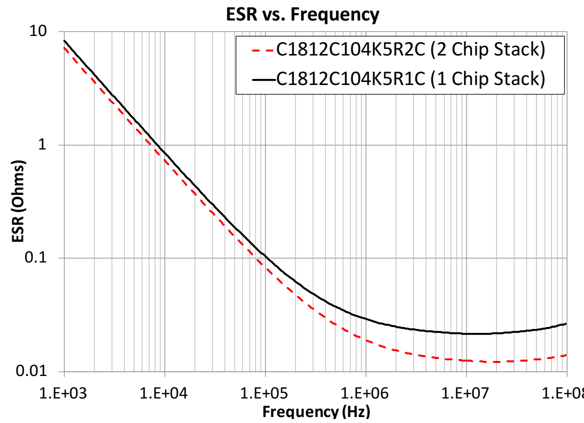


Electrical Characteristics cont.

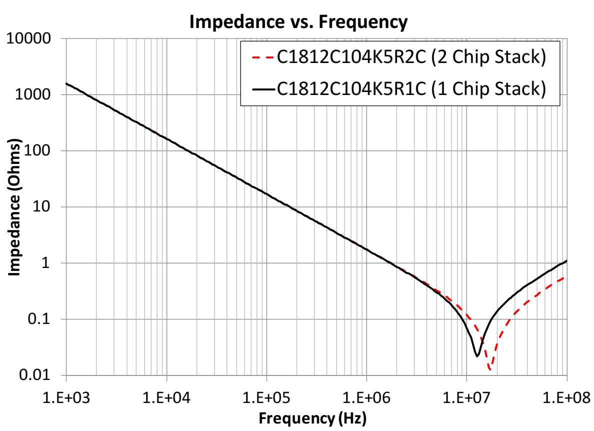
Z and ESR C2220C476M3R2C



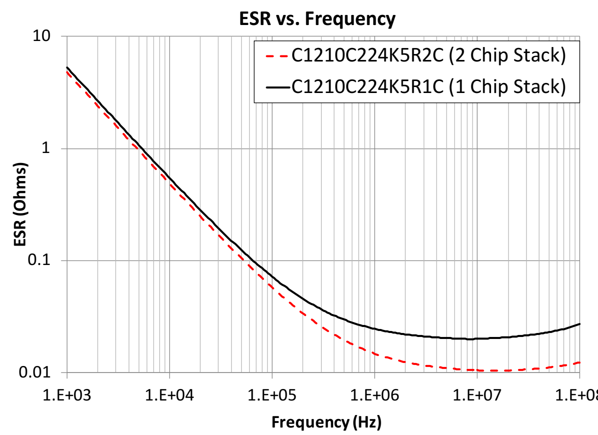
ESR – 1812, .10 µF, 50 V X7R



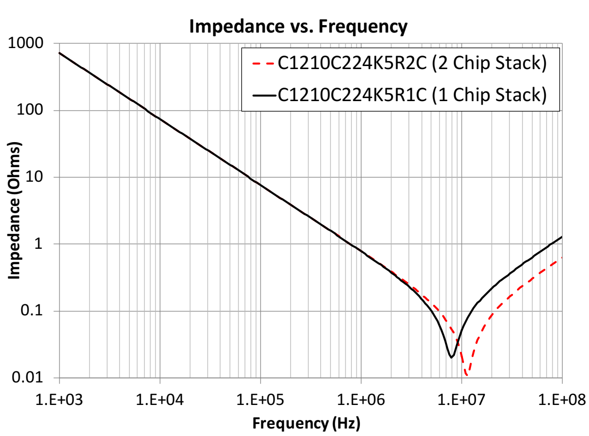
Impedance – 1812, .10 µF, 50 V X7R



ESR – 1210, .22 µF, 50 V X7R

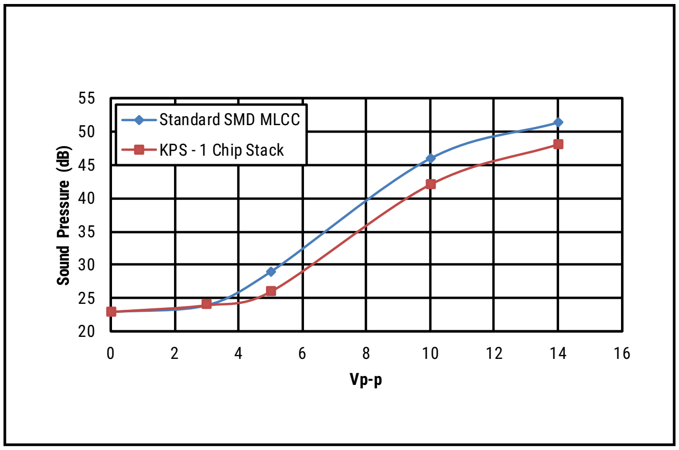


Impedance – 1210, .22 µF, 50 V X7R

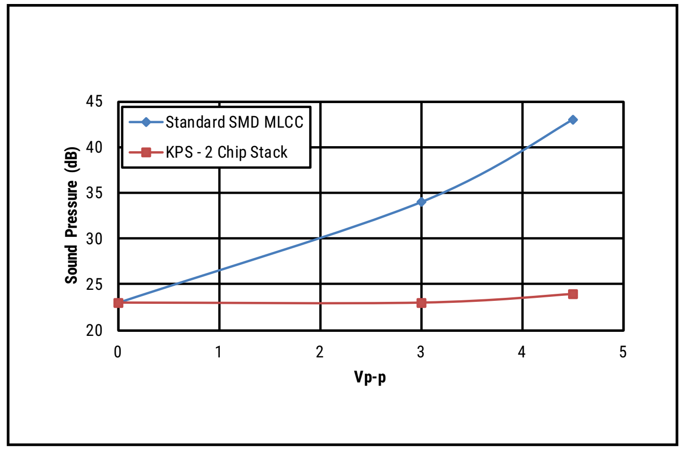


Electrical Characteristics cont.

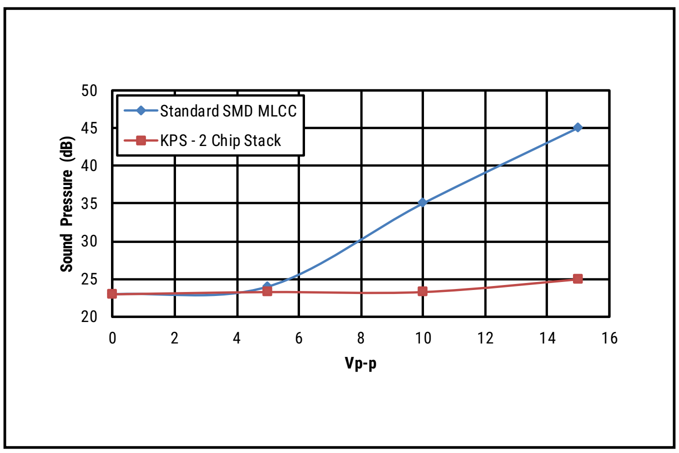
Microphonics – 1210, 4.7 µF, 50 V, X7R



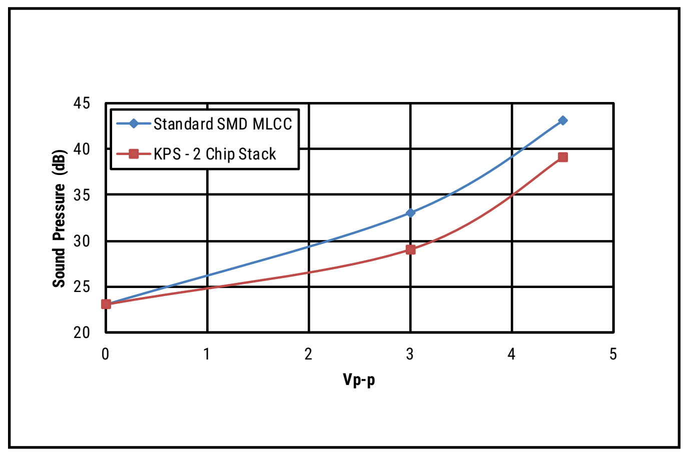
Microphonics – 2220, 22 µF, 50 V, X7R



Microphonics – 2220, 47 µF, 25 V, X7R

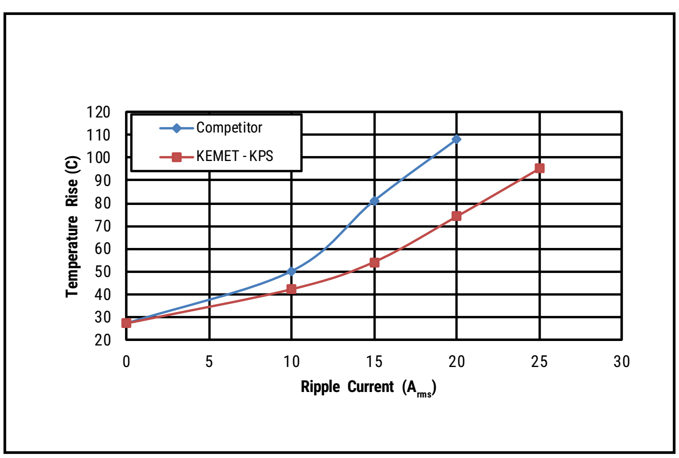


Microphonics – 1210, 22 µF, 25 V, X7R



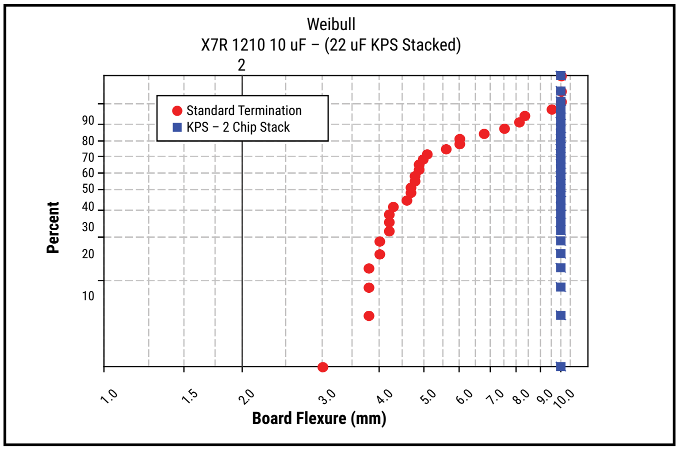
Competitive Comparision

Ripple Current (A_{rms}) 2220, 22 µF, 50 V

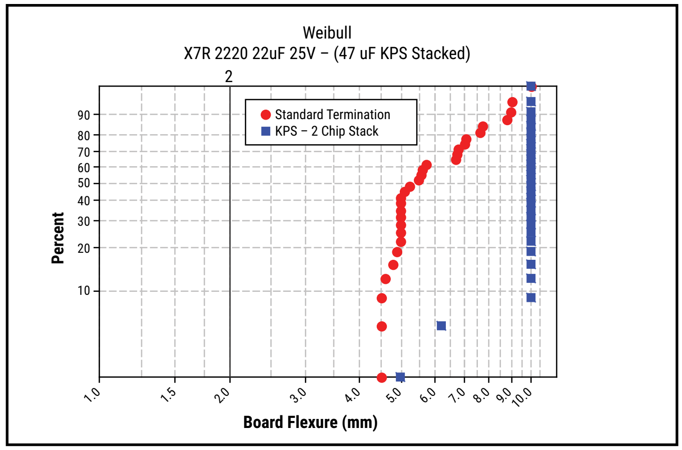


Electrical Characteristics cont.

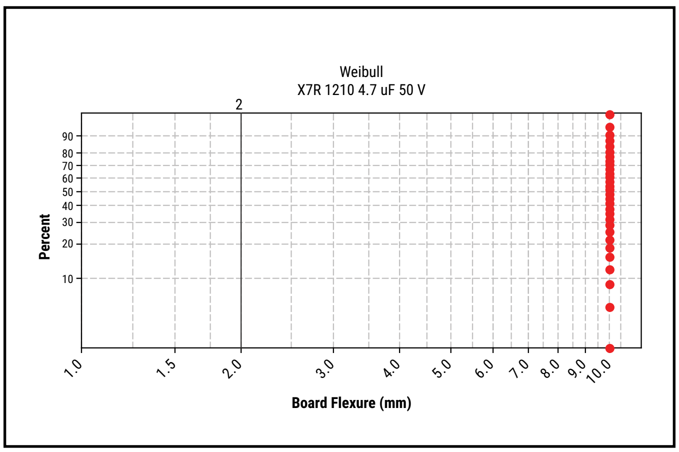
Board Flex vs. Termination Type



Board Flex vs. Termination Type



Board Flexure to 10 mm



Board Flexure to 10 mm

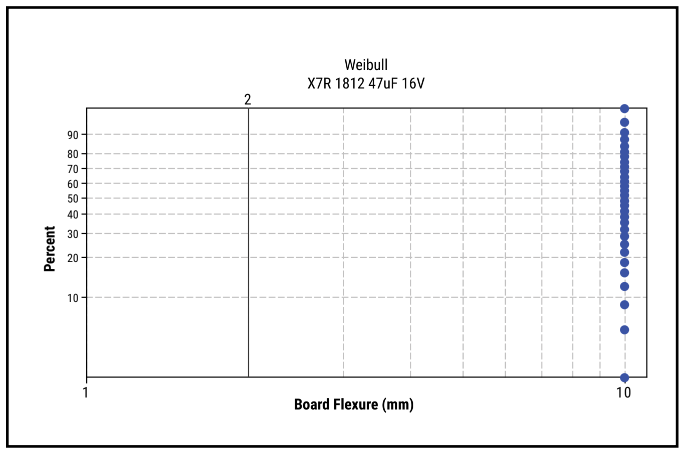


Table 1 – Capacitance Range/Selection Waterfall (1210 – 2220 Case Sizes)

Capacitance	Cap Code	Case Size/Series		C1210C						C1812C					C2220C				
		Voltage Code		8	4	3	5	1	A	4	3	5	1	A	4	3	5	1	A
		Rated Voltage (VDC)		10	16	25	50	100	250	16	25	50	100	250	16	25	50	100	250
		Capacitance Tolerance		Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions															
Single Chip Stack																			
0.10 µF	104	K	M	FV	FV	FV	FV	FV	FV	GP	GP	GP	GP	GP	JP	JP	JP	JP	JP
0.22 µF	224	K	M	FV	FV	FV	FV	FV		GP	GP	GP	GP	GP	JP	JP	JP	JP	JP
0.47 µF	474	K	M	FV	FV	FV	FV	FV		GP	GP	GP	GP	GP	JP	JP	JP	JP	JP
1.0 µF	105	K	M	FV	FV	FV	FV	FV		GP	GP	GP	GP		JP	JP	JP	JP	JP
2.2 µF	225	K	M	FV	FV	FV	FV	FV		GP	GP	GP			JP	JP	JP	JP	
3.3 µF	335	K	M	FV	FV	FV	FV			GP	GP	GP			JP	JP	JP	JP	
4.7 µF	475	K	M	FV	FV	FV	FV			GP	GP	GP			JP	JP	JP		
10 µF	106	K	M	FV	FV	FV				GP	GP				JP	JP	JP		
15 µF	156	K	M	FV											JP	JP			
22 µF	226	K	M	FV											JP	JP			
Double Chip Stack																			
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		M	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		M	FW											JR	JR			
47 µF	476		M	FW											JR	JR			
Capacitance	Cap Code	Rated Voltage (VDC)		10	16	25	50	100	250	16	25	50	100	250	16	25	50	100	250
		Voltage Code		8	4	3	5	1	A	4	3	5	1	A	4	3	5	1	A
		Case Size/Series		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

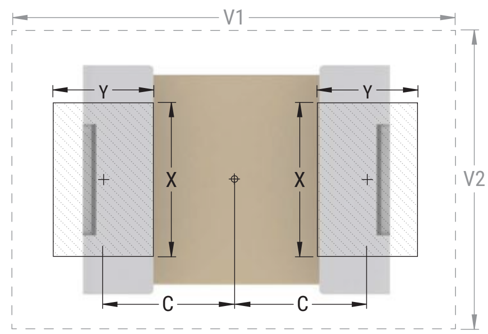
Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
FV	1210	3.35 ± 0.10	0	0	600	2,000
FW	1210	6.15 ± 0.15	0	0	300	1,000
GP	1812	2.65 ± 0.35	0	0	500	2,000
GR	1812	5.00 ± 0.50	0	0	400	1,700
JP	2220	3.50 ± 0.30	0	0	300	1,300
JR	2220	5.00 ± 0.50	0	0	200	800
Thickness 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 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
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.



Grid Placement Courtyard

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_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.

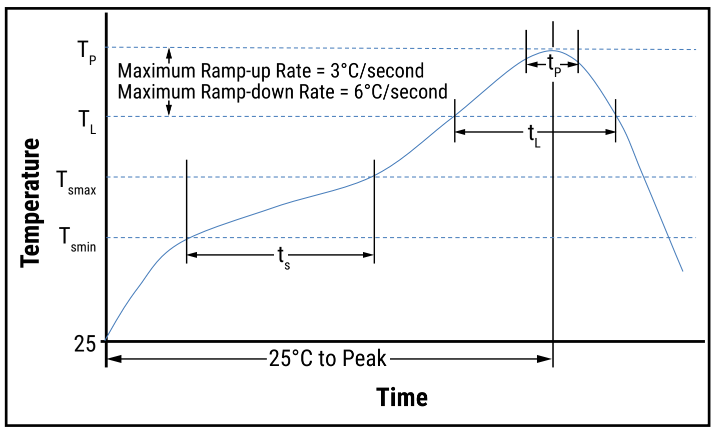


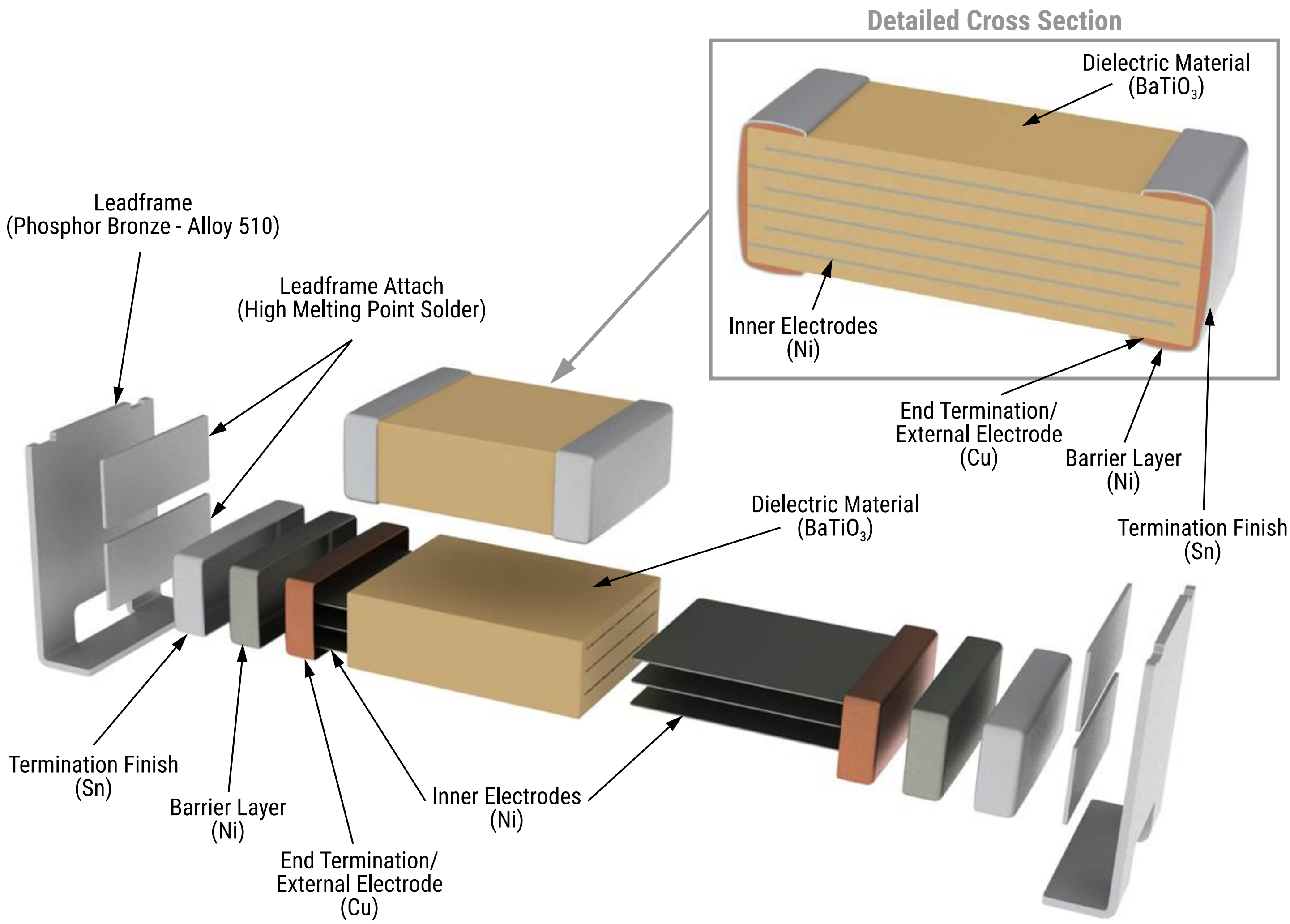
Table 4 – Performance & Reliability: Test Methods and Conditions

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
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 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 40ºC 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:

- C0G, 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.

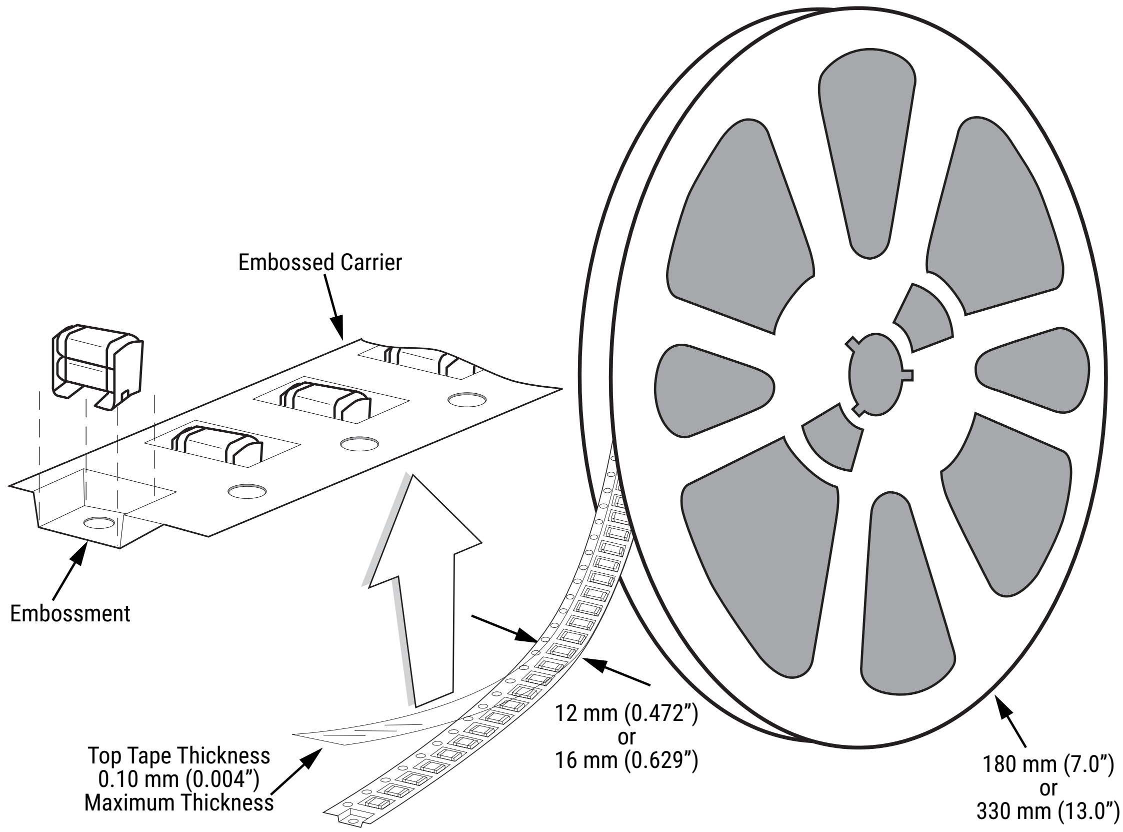


Table 5 – Carrier Tape Configuration – Embossed Plastic (mm)

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_1 carrier tape reference locations.*
**Refer to Table 5 for tolerance specifications.*

Figure 1 – Embossed (Plastic) Carrier Tape Dimensions

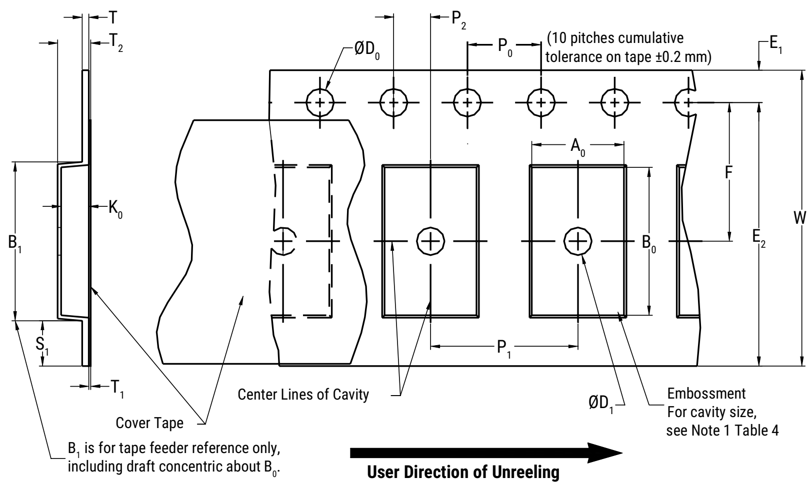


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +0.10/0.0−0.0 (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)			
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)	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 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 < 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_1 dimension is a reference dimension for tape feeder clearance only.*
5. *The cavity defined by A_0, B_0 and K_0 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

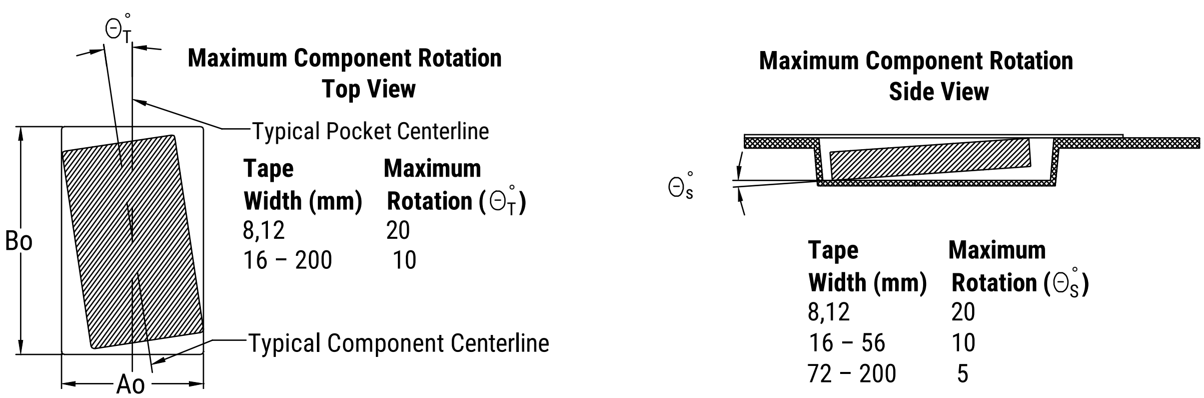


Figure 3 – Maximum Lateral Movement

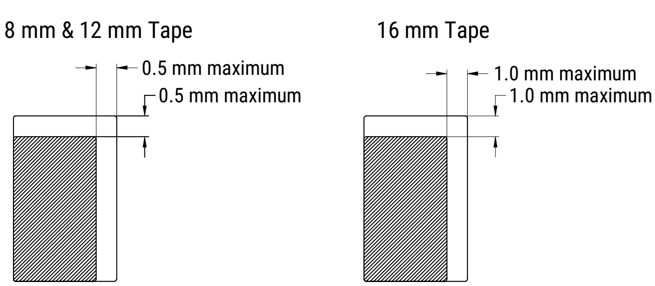


Figure 4 – Bending Radius

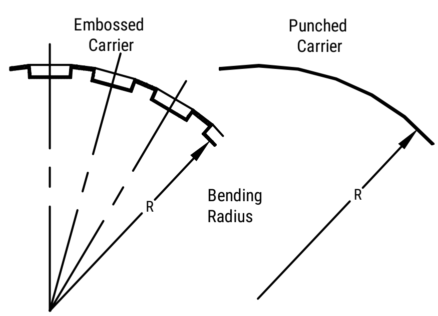
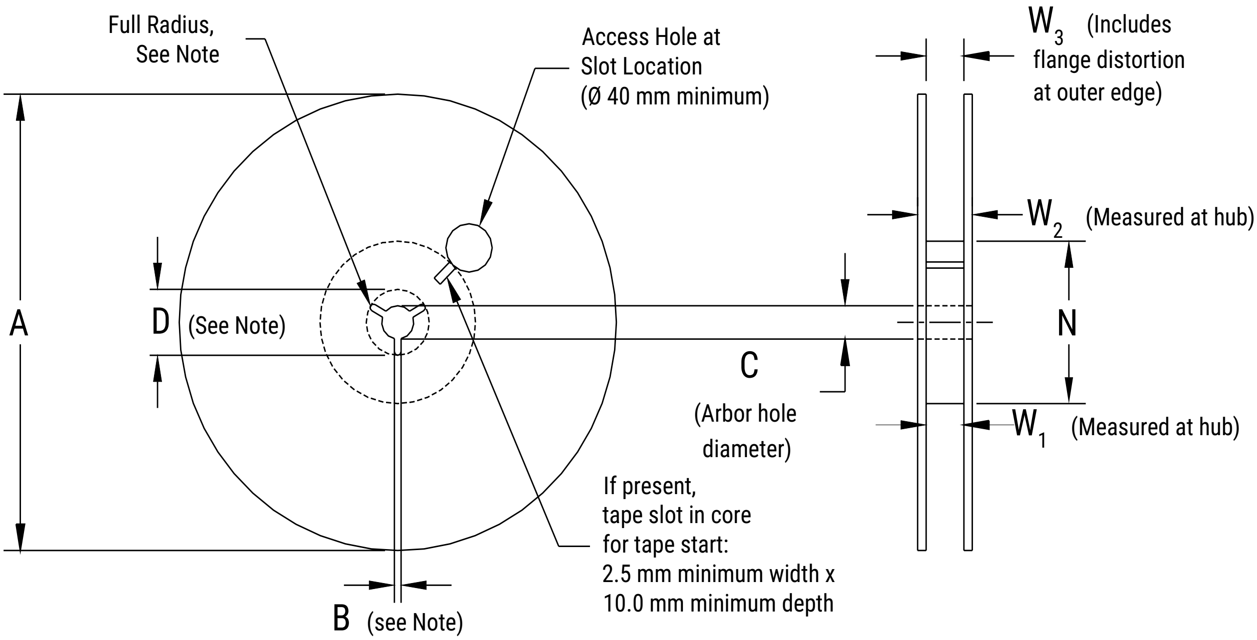


Figure 5 – Reel Dimensions



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

Table 7 – Reel Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)				
Tape Size	A	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 6 – Tape Leader & Trailer Dimensions

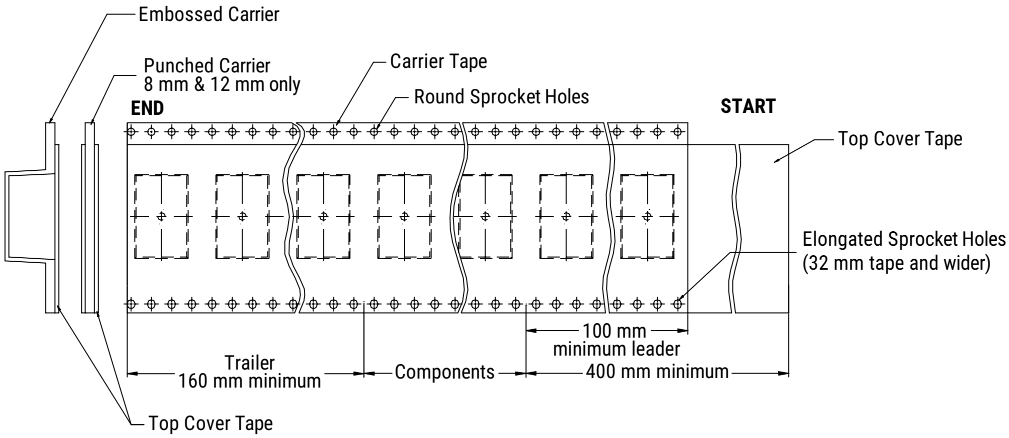
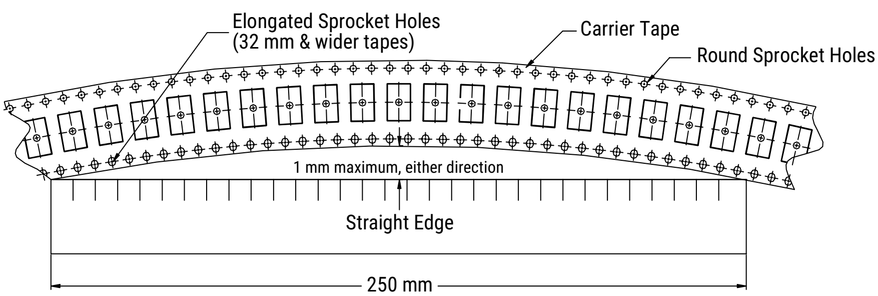


Figure 7 – Maximum Camber



KPS, X7R Dielectric, 10 – 250 VDC (Automotive Grade)

KEMET a YAGEO company

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 ±15% from −55°C to +125°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

C	2220	C	106	M	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 (±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	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 0.1µF up to 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
- 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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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.

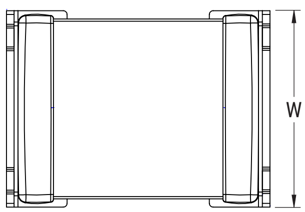
KEMET Automotive C-Spec	PPAP (Product Part Approval Process) Level				
	1	2	3	4	5
KEMET assigned[1]	●	●	●	●	●
AUTO			○		

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

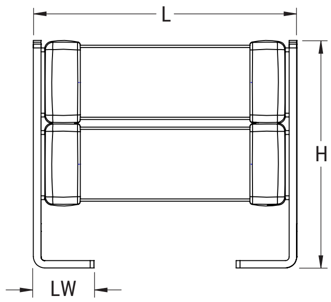
● Part number specific PPAP available
○ Product family PPAP only

Dimensions – Millimeters (Inches)

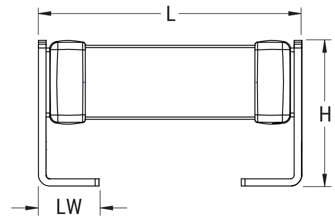
Single or Double Chip Stack



Double Chip Stack



Single Chip Stack



Number of Chips	EIA Size Code	Metric Size Code	L Length	W Width	H Height	LW Lead Width	Mounting Technique
Single	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)	Solder Reflow Only
	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)	
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)	
	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%
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 MΩ-µF value by the capacitance and compare to GΩ 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 ≤ 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

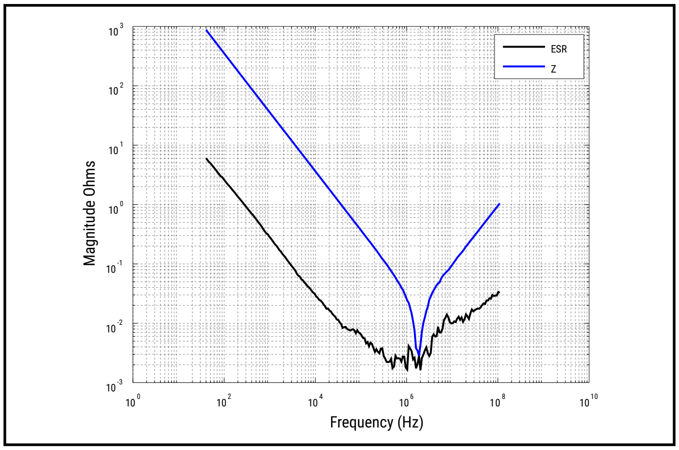
High Temperature Life, Biased Humidity, Moisture Resistance					
Dielectric	Rated DC Voltage	Capacitance Value	Dissipation Factor (Maximum %)	Capacitance Shift	Insulation Resistance
X7R	> 25	All	3.0	±20%	10% of Initial Limit
	16/25		5.0		
	< 16		7.5		

Insulation Resistance Limit Table

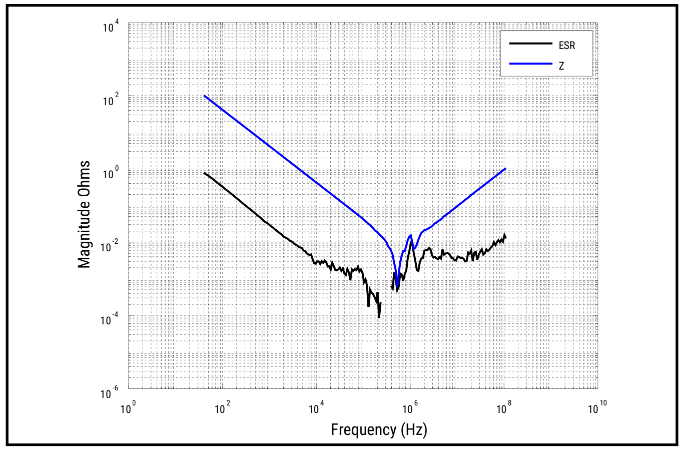
EIA Case Size	1,000 Megohm Microfarads or 100 GΩ	500 Megohm Microfarads or 10 GΩ
1210	< 0.39 µF	≥ 0.39 µF
1812	< 2.2 µF	≥ 2.2 µF
2220	< 10 µF	≥ 10 µF

Electrical Characteristics

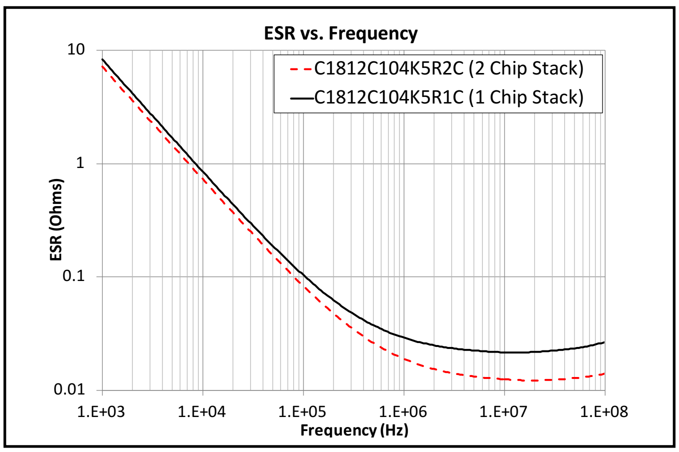
Z and ESR C1210C475M5R1C



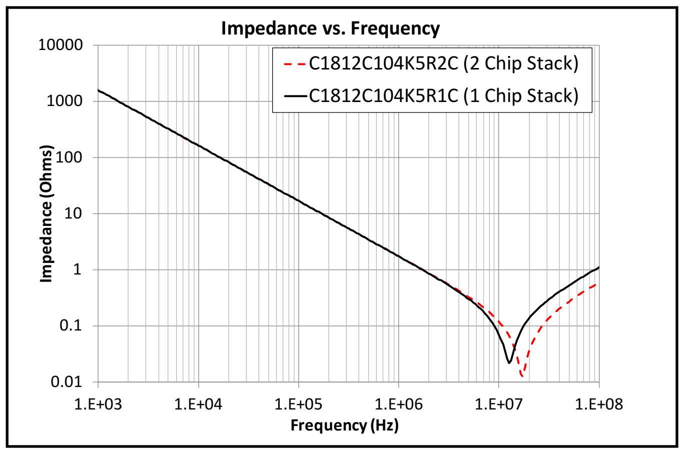
Z and ESR C2220C476M3R2C



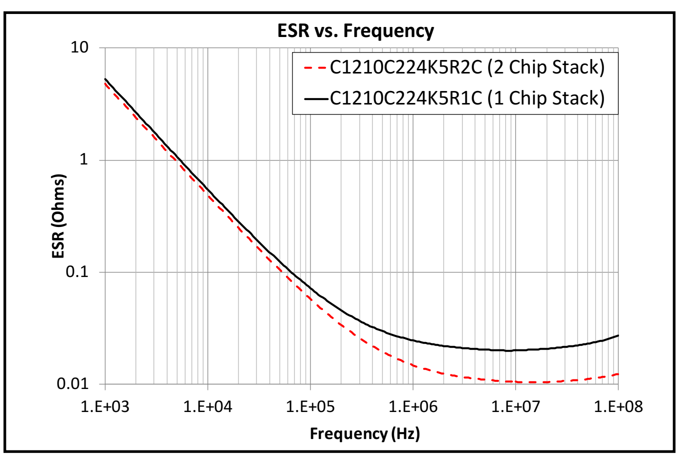
ESR – 1812, .10 µF, 50 V X7R



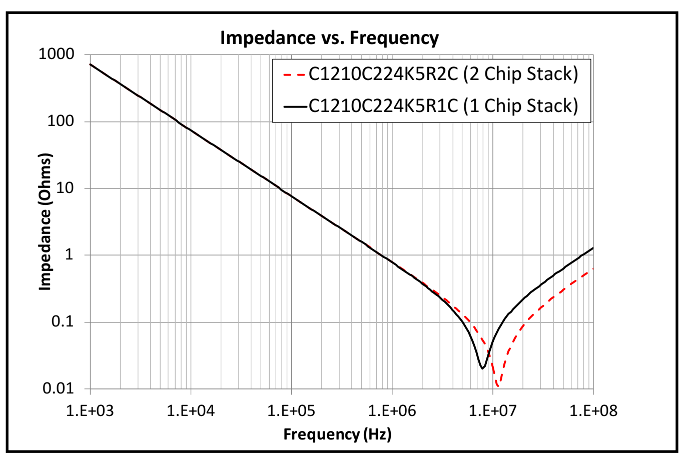
Impedance – 1812, .10 µF, 50 V X7R



ESR – 1210, .22 µF, 50 V X7R

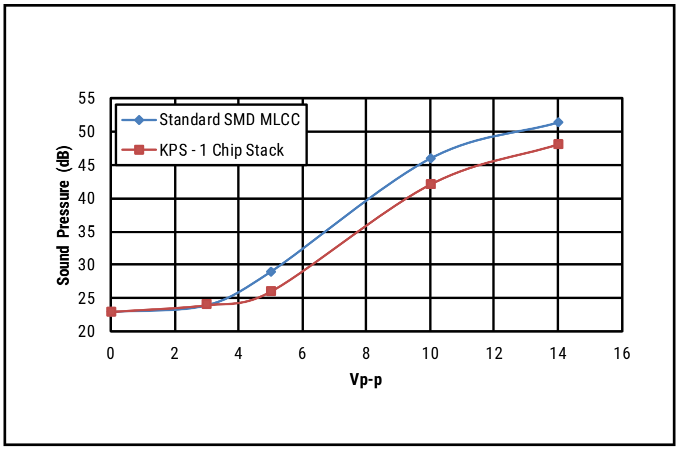


Impedance – 1210, .22 µF, 50 V X7R

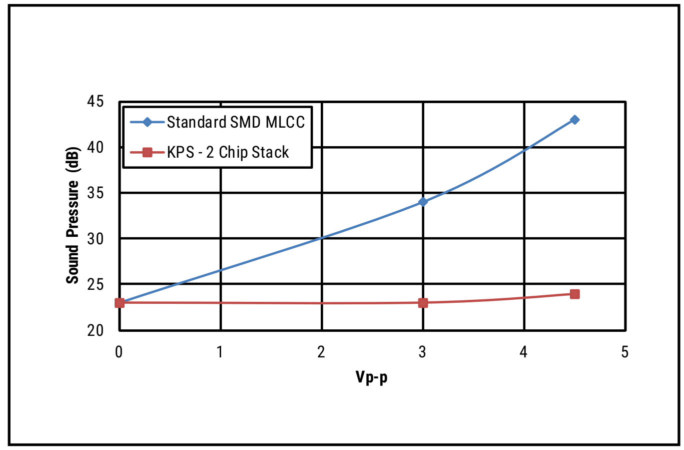


Electrical Characteristics cont.

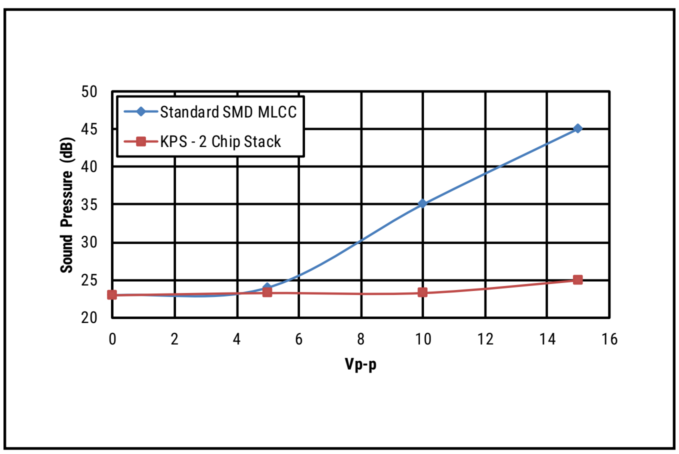
Microphonics – 1210, 4.7 µF, 50 V, X7R



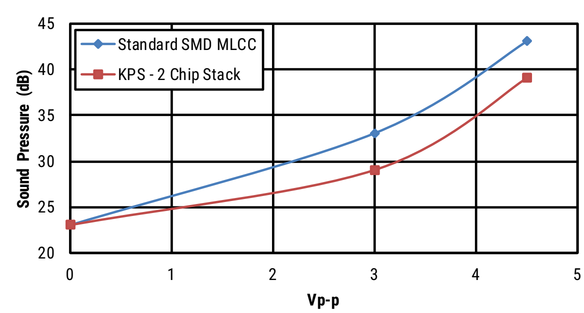
Microphonics – 2220, 22 µF, 50 V, X7R



Microphonics – 2220, 47 µF, 25 V, X7R

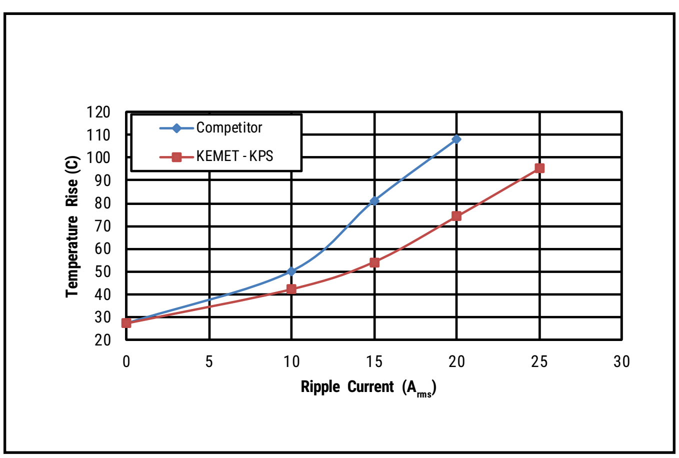


Microphonics – 1210, 22 µF, 25 V, X7R



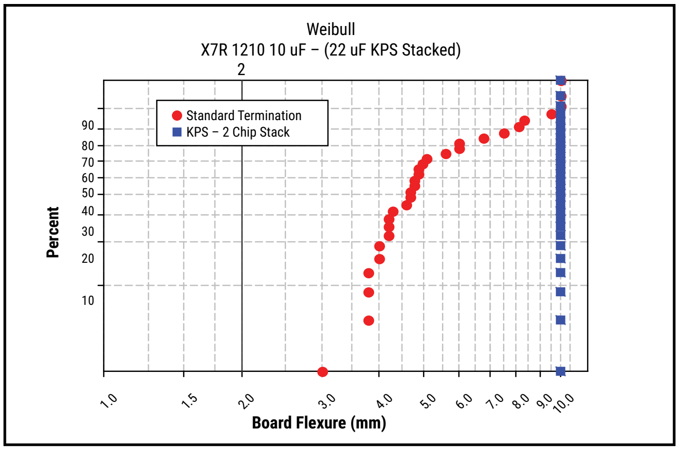
Competitive Comparision

Ripple Current (A_{rms}) 2220, 22 µF, 50 V

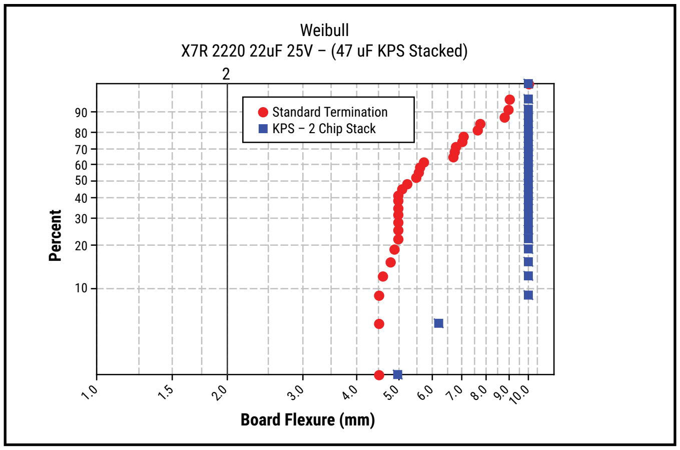


Electrical Characteristics cont.

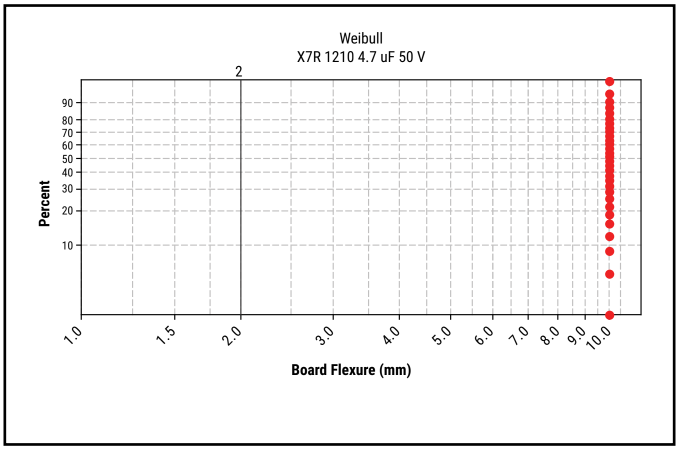
Board Flex vs. Termination Type



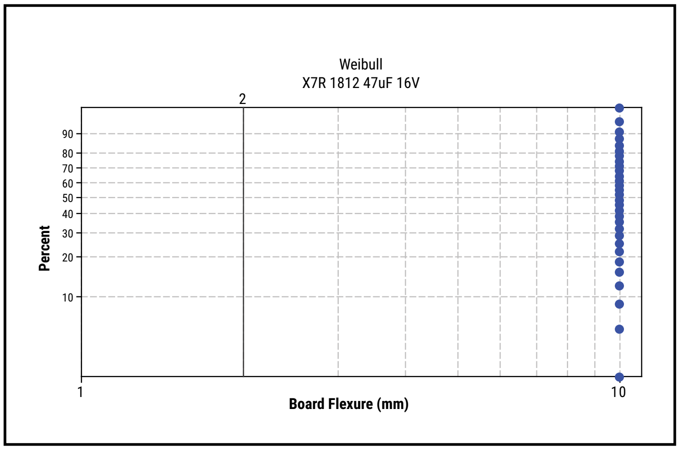
Board Flex vs. Termination Type



Board Flexure to 10 mm



Board Flexure to 10 mm



KEMET a YAGEO company

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

Capacitance	Cap Code	Case Size/Series		C1210C						C1812C					C2220C				
		Voltage Code		8	4	3	5	1	A	4	3	5	1	A	4	3	5	1	A
		Rated Voltage (VDC)		10	16	25	50	100	250	16	25	50	100	250	16	25	50	100	250
		Capacitance Tolerance		Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions															
Single Chip Stack																			
0.10 µF	104	K	M	FV	FV	FV	FV	FV	FV	GP	GP	GP	*UD*	*UD*	JP	JP	JP	JP	JP
0.22 µF	224	K	M	FV	FV	FV	FV	FV		GP	GP	GP	*UD*	*UD*	JP	JP	JP	JP	JP
0.47 µF	474	K	M	FV	FV	FV	FV	FV		GP	GP	GP	*UD*	*UD*	JP	JP	JP		
1.0 µF	105	K	M	FV	FV	FV	FV	FV		GP	GP	GP	*UD*		JP	JP	JP		
2.2 µF	225	K	M	FV	FV	FV	FV			GP	GP	GP			JP	JP	JP	*UD*	
3.3 µF	335	K	M	FV	FV	FV	FV			GP	GP	GP			JP	JP	JP	*UD*	
4.7 µF	475	K	M	FV	FV	FV	FV			GP	GP	GP			JP	JP	JP		
10 µF	106	K	M	FV	FV	FV				GP	GP				JP	JP	JP		
15 µF	156	K	M												JP	JP			
22 µF	226	K	M												JP	JP			
Double Chip Stack																			
0.10 µF	104		M	FW	FW	FW	FW	FW	FW	GR	GR	GR	*UD*	*UD*	JR	JR	JR	JR	JR
0.22 µF	224		M	FW	FW	FW	FW	FW	FW	GR	GR	GR	*UD*	*UD*	JR	JR	JR	JR	JR
0.47 µF	474		M	FW	FW	FW	FW	FW		GR	GR	GR	*UD*	*UD*	JR	JR	JR	JR	JR
1.0 µF	105		M	FW	FW	FW	FW	FW		GR	GR	GR	*UD*	*UD*	JR	JR	JR		
2.2 µF	225		M	FW	FW	FW	FW	FW		GR	GR	GR	*UD*		JR	JR	JR		
3.3 µF	335		M	FW	FW	FW	FW			GR	GR	GR	*UD*		JR	JR	JR	*UD*	
4.7 µF	475		M	FW	FW	FW	FW			GR	GR	GR			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		M												JR	JR			
47 µF	476		M												JR	JR			
Capacitance	Cap Code	Rated Voltage (VDC)		10	16	25	50	100	250	16	25	50	100	250	16	25	50	100	250
		Voltage Code		8	4	3	5	1	A	4	3	5	1	A	4	3	5	1	A
		Case Size/Series		C1210C						C1812C					C2220C				

UD = Under development

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

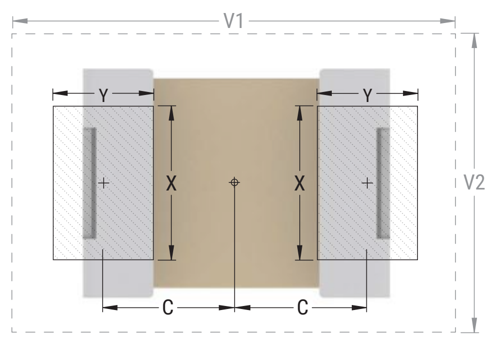
Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
FV	1210	3.35 ± 0.10	0	0	600	2,000
FW	1210	6.15 ± 0.15	0	0	300	1,000
GP	1812	2.65 ± 0.35	0	0	500	2,000
GR	1812	5.00 ± 0.50	0	0	400	1,700
JP	2220	3.50 ± 0.30	0	0	300	1,300
JR	2220	5.00 ± 0.50	0	0	200	800
Thickness 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 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
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.

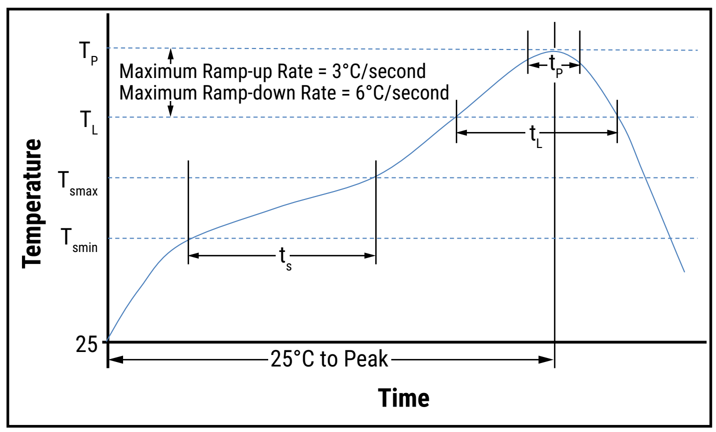
To prevent degradation of temperature cycling capability, care must be taken to prevent solder from flowing into the inner side of the lead frames (inner side of "J" lead in contact with the circuit board).

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_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

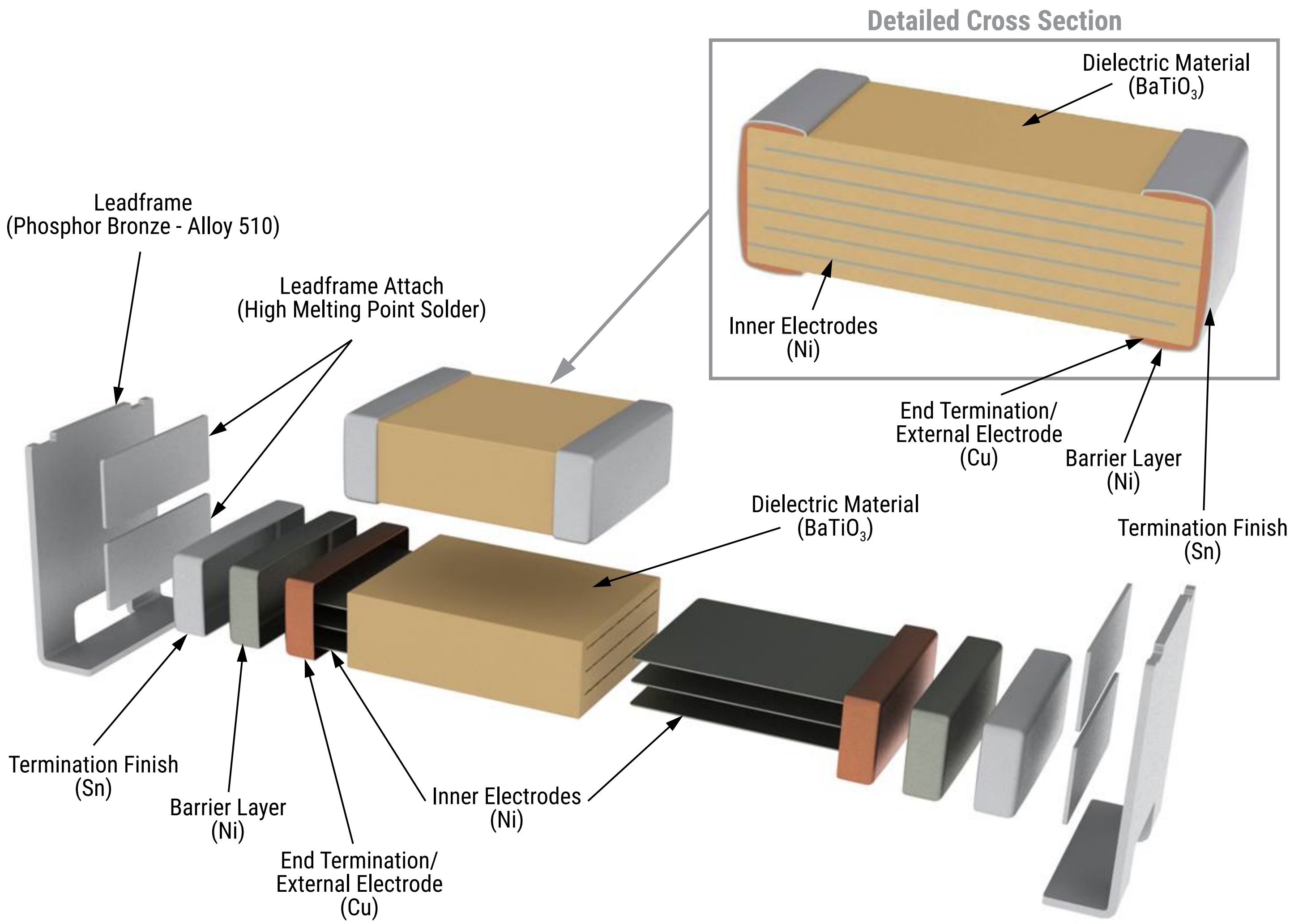
Note: All temperatures refer to the center of the package, measured on the package body surface that is facing up during assembly reflow.



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 40ºC 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:

- C0G, 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.

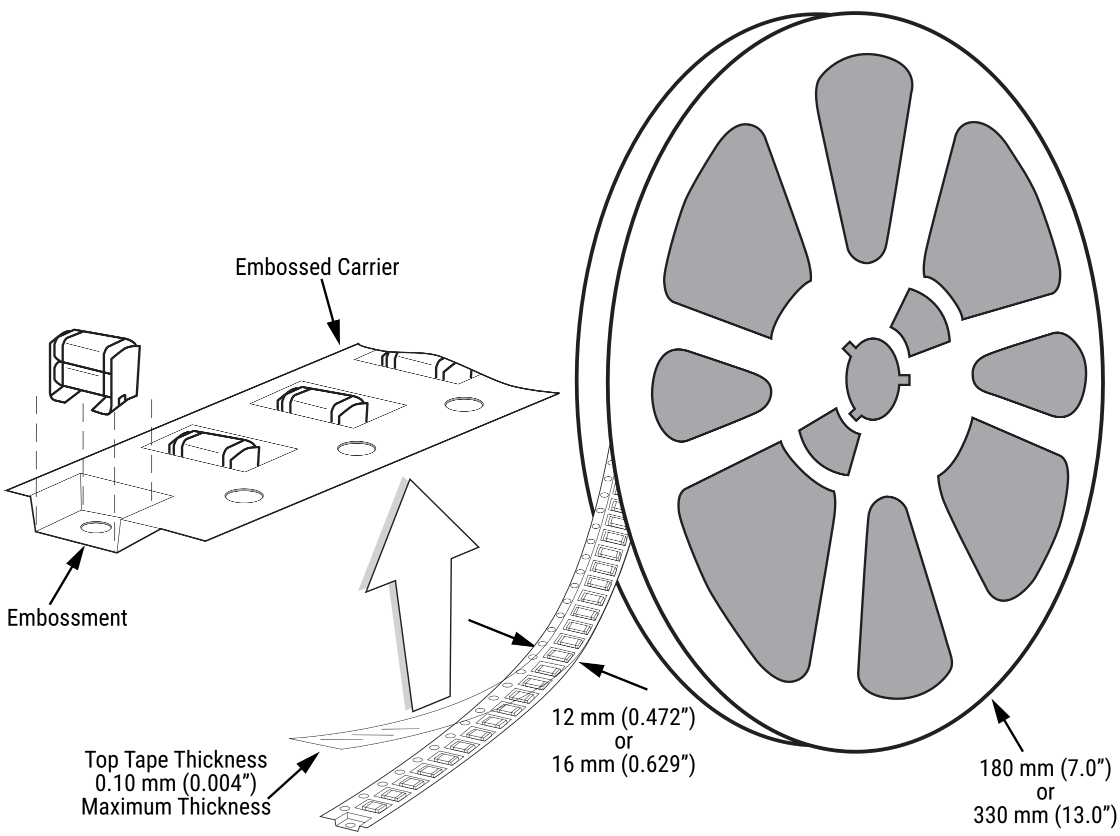


Table 4 – Carrier Tape Configuration – Embossed Plastic (mm)

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

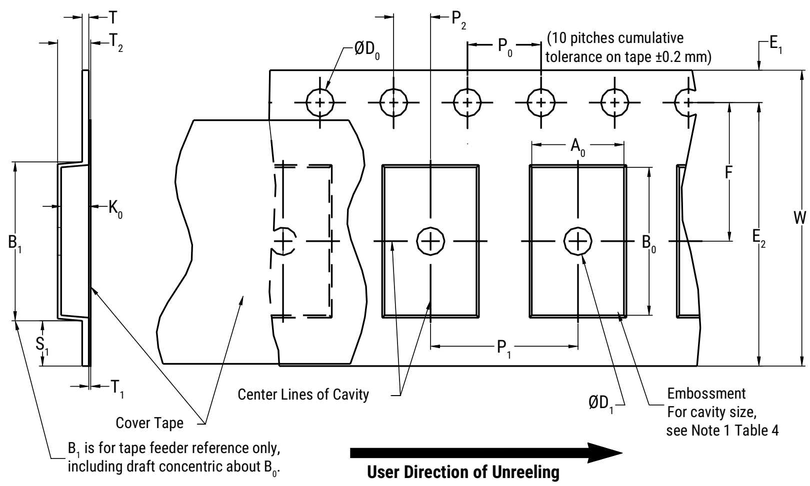


Table 5 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

<table>
<tr><th colspan="9">Constant Dimensions — Millimeters (Inches)</th></tr>
<tr><th>Tape Size</th><th>D_0</th><th>D_1 Minimum Note 1</th><th>E_1</th><th>P_0</th><th>P_2</th><th>R Reference Note 2</th><th>S_1 Minimum Note 3</th><th>T Maximum</th><th>T_1 Maximim</th></tr>
<tr><td>8 mm</td><td rowspan="3">1.5+0.10/0.0−0.0 (0.059+0.004/−0.0)</td><td>1.0 (0.039)</td><td rowspan="3">1.75±0.10 (0.069±0.004)</td><td rowspan="3">4.0±0.10 (0.157±0.004)</td><td rowspan="3">2.0±0.05 (0.079±0.002)</td><td>25.0 (0.984)</td><td rowspan="3">0.600 (0.024)</td><td rowspan="3">0.600 (0.024)</td><td rowspan="3">0.100 (0.004)</td></tr>
<tr><td>12 mm</td><td rowspan="2">1.5 (0.059)</td><td rowspan="2">30 (1.181)</td></tr>
<tr><td>16 mm</td></tr>
<tr><th colspan="10">Variable Dimensions — Millimeters (Inches)</th></tr>
<tr><th>Tape Size</th><th>Pitch</th><th>B_1 Maximum Note 4</th><th>E_2 Minimum</th><th>F</th><th>P_1</th><th>T_2 Maximum</th><th>W Maximum</th><th colspan="2">A_0, B_0 & K_0</th></tr>
<tr><td>8 mm</td><td>Single (4 mm)</td><td>4.35 (0.171)</td><td>6.25 (0.246)</td><td>3.5±0.05 (0.138±0.002)</td><td>4.0±0.10 (0.157±0.004)</td><td>2.5 (0.098)</td><td>8.3 (0.327)</td><td colspan="2" rowspan="3">Note 5</td></tr>
<tr><td>12 mm</td><td>Single (4 mm) & Double (8 mm)</td><td>8.2 (0.323)</td><td>10.25 (0.404)</td><td>5.5±0.05 (0.217±0.002)</td><td>8.0±0.10 (0.315±0.004)</td><td>4.6 (0.181)</td><td>12.3 (0.484)</td></tr>
<tr><td>16 mm</td><td>Triple (12 mm)</td><td>12.1 (0.476)</td><td>14.25 (0.561)</td><td>7.5±0.05 (0.138±0.002)</td><td>12.0±0.10 (0.157±0.004)</td><td>4.6 (0.181)</td><td>16.3 (0.642)</td></tr>
</table>

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 < 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_1 dimension is a reference dimension for tape feeder clearance only.*
5. *The cavity defined by A_0, B_0 and K_0 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

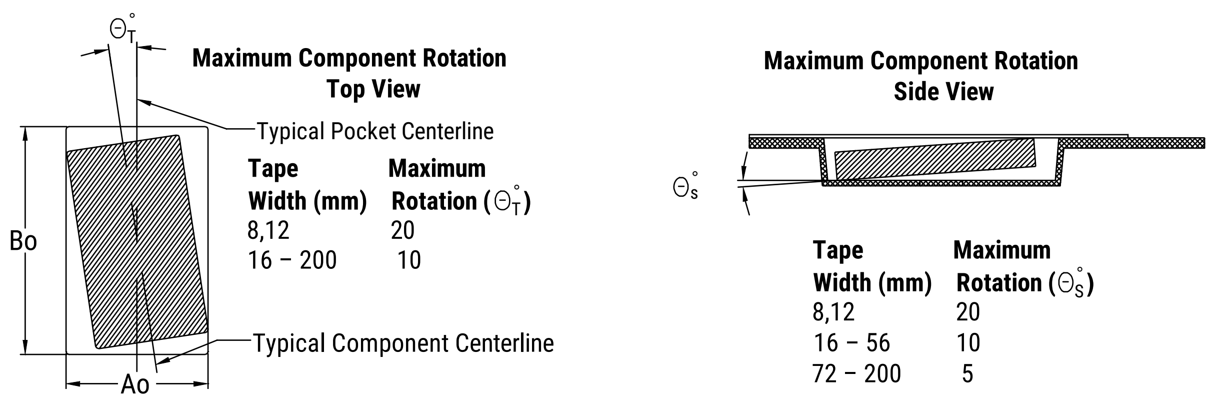


Figure 3 – Maximum Lateral Movement

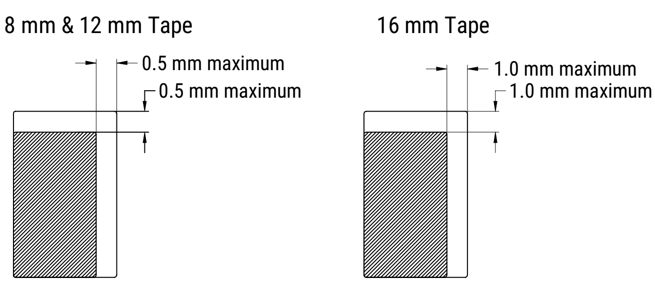


Figure 4 – Bending Radius

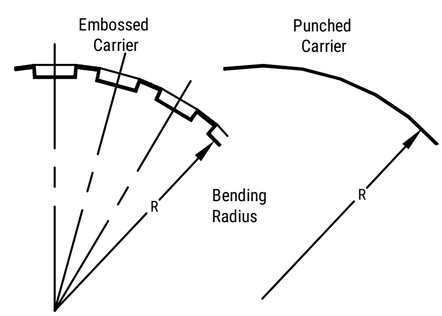
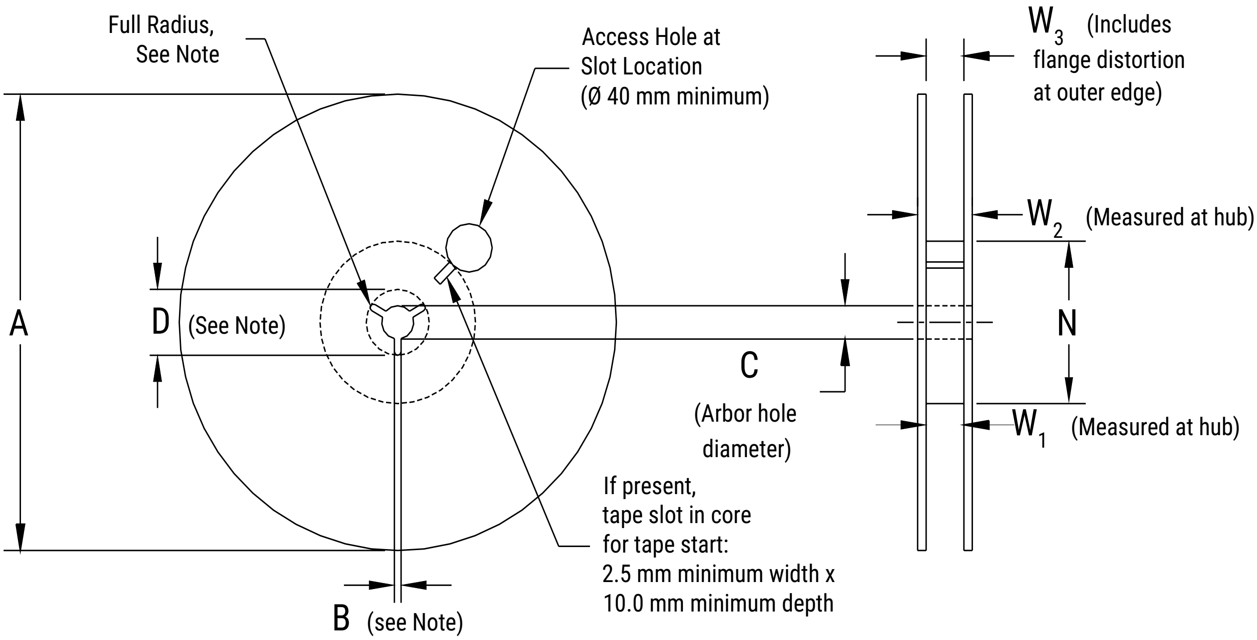


Figure 5 – Reel Dimensions



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	A	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 6 – Tape Leader & Trailer Dimensions

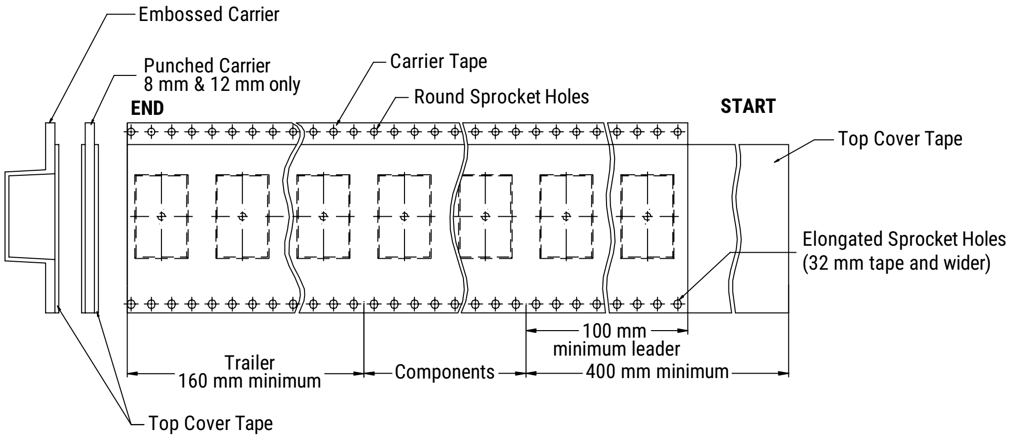
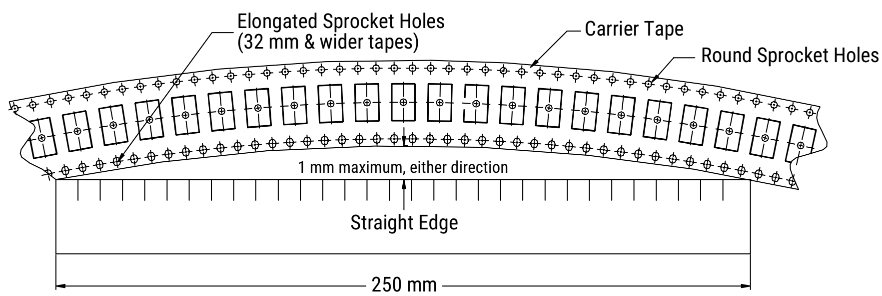


Figure 7 – Maximum Camber



C0G Dielectric, 10 – 250 VDC (Automotive Grade)

Overview

KEMET's Automotive Grade Series surface mount capacitors in C0G 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.

C0G dielectric features a 125°C maximum operating temperature and is considered "stable." The Electronics Industries Alliance (EIA) characterizes C0G 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. C0G 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/ºC 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

C	1206	C	104	J	3	G	A	C	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 0.5 – .99 pF ex. 2.2 pF = 229 ex. 0.5 pF = 508	B = ±0.10 pF C = ±0.25 pF D = ±0.5 pF F = ±1% G = ±2% J = ±5% K = ±10% M = ±20%	8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 2 = 200 A = 250	G = C0G	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)[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 cont.

- 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
- 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 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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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:

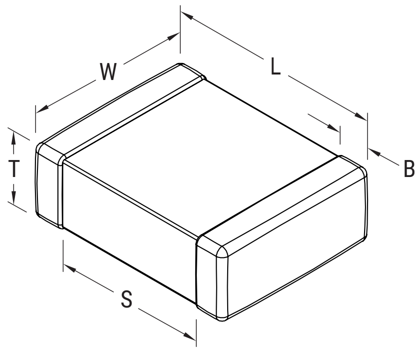
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

[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)



<table>
<tr><th>EIA Size Code</th><th>Metric Size Code</th><th>L
Length</th><th>W
Width</th><th>T
Thickness</th><th>B
Bandwidth</th><th>S
Separation Minimum</th><th>Mounting Technique</th></tr>
<tr><td>0402</td><td>1005</td><td>1.00 (0.040) ±0.05 (0.002)</td><td>0.50 (0.020) ±0.05 (0.002)</td><td rowspan="7">See Table 2 for Thickness</td><td>0.30 (0.012) ±0.10 (0.004)</td><td>0.30 (0.012)</td><td>Solder Reflow Only</td></tr>
<tr><td>0603</td><td>1608</td><td>1.60 (0.063) ±0.15 (0.006)</td><td>0.80 (0.032) ±0.15 (0.006)</td><td>0.35 (0.014) ±0.15 (0.006)</td><td>0.70 (0.028)</td><td rowspan="3">Solder Wave or Solder Reflow</td></tr>
<tr><td>0805</td><td>2012</td><td>2.00 (0.079) ±0.20 (0.008)</td><td>1.25 (0.049) ±0.20 (0.008)</td><td>0.50 (0.02) ±0.25 (0.010)</td><td>0.75 (0.030)</td></tr>
<tr><td>1206</td><td>3216</td><td>3.20 (0.126) ±0.20 (0.008)</td><td>1.60 (0.063) ±0.20 (0.008)</td><td>0.50 (0.02) ±0.25 (0.010)</td><td rowspan="4">N/A</td></tr>
<tr><td>1210</td><td>3225</td><td>3.20 (0.126) ±0.20 (.008)</td><td>2.50 (0.098) ±0.20 (0.008)</td><td>0.50 (0.02) ±0.25 (0.010)</td><td rowspan="3">Solder Reflow Only</td></tr>
<tr><td>1812</td><td>4532</td><td>4.50 (0.177) ±0.30 (0.012)</td><td>3.20 (0.126) ±0.30 (0.012)</td><td>0.60 (0.024) ±0.35 (0.014)</td></tr>
<tr><td>2220</td><td>5650</td><td>5.70 (0.224) ±0.40 (0.016)</td><td>5.00 (0.197) ±0.40 (0.016)</td><td>0.60 (0.024) ±0.35 (0.014)</td></tr>
</table>

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 ≤ 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 MΩ-µF value by the capacitance and compare to GΩ 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
C0G	All	All	0.5	0.3% or ±0.25 pF	10% of Initial Limit

Table 1A – Capacitance Range/Selection Waterfall (0402 – 0805 Case Sizes)

Capacitance	Cap Code	Case Size/Series								C0402C							C0603C							C0805C						
		Voltage Code								8	4	3	5	1	2	A	8	4	3	5	1	2	A	8	4	3	5	1	2	A
		Rated Voltage (VDC)								10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Table 2 for Chip 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
1.0 – 9.1 pF*	109 – 919*	B	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	M	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	K	M	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	M	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	K	M	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	M	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	M	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	M	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	M	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	M	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	M	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	M	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	M	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	M	BB	BB	BB	BB				CF	CF	CF	CF	CF	CH	CH	DN	DN	DN	DN	DN	DN	DN
1,200 pF	122				F	G	J	K	M	BB	BB	BB	BB				CF	CF	CF	CF	CF	CH	CH	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	CH	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	BB	BB					CF	CF	CF	CF	CF	CH	CH	DP	DP	DP	DP	DP	DN	DN
2,000 pF	202				F	G	J	K	M	BB	BB	BB					CF	CF	CF	CF	CF	CH	CH	DN	DN	DN	DN	DN	DN	DN
2,200 pF	222				F	G	J	K	M	BB	BB	BB					CF	CF	CF	CF	CF	CH	CH	DN	DN	DN	DN	DN	DN	DN
2,400 pF	242				F	G	J	K	M								CF	CF	CF	CF	CF			DN	DN	DN	DN	DN	DN	DN
2,700 pF	272				F	G	J	K	M								CF	CF	CF	CF	CF			DN	DN	DN	DN	DN	DN	DN
3,000 pF	302				F	G	J	K	M								CF	CF	CF	CF	CF			DP	DP	DP	DP	DN	DN	DN
3,300 pF	332				F	G	J	K	M								CF	CF	CF	CF	CF			DP	DP	DP	DP	DN	DN	DN
3,600 pF	362				F	G	J	K	M								CF	CF	CF	CF	CF			DP	DP	DP	DP	DN	DP	DP
3,900 pF	392				F	G	J	K	M								CF	CF	CF	CF	CF			DE	DE	DE	DE	DN	DP	DP
4,300 pF	432				F	G	J	K	M								CF	CF	CF	CF	CF			DE	DE	DE	DE	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	K	M								CF	CF	CF	CF				DN	DN	DN	DN	DN	DG	DG
6,800 pF	682				F	G	J	K	M								CF	CF	CF	CF				DN	DN	DN	DN	DN	DG	DG
7,500 pF	752				F	G	J	K	M								CF	CF	CF					DN	DN	DN	DN	DN	DG	DG
8,200 pF	822				F	G	J	K	M								CF	CF	CF					DN	DN	DN	DN	DN	DG	DG
9,100 pF	912				F	G	J	K	M								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	M								CF	CF	CF					DN	DN	DN	DN	DE		
15,000 pF	153				F	G	J	K	M								CF	CF	CF					DN	DN	DN	DP	DG		
18,000 pF	183				F	G	J	K	M															DN	DN	DN	DP			
22,000 pF	223				F	G	J	K	M															DP	DP	DP	DF			
27,000 pF	273				F	G	J	K	M															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	473				F	G	J	K	M															DG	DG	DG				
Capacitance	Cap Code	Rated Voltage (VDC)								10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250
		Voltage Code								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							C0805C						

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)

Cap	Cap Code	Case Size/Series								C1206C							C1210C							C1812C				C2220C		
		Voltage Code								8	4	3	5	1	2	A	8	4	3	5	1	2	A	5	1	2	A	5	1	2
		Rated Voltage (VDC)								10	16	25	50	100	200	250	10	16	25	50	100	200	250	50	100	200	250	50	100	200
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																				
1.0 – 9.1 pF*	109 – 919*	B	C	D						EB	EB	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB	FB	FB							
10 – 91 pF*	100 – 910*				F	G	J	K	M	EB	EB	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB	FB	FB							
100 – 430 pF*	101 – 431*				F	G	J	K	M	EB	EB	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB	FB	FB							
470 – 910 pF*	471 – 911*				F	G	J	K	M	EB	EB	EB	EB	EB	EB	EB	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	M	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	M	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	M	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	M	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	M	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	M	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	M	EB	EB	EB	EB	EC	EC	EC	FB	FB	FB	FB	FC	FC	FC							
2,700 pF	272				F	G	J	K	M	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	M	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							
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	752				F	G	J	K	M	EB	EB	EB	EB	EB	EB	EB	FC	FC	FC	FC	FC	FB	FB							
8,200 pF	822				F	G	J	K	M	EC	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	G	J	K	M	EC	EC	EC	EC	EB	EC	EC	FE	FE	FE	FE	FE	FB	FB							
10,000 pF	103				F	G	J	K	M	ED	ED	ED	ED	EB	EC	EC	FF	FF	FF	FF	FF	FB	FB	GB	GH	GB	GB	JE	JE	JB
12,000 pF	123				F	G	J	K	M	EB	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	G	J	K	M	EB	EB	EB	EB	EB	EF	EF	FG	FG	FG	FG	FB	FC	FC	GB	GB	GB	GB	JE	JE	JB
18,000 pF	183				F	G	J	K	M	EB	EB	EB	EB	EB	EH	EH	FB	FB	FB	FB	FB	FC	FC	GB	GB	GB	GB	JE	JE	JB
22,000 pF	223				F	G	J	K	M	EB	EB	EB	EB	EC	EH	EH	FB	FB	FB	FB	FB	FF	FF	GB	GB	GB	GB	JE	JB	JB
27,000 pF	273				F	G	J	K	M	EB	EB	EB	EB	EE			FB	FB	FB	FB	FB	FG	FG	GB	GB	GB	GB	JE	JB	JB
33,000 pF	333				F	G	J	K	M	EB	EB	EB	EB	EE			FB	FB	FB	FB	FB	FH	FH	GB	GB	GB	GB	JB	JB	JB
39,000 pF	393				F	G	J	K	M	EC	EC	EC	EE	EH			FB	FB	FB	FB	FE	FH	FH	GB	GB	GB	GB	JB	JB	JB
47,000 pF	473				F	G	J	K	M	EC	EC	EC	EE	EH			FB	FB	FB	FB	FE	FJ	FJ	GB	GB	GD	GD	JB	JB	JB
56,000 pF	563				F	G	J	K	M	ED	ED	ED	EF				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	K	M	EH	EH	EH	EH				FC	FC	FC	FF	FH			GB	GB	GM	GM	JB	JB	JB
0.10 μF	104				F	G	J	K	M	EH	EH	EH					FE	FE	FE	FG	FM			GB	GD	GM	GM	JB	JB	JD
0.12 μF	124				F	G	J	K	M								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	M								FJ	FJ	FJ					GH				JB	JD	JG
0.22 μF	224				F	G	J	K	M								FK	FK	FK					GK				JB	JD	JL
0.27 μF	274				F	G	J	K	M																			JB	JF	
0.33 μF	334				F	G	J	K	M																			JD	JG	
0.39 μF	394				F	G	J	K	M																			JG		
0.47 μF	474				F	G	J	K	M																			JG		
Cap	Cap Code	Rated Voltage (VDC)								10	16	25	50	100	200	250	10	16	25	50	100	200	250	50	100	200	250	50	100	200
		Voltage Code								8	4	3	5	1	2	A	8	4	3	5	1	2	A	5	1	2	A	5	1	2
		Case Size/Series								C1206C							C1210C							C1812C				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)*
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 Code	Case Size1	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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	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
FK	1210	2.10 ± 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 Code	Case Size1	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[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 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)				
		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

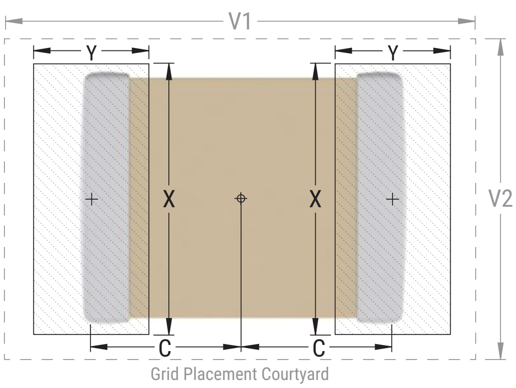
[1] *Only for capacitance values ≥ 22 µF*

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:

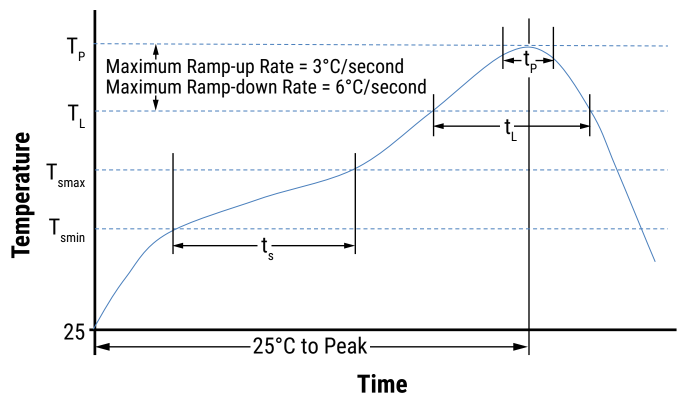
- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- All other EIA case sizes are limited to solder reflow only

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	
	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

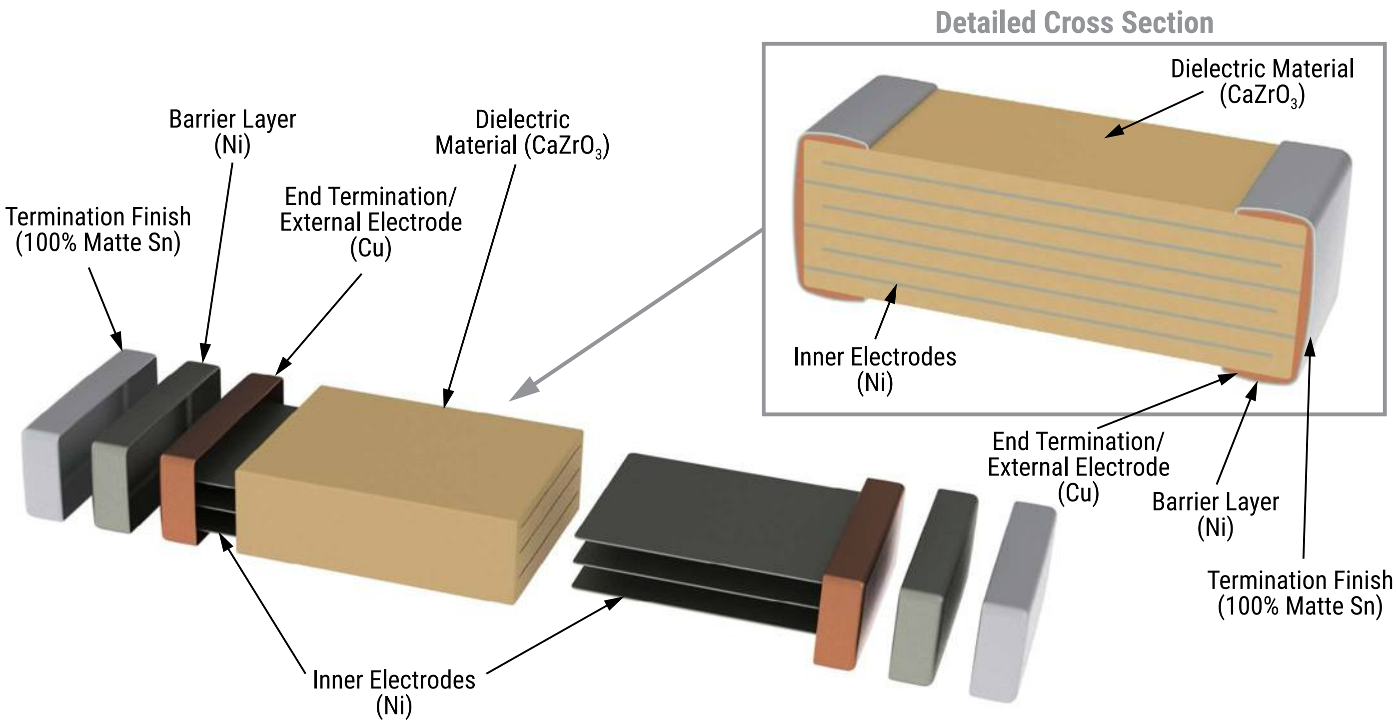
Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.



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 40ºC 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)

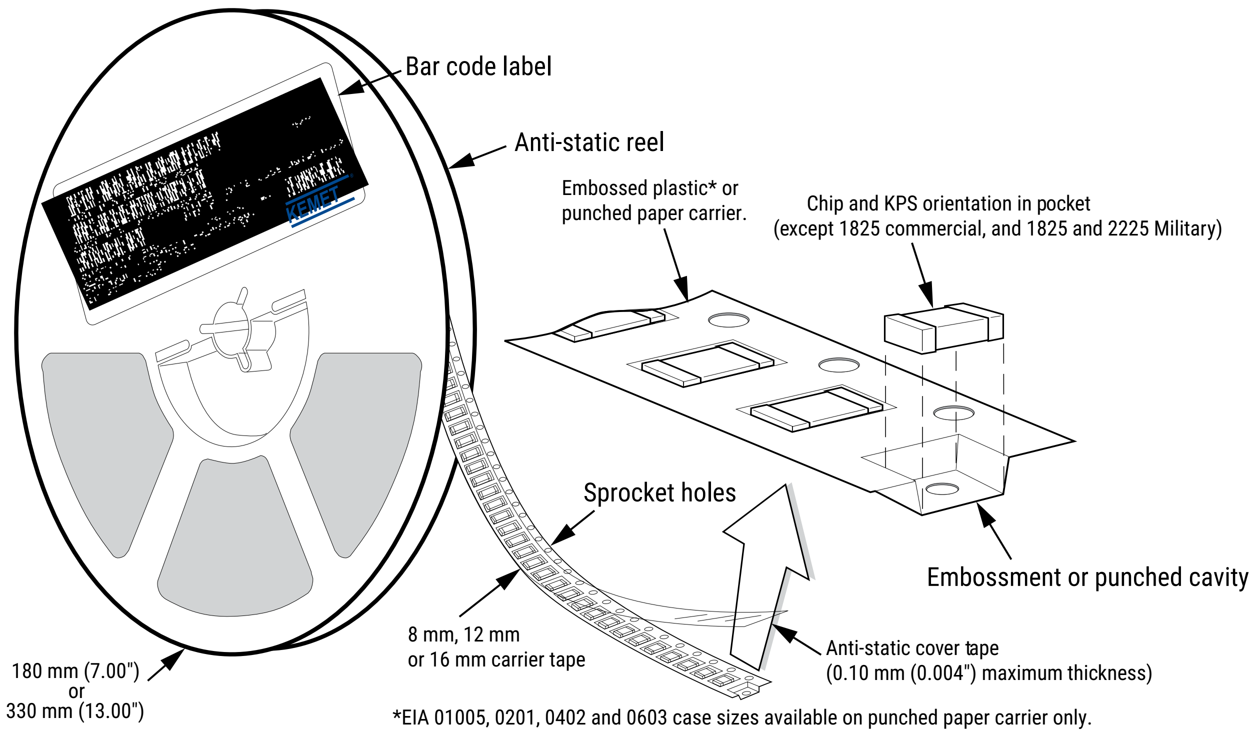
Laser marking option is not available on:

- C0G, 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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

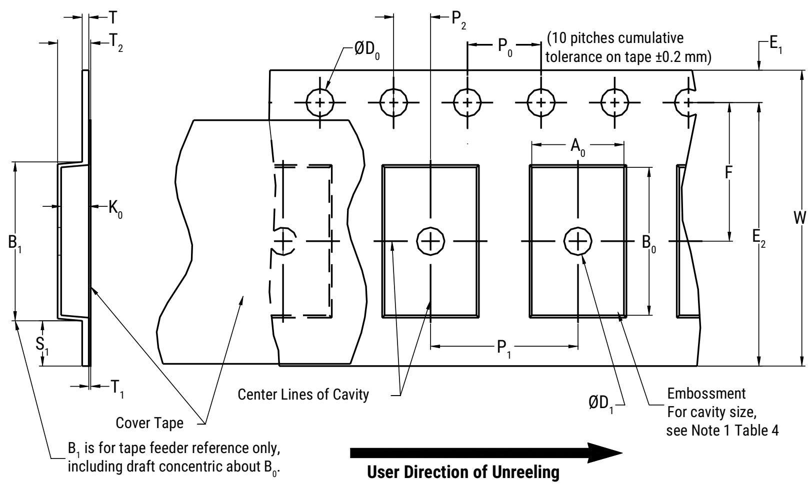


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +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)			
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)	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 S_1 < 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_0, B_0 and K_0 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

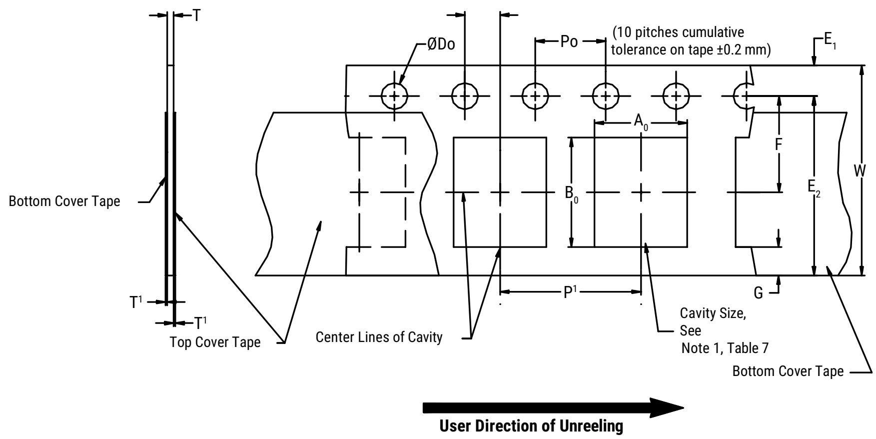


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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.)

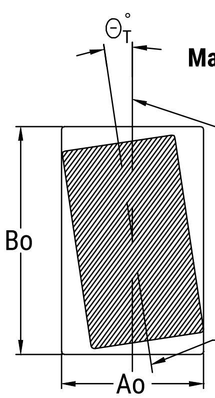
Packaging Information Performance Notes

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:

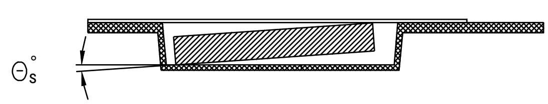
Tape Width	Peel Strength
8 mm	0.1 to 1.0 newton (10 to 100 gf)
12 and 16 mm	0.1 to 1.3 newton (10 to 130 gf)

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



Tape Width (mm)	Maximum Rotation (Θ°T)
8,12	20
16 – 200	10



Tape Width (mm)	Maximum Rotation (Θ°S)
8,12	20
16 – 56	10
72 – 200	5

Figure 4 – Maximum Lateral Movement

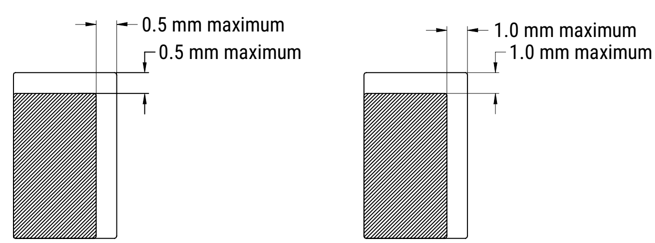


Figure 5 – Bending Radius

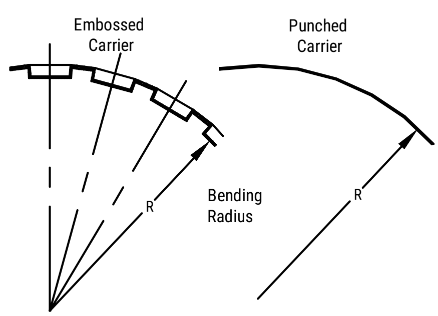
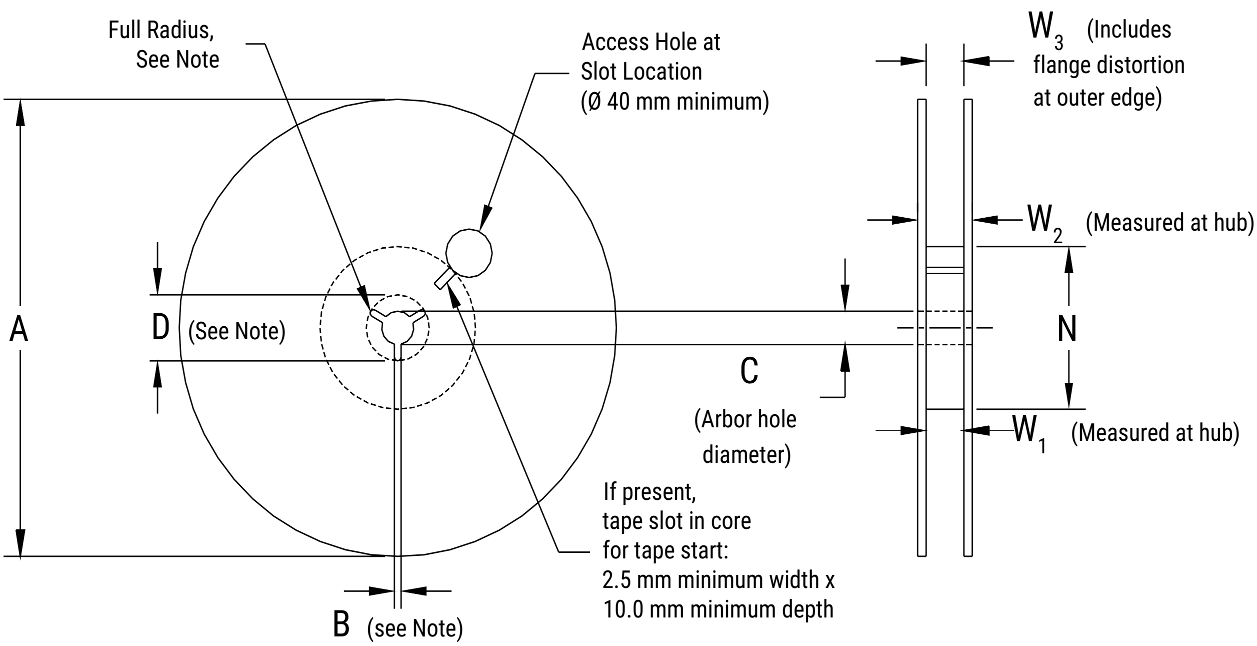


Figure 6 – Reel Dimensions



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	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

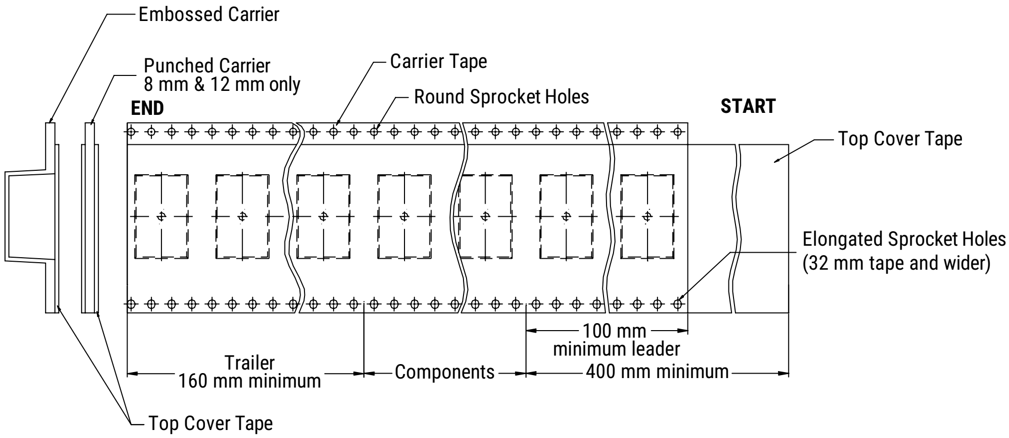
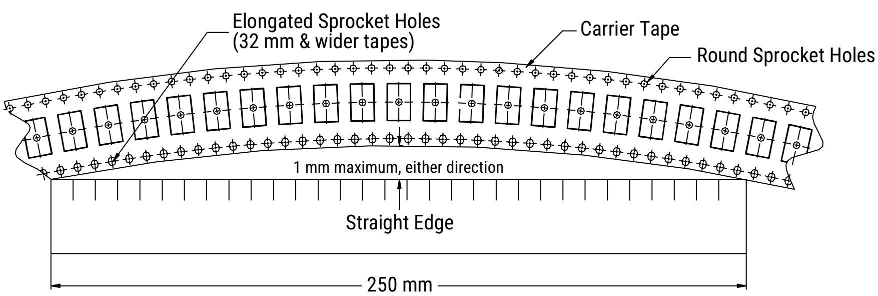


Figure 8 – Maximum Camber



X7R Dielectric, 6.3 – 250 VDC (Automotive Grade)

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 ±15% 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
- 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

C	0805	C	225	M	4	R	A	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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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:

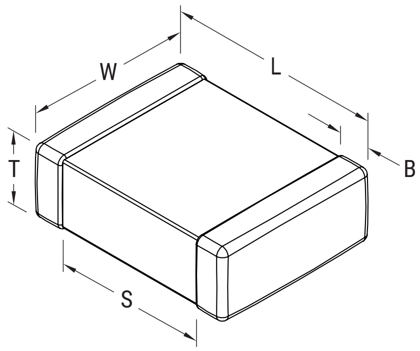
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

[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[1]	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)		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 ≥ 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 µF or ≥ 2.2 µF add 0.10 (0.004) to length tolerance dimension.
[3] For capacitance value 1.0 µF all voltages and 10 µF with 25 V add 0.05 (0.002) to length tolerance dimension.
[4] For capacitance values ≥ 4.7 µF 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*
[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 ≤ 10 µF
120 Hz ± 10 Hz and 0.5 ± 0.1 V_{rms} if capacitance > 10 µF
[4] *To obtain IR limit, divide MΩ – µF value by the capacitance and compare to GΩ 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
0402	< 100 V	< 0.012 µF	≥ 0.012 µF< 0.47 µf	≥ 0.47 µf
	100 V	N/A	ALL	N/A
0603[1]	≤ 200 V	< 0.047 µF	≥ 0.047 µf < 0.47 µf	≥ 0.47 µf
	250 V	N/A	N/A	ALL
0805[2]	≤ 200 V	< 0.15 µF	≥ 0.15 µF < 2.2 µf	≥ 2.2 µf
	250 V	< .027 µF	N/A	≥ .027 µF
1206	≤ 200 V	< 0.47 µF	≥ 0.47 µF < 2.2 µf	≥ 2.2 µf
	250 V	< 0.12 µF	N/A	≥ 0.12 µF
1210[3]	≤ 200 V	< 0.39 µF	≥ 0.39 µF < 10 µf	≥ 10 µf
	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 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 µF (50 V) IR should be calculated under 100 megohm microfarads or 10 GΩ.*
[3] *For Capacitance value 4.7 µF (50 V) IR should be calculated under 100 megohm microfarads or 10 GΩ.*

Dissipation Factor (DF) Limits Table

EIA Case Size	Rated DC Voltage	Capacitance	Dissipation Factor (Maximum %)
0402	< 16	All	5.0
	16/25		3.5
	> 25		2.5
0603[1]	< 16	< 1.0 µF	5.0
	16/25		3.5
	> 25		2.5
	All	≥ 1.0 µF	10.0
0805[2]	< 16	< 4.7 µF	5.0
		≥ 4.7 µF	10.0
	16	< 4.7 µF	3.5
		≥ 4.7 µF	10.0
	25	<2.2 µF	3.5
		≥ 2.2 µF	10.0
	> 25	<1.0 µF	2.5
		≥ 1.0 µF	10.0
1206[3]	< 16	All	5.0
	16/25	All	3.5
	> 25	All	2.5
1210[4]	< 16	All	5.0
	16	All	3.5
	25	< 10 µF	3.5
		≥ 10 µF	10.0
	> 25	All	2.5
	50	All	2.5
	> 50	All	2.5
1805 - 2225	< 16	All	5.0
	16/25		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 µF (≤ 16 V) DF is 10% and for Capacitance value 4.7 µF (50 V) DF is 5%.

Post Environmental Limits

High Temperature Life, Biased Humidity, Moisture Resistance					
EIA Case Size	Rated DC Voltage	Capacitance	Dissipation Factor (Maximum %)	Capacitance Shift	Insulation Resistance
0402	< 16	All	7.5	±20%	10% of Initial limit
	16/25	All	5.0		
	> 25	All	3.0		
0603[1]	< 16	< 1.0 µF	7.5		
	16/25		5.0		
	> 25		3.0		
	All	≥ 1.0 µF	20.0		
0805[2]	< 16	< 4.7 µF	7.5		
		≥ 4.7 µF	20.0		
	16	< 4.7 µF	5.0		
		≥ 4.7 µF	20.0		
	25	< 2.2 µF	5.0		
		≥ 2.2 µF	20.0		
	> 25	< 1.0 µF	3.0		
		≥ 1.0 µF	20.0		
1206[3]	< 16	All	7.5		
	16/25	All	5.0		
	> 25	All	3.0		
1210[4]	< 16	All	7.5		
	16	All	5.0		
	25	< 10 µF	5.0		
		≥ 10 µF	20.0		
	> 25	All	3.0		
	50	All	3.0		
	> 50	All	3.0		
1805 – 2225	< 16	All	7.5		
	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 µF (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 ≥ 10 µF (≤ 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)

Capacitance	Cap Code	Case Size /Series			C0402C						C0603C								C0805C								C1206C							
		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
		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
		Capacitance Tolerance			Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions																													
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	CF	DN	DN	DN	DN	DN	DN	DN	DN	EB	EB	EB	EB	EB	EB	EB	EB
1,200 pF	122	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
1,500 pF	152	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	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
2,200 pF	222	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
2,700 pF	272	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
3,300 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	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	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
5,600 pF	562	J	K	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
6,800 pF	682	J	K	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
8,200 pF	822	J	K	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	J	K	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
12,000 pF	123	J	K	M	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	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
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	273	J	K	M	BB	BB	BB	BB			CF	CF	CF	CF	CF	CF			DN	DN	DN	DN	DN	DP	DE	DG	EB	EB	EB	EB	EB	EB	EB	EB
33,000 pF	333	J	K	M	BB	BB	BB	BB			CF	CF	CF	CF	CF	CF			DN	DN	DN	DN	DN	DP	DE	DG	EB	EB	EB	EB	EB	EB	EB	EB
39,000 pF	393	J	K	M	BB	BB	BB	BB			CF	CF	CF	CF	CF	CF			DN	DN	DN	DN	DN	DP	DE	DG	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	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	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
82,000 pF	823	J	K	M	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	M	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	DN	DN	DN	DP	DG			EC	EC	EC	EC	EC	EC	EG	EG
0.18 µF	184	J	K	M							CF	CF	CF	CF					DN	DN	DN	DN	DP	DG			EC	EC	EC	EC	EC	EC	EM	EM
0.22 µF	224	J	K	M							CF	CF	CF	CF	CJ				DN	DN	DN	DN	DP	DG			EC	EC	EC	EC	EC	EC	EG	EG
0.27 µF	274	J	K	M							CF	CF	CF						DP	DP	DP	DP	DP				EB	EB	EB	EB	EC	EM		
0.33 µF	334	J	K	M							CF	CF	CF						DP	DP	DP	DP	DP				EB	EB	EB	EB	EC	EG		
0.39 µF	394	J	K	M							CF	CF	CF						DG	DG	DG	DG	DE				EB	EB	EB	EB	EC	EG		
0.47 µF	474	J	K	M							CF	CF	CF	CG					DP	DP	DP	DP	DE				EC	EC	EC	EC	EC	EG		
0.56 µF	564	J	K	M															DP	DP	DP	DG	DH				ED	ED	ED	ED	EC	EM		
0.68 µF	684	J	K	M															DP	DP	DP	DG	DH				EE	EE	EE	EE	ED	EM		
0.82 µF	824	J	K	M															DP	DP	DP	DG					EF	EF	EF	EF	ED	EH		
1.0 µF	105	J	K	M							CJ[1]	CJ[1]	CJ[1]						DP	DP	DP	DG	DH				EF	EF	EF	EG	ED	EH		
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	DG	DH				EH	EH	EH	EH	EH			
2.7 µF	275	J	K	M																							EN	EN	EN	EH				
3.3 µF	335	J	K	M																							ED	ED	ED	EH				
3.9 µF	395	J	K	M																							EF	EF	EF	EH				
Capacitance	Cap 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
		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
		Case Size /Series			C0402C						C0603C								C0805C								C1206C							

**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.

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Table 1A – Capacitance Range/Selection Waterfall (0402 – 1206 Case Sizes) cont.

Capacitance	Cap Code	Case Size /Series			C0402C						C0603C								C0805C								C1206C							
		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
		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
		Capacitance Tolerance			Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions																													
4.7 µF	475	J	K	M															DG	DG	DG	DH					EF	EH	EH	EH	EH			
5.6 µF	565	J	K	M																							EH	EH	EH					
6.8 µF	685	J	K	M																							EH	EH	EH					
8.2 µF	825	J	K	M																							EH	EH	EH					
10 µF	106	J	K	M															DH	DH							EH	EH	EH	EH				
Capacitance	Cap 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
		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
		Case Size /Series			C0402C						C0603C								C0805C								C1206C							

*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 tolerance.

Table 1B – Capacitance Range/Selection Waterfall (1210 – 1808 Case Sizes)

Capacitance	Cap Code	Case Size /Series			C1210C								C1805C			C1808C		
		Voltage Code			9	8	4	3	5	1	2	A	5	1	2	5	1	2
		Rated Voltage (VDC)			6.3	10	16	25	50	100	200	250	50	100	200	50	100	200
		Capacitance Tolerance			Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions													
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	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	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	
Capacitance	Cap Code	Rated Voltage (VDC)			6.3	10	16	25	50	100	200	250	50	100	200	50	100	200
		Voltage Code			9	8	4	3	5	1	2	A	5	1	2	5	1	2
		Case Size /Series			C1210C								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 X7R with KONNEKT Technology.

Table 1B – Capacitance Range/Selection Waterfall (1210 – 1808 Case Sizes) cont.

Capacitance	Cap Code	Case Size /Series			C1210C								C1805C			C1808C		
		Voltage Code			9	8	4	3	5	1	2	A	5	1	2	5	1	2
		Rated Voltage (VDC)			6.3	10	16	25	50	100	200	250	50	100	200	50	100	200
		Capacitance Tolerance			Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions													
12,000 pF	123	J	K	M	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	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	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	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	FP	FP						
0.33 µF	334	J	K	M	FD	FD	FD	FD	FD	FD	FM	FM						
0.39 µF	394	J	K	M	FD	FD	FD	FD	FD	FD	FK	FK						
0.47 µF	474	J	K	M	FD	FD	FD	FD	FD	FD	FS	FS						
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	FH								
1.5 µF	155	J	K	M	FH	FH	FH	FH	FG	FM								
1.8 µF	185	J	K	M	FH	FH	FH	FH	FG	FJ								
2.2 µF	225	J	K	M	FJ	FJ	FJ	FJ	FG	FK								
2.7 µF	275	J	K	M	FE	FE	FE	FG	FH									
3.3 µF	335	J	K	M	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	M	FG	FG	FG	FM										
8.2 µF	825	J	K	M	FH	FH	FH	FK										
10 µF	106	J	K	M	FS	FS	FS	FS										
22 µF	226	J	K	M	FS	FS												
Capacitance	Cap Code	Rated Voltage (VDC)			6.3	10	16	25	50	100	200	250	50	100	200	50	100	200
		Voltage Code			9	8	4	3	5	1	2	A	5	1	2	5	1	2
		Case Size /Series			C1210C								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 X7R with KONNEKT Technology.

Table 1C – Capacitance Range/Selection Waterfall (1812 – 2220 Case Sizes)

Capacitance	Cap Code	Case Size /Series			C1812C[2]					C1825C				C2220C				
		Voltage Code			3	5	1	2	A	5	1	2	A	3	5	1	2	A
		Rated Voltage (VDC)			25	50	100	200	250	50	100	200	250	25	50	100	200	250
		Capacitance Tolerance			Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions													
470 - 820 pF**	471 - 821**	J	K	M	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	K	M	GB	GB	GB	GB										
2,700 pF	272	J	K	M	GB	GB	GB	GB										
3,300 pF	332	J	K	M	GB	GB	GB	GB										
3,900 pF	392	J	K	M	GB	GB	GB	GB										
4,700 pF	472	J	K	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	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	K	M	GB	GB	GB	GB	GB	HB	HB	HB	HB	JE	JE	JE		
33,000 pF	333	J	K	M	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	HB	HB	HB	HB	JB	JB	JC	JC	JC
0.15 µF	154	J	K	M	GB	GB	GB	GE	GE	HB	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	HB	HB	HB	HB	JB	JB	JC	JC	JC
Capacitance	Cap Code	Rated Voltage (VDC)			25	50	100	200	250	50	100	200	250	25	50	100	200	250
		Voltage Code			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 X7R with KONNEKT Technology.

Table 1C – Capacitance Range/Selection Waterfall (1812 – 2220 Case Sizes) cont.

Capacitance	Cap Code	Case Size /Series			C1812C²					C1825C				C2220C				
		Voltage Code			3	5	1	2	A	5	1	2	A	3	5	1	2	A
		Rated Voltage (VDC)			25	50	100	200	250	50	100	200	250	25	50	100	200	250
		Capacitance Tolerance			Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions													
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	HB	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	K	M	GE	GE	GG			HF	HF	HF	HF	JC	JF	JF	JF	JF
1.2 µF	125	J	K	M	GB	GB	GB							JC	JC			
1.5 µF	155	J	K	M	GC	GC	GC							JC	JC			
1.8 µF	185	J	K	M	GE	GE	GE							JD	JD			
2.2 µF	225	J	K	M	GO	GO	GG							JF	JF			
2.7 µF	275	J	K	M	GJ	GJ	GJ											
3.3 µF	335	J	K	M	GL	GL	GL											
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	JO			
15 µF	156	J	K	M										JO				
22 µF	226	J	K	M										JO				
Capacitance	Cap Code	Rated Voltage (VDC)			25	50	100	200	250	50	100	200	250	25	50	100	200	250
		Voltage Code			3	5	1	2	A	5	1	2	A	3	5	1	2	A
		Case Size /Series			C1812C²					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 X7R with KONNEKT Technology.*

Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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 Code	**Case Size[1]**	**Thickness ± Range (mm)**	**7" Reel**	**13" Reel**	**7" Reel**	**13" Reel**
			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 Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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 Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			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 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)				
		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

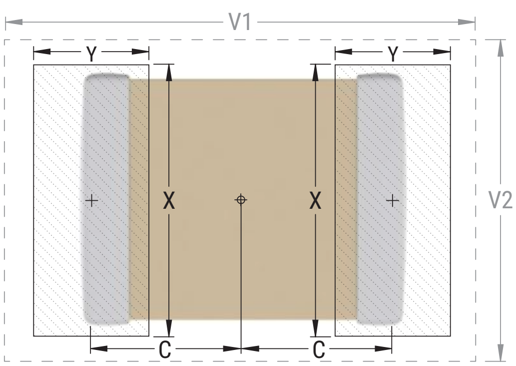
[1] *Only for capacitance values ≥ 22 µF*

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:

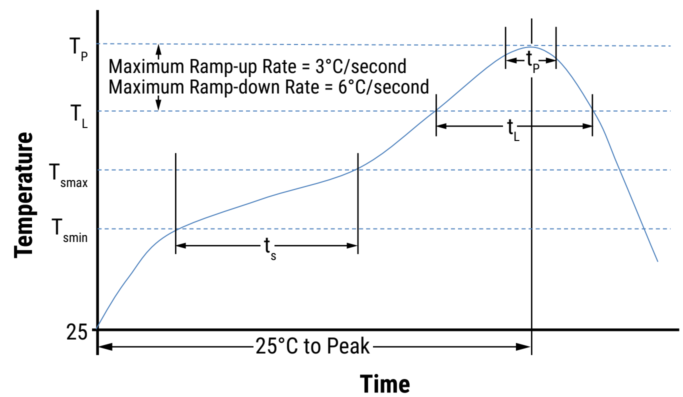
- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- All other EIA case sizes are limited to solder reflow only

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	
	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

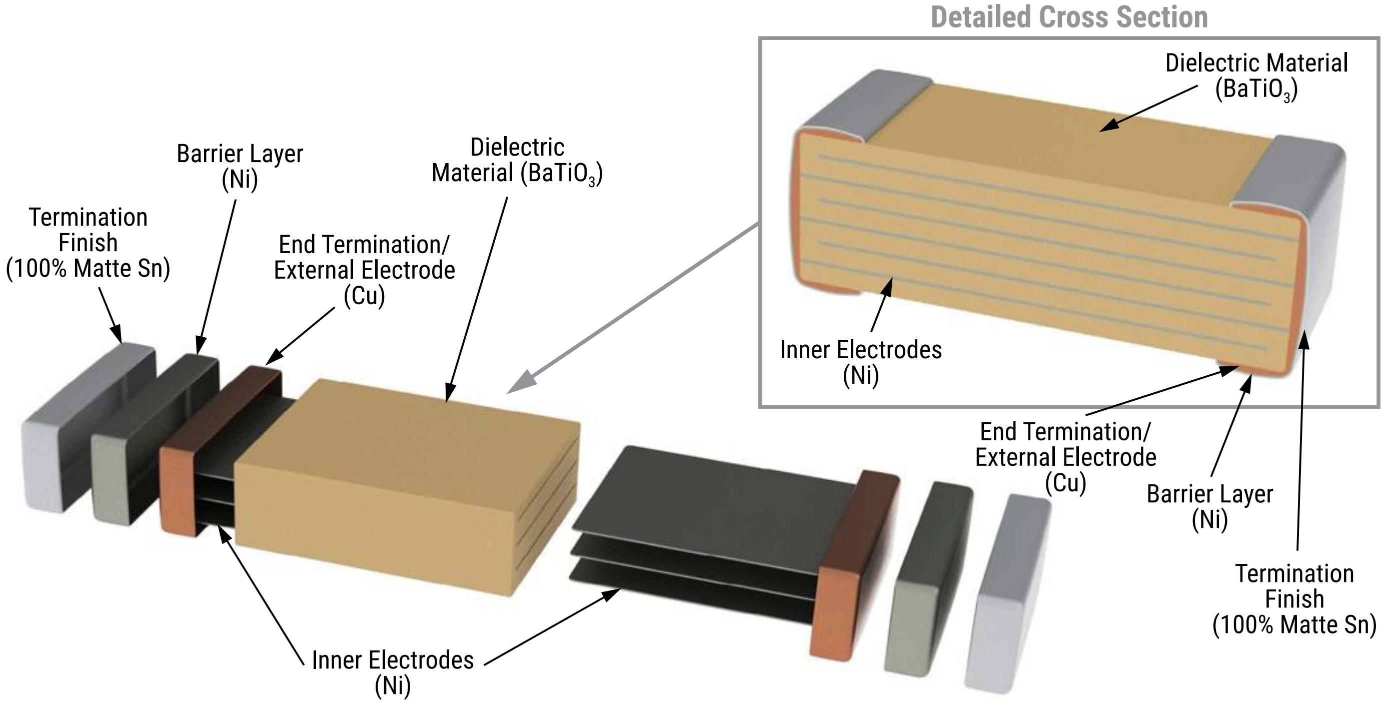
Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.



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 40ºC 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)

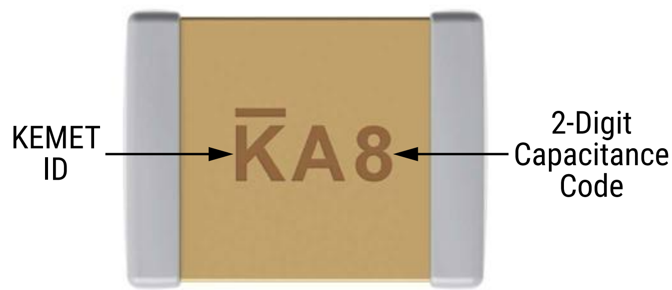
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic 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:

- C0G, 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 µF. Orientation of marking is vendor optional.

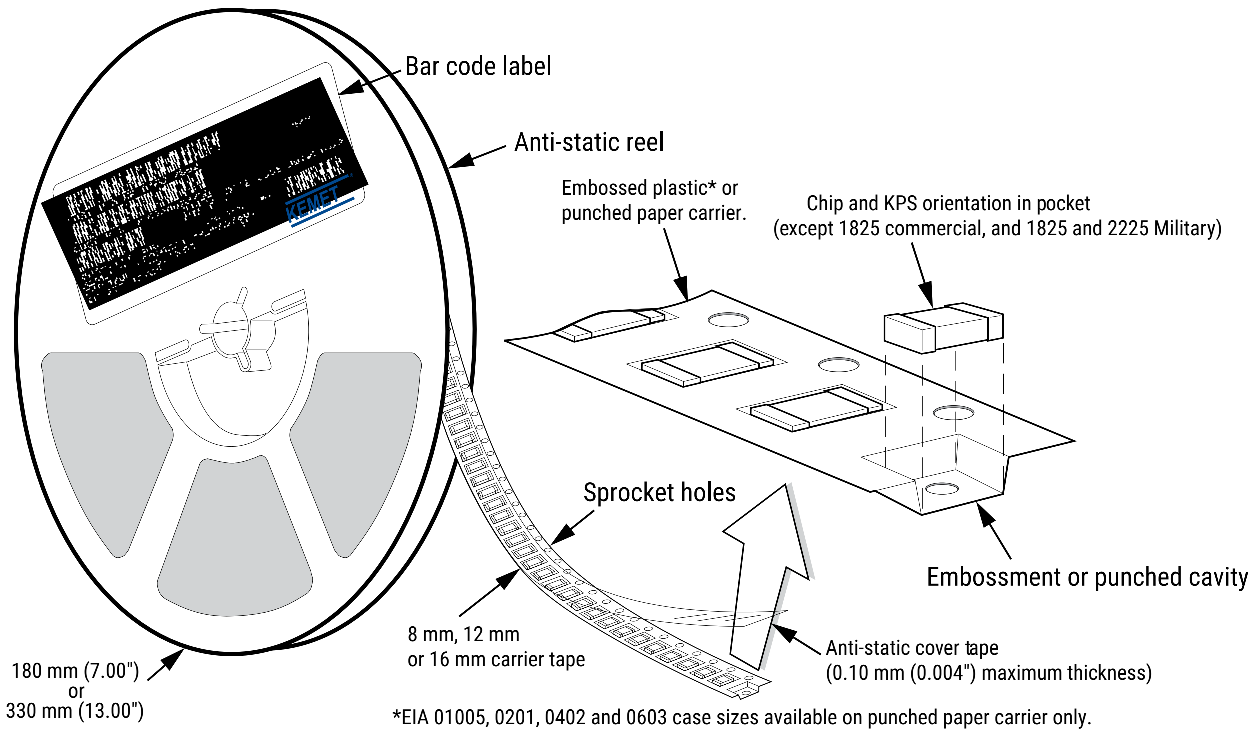


Capacitor Marking (Optional) cont.

Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.10	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

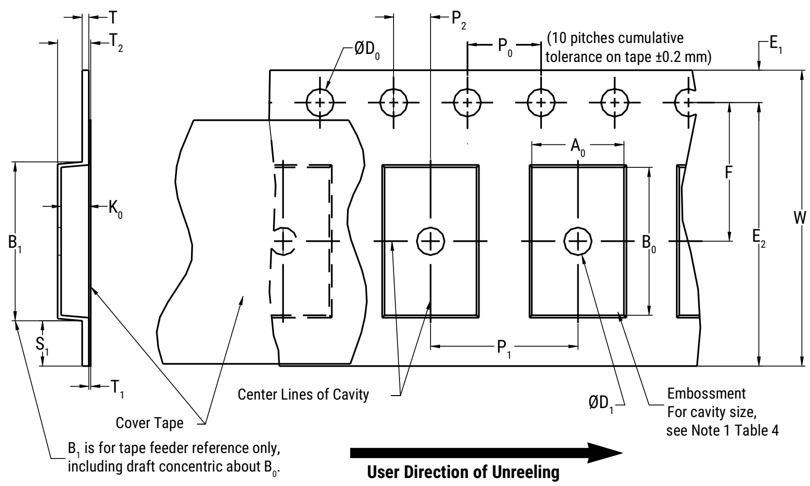


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

<table>
<tr><th colspan="10">Constant Dimensions — Millimeters (Inches)</th></tr>
<tr><th>Tape Size</th><th>D_0</th><th>D_1 Minimum Note 1</th><th>E_1</th><th>P_0</th><th>P_2</th><th>R Reference Note 2</th><th>S_1 Minimum Note 3</th><th>T Maximum</th><th>T_1 Maximum</th></tr>
<tr><td>8 mm</td><td rowspan="3">1.5 +0.10/−0.0 (0.059 +0.004/−0.0)</td><td>1.0 (0.039)</td><td rowspan="3">1.75 ±0.10 (0.069 ±0.004)</td><td rowspan="3">4.0 ±0.10 (0.157 ±0.004)</td><td rowspan="3">2.0 ±0.05 (0.079 ±0.002)</td><td>25.0 (0.984)</td><td rowspan="3">0.600 (0.024)</td><td rowspan="3">0.600 (0.024)</td><td rowspan="3">0.100 (0.004)</td></tr>
<tr><td>12 mm</td><td rowspan="2">1.5 (0.059)</td><td rowspan="2">30 (1.181)</td></tr>
<tr><td>16 mm</td></tr>
<tr><th colspan="10">Variable Dimensions — Millimeters (Inches)</th></tr>
<tr><th>Tape Size</th><th>Pitch</th><th>B_1 Maximum Note 4</th><th>E_2 Minimum</th><th>F</th><th>P_1</th><th>T_2 Maximum</th><th>W Maximum</th><th colspan="2">A_0,B_0 & K_0</th></tr>
<tr><td>8 mm</td><td>Single (4 mm)</td><td>4.35 (0.171)</td><td>6.25 (0.246)</td><td>3.5 ±0.05 (0.138 ±0.002)</td><td>4.0 ±0.10 (0.157 ±0.004)</td><td>2.5 (0.098)</td><td>8.3 (0.327)</td><td colspan="2" rowspan="3">Note 5</td></tr>
<tr><td>12 mm</td><td>Single (4 mm) and double (8 mm)</td><td>8.2 (0.323)</td><td>10.25 (0.404)</td><td>5.5 ±0.05 (0.217 ±0.002)</td><td>8.0 ±0.10 (0.315 ±0.004)</td><td>4.6 (0.181)</td><td>12.3 (0.484)</td></tr>
<tr><td>16 mm</td><td>Triple (12 mm)</td><td>12.1 (0.476)</td><td>14.25 (0.561)</td><td>7.5 ±0.05 (0.138 ±0.002)</td><td>12.0 ±0.10 (0.157 ±0.004)</td><td>4.6 (0.181)</td><td>16.3 (0.642)</td></tr>
</table>

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 < 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_0, B_0 and K_0 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

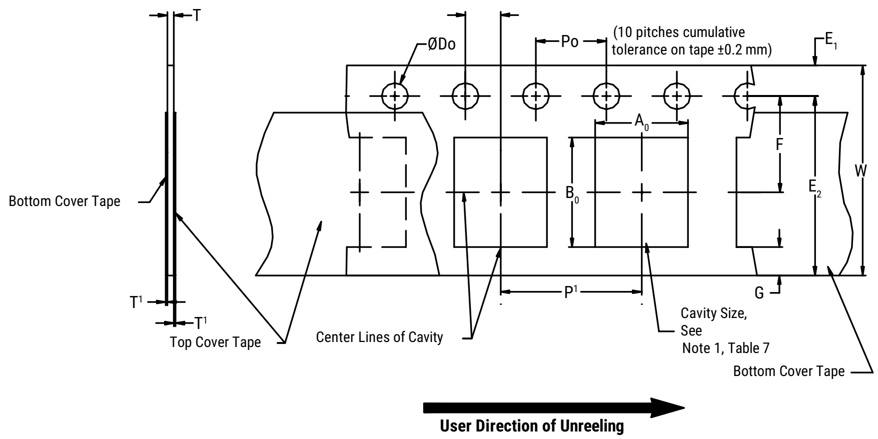


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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

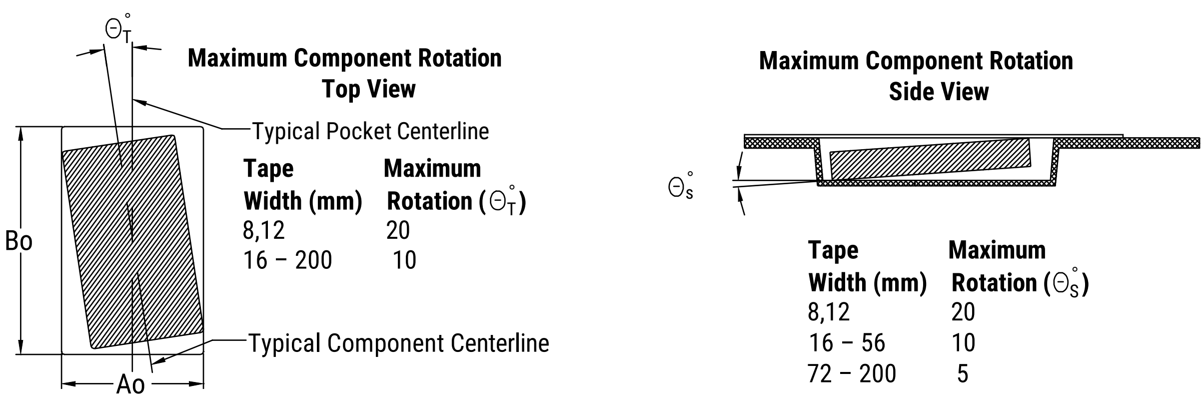


Figure 4 – Maximum Lateral Movement

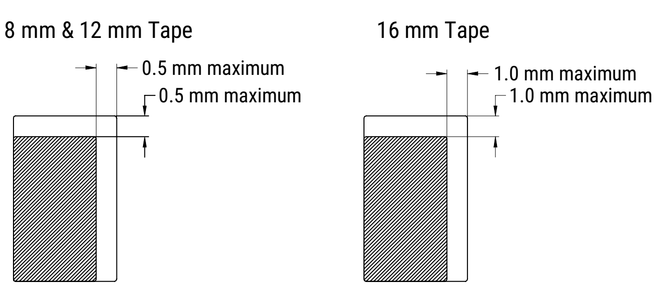


Figure 5 – Bending Radius

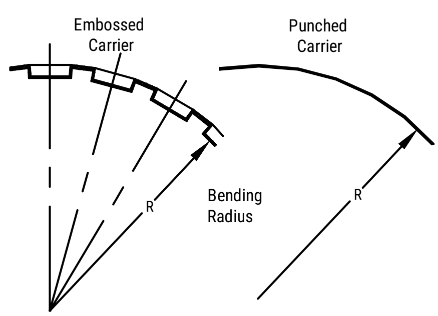
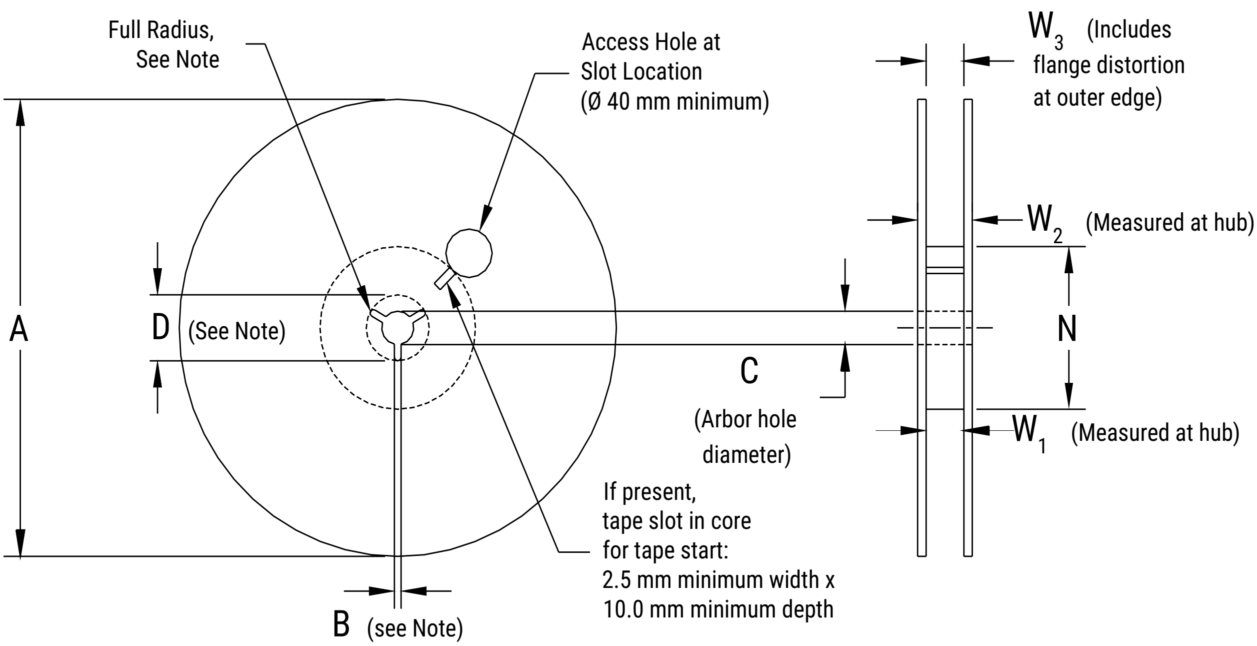


Figure 6 – Reel Dimensions



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	A	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

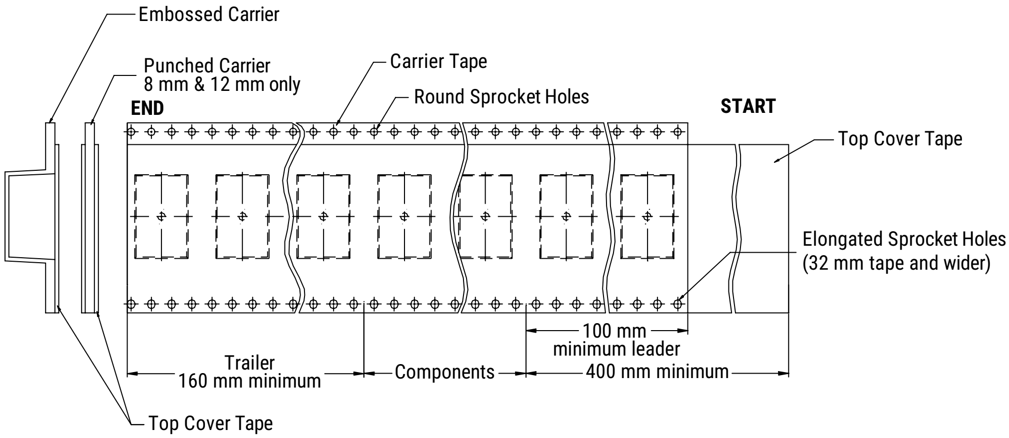
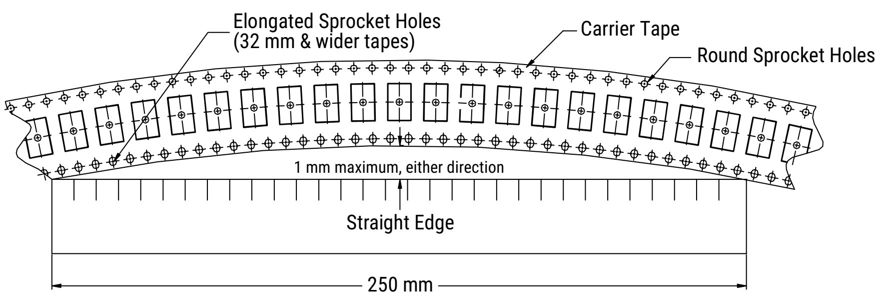


Figure 8 – Maximum Camber



Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs)

High Voltage with Flexible Termination System (HV FT-CAP) X7R Dielectric, 500 – 3,000 VDC (Commercial Grade)

KEMET a YAGEO company

Overview

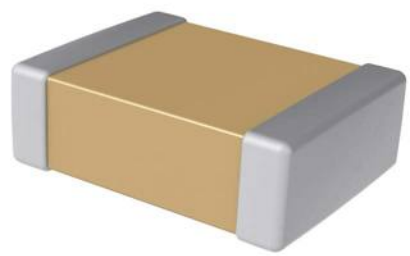
KEMET's High Voltage with Flexible Termination (HV FT-CAP) surface mount MLCCs in X7R dielectric address the primary failure mode of MLCCs—flex cracks, which are typically the result of excessive tensile and shear stresses produced during board flexure and thermal cycling. Featuring several of the highest 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.

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

C	1210	X	154	K	C	R	A	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	TM
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".*

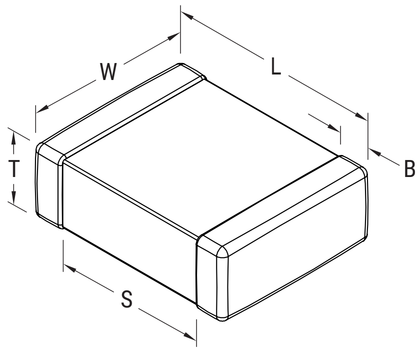
Benefits

- −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)	See Table 2 for Thickness	0.45 (0.018) ±0.15 (0.006)	0.58 (0.023)	Solder Wave or Solder Reflow
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)	
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	
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)		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)		
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)		

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)

Cap	Cap Code	Case Size/ Series			C0603X			C0805X			C1206X					C1210X					C1808X							C1812X						
		Voltage Code			C	B	D	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	H
		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	500	630	1000	1500	2000	2500	3000
		Capacitance Tolerance			Product Availability and Chip Thickness Codes - See Table 2 for Chip Thickness Dimensions																													
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	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
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	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
15 pF	150	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
16 pF	160	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
18 pF	180	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
20 pF	200	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
22 pF	220	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
24 pF	240	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
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	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
33 pF	330	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
36 pF	360	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
39 pF	390	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	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
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	LB	GB	GB	GB	GB	GB	GB	GB
51 pF	510	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
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	LB	GB	GB	GB	GB	GB	GB	GB
62 pF	620	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
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	750	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
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	M				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	M				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	K	M				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	K	M				DG	DG	DG	ES	ES	ES	ES	EU	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	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	M				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	181	J	K	M				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
220 pF	221	J	K	M				DG	DG	DG	ES	ES	ES	EF	EF	FZ	FZ	FZ	FM	FM	LB	LB	LB	LB	LB	LB	LB	GB	GB	GB	GB	GB	GD	GB
270 pF	271	J	K	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	M				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	391	J	K	M				DG	DG	DG	ES	ES	EF	EF	EF	FZ	FZ	FZ	FK	FS	LB	LB	LB	LB	LB	LB	LC	GB	GB	GB	GB	GD	GK	GH
470 pF	471	J	K	M				DG	DG	DG	ES	ES	EF	EF	EF	FZ	FM	FM	FS	FS	LB	LB	LB	LB	LB	LB	LC	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	M				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	J	K	M				DG	DG	DG	ES	ES	ES	EF	EF	FL	FL	FL	FL	FL	LA	LA	LA	LA	LB	LC	LC	GB	GB	GB	GD	GH	GH	GK
1,000 pF	102	J	K	M	CG	CG	CG	DG	DG	DG	ES	ES	ES	EF	EF	FL	FL	FL	FL	FL	LA	LA	LA	LA	LB	LC	LC	GB	GB	GB	GB	GH	GH	GK
1,200 pF	122	J	K	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	M	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	FL	FM	LB	LB	LB	LB	LC	LC		GB	GD	GD	GB	GH	GK	
2,200 pF	222	J	K	M	CG			DG	DG	DG	ES	ES	ES	EU	EU	FL	FL	FL	FL	FM	LA	LA	LA	LB	LC	LC		GB	GH	GH	GB	GH	GK	
2,700 pF	272	J	K	M	CG			DG	DG	DG	ES	ES	ES	EU		FL	FL	FL	FL	FM	LA	LA	LA	LB	LC			GB	GB	GB	GH	GK	GM	
3,300 pF	332	J	K	M	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	LA	LA	LA	LB	LB			GB	GB	GB	GH	GM	GO	
4,700 pF	472	J	K	M				DG	DG	DG	ES	ES	ES	EU		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		ES	EF	EF	EF		FL	FL	FL	FM	FK	LA	LB	LB	LC				GH	GH	GH	GK	GK		
6,800 pF	682	J	K	M				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		
10,000 pF	103	J	K	M				DG	DG		EF	EU	EU	EU		FL	FL	FL	FK		LA	LB	LB	LC				GH	GH	GH	GK	GO		
12,000 pF	123	J	K	M				DG	DG		EU	EJ	EJ			FL	FL	FL	FK		LA	LC	LC	LB				GB	GK	GK	GK			
Cap	Cap 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	500	630	1000	1500	2000	2500	3000
		Voltage Code			C	B	D	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	H
		Case Size/ Series			C0603X			C0805X			C1206X					C1210X					C1808X							C1812X						

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.

Cap	Cap Code	Case Size/ Series			C0603X			C0805X			C1206X					C1210X					C1808X							C1812X						
		Voltage Code			C	B	D	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	H
		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	500	630	1000	1500	2000	2500	3000
		Capacitance Tolerance			Product Availability and Chip Thickness Codes - See Table 2 for Chip Thickness Dimensions																													
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	M							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	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																								GS						
Cap	Cap 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	500	630	1000	1500	2000	2500	3000
		Voltage Code			C	B	D	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	H
		Case Size/ Series			C0603X			C0805X			C1206X					C1210X					C1808X							C1812X						

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)

Capacitance	Cap Code	Case Size/ Series			C1825X							C2220X							C2225X						
		Voltage Code			C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		Rated Voltage (VDC)			500	630	1000	1500	2000	2500	3000	500	630	1000	1500	2000	2500	3000	500	630	1000	1500	2000	2500	3000
		Capacitance Tolerance			Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions																				
470 pF	471	J	K	M	HG	HG	HG	HG	HG	HG	HG	JK	JK	JK	JK	JK	JK	JK							
560 pF	561	J	K	M	HG	HG	HG	HG	HG	HG	HG	JK	JK	JK	JK	JK	JK	JK							
680 pF	681	J	K	M	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	M	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	M	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	M	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	M	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	M	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	M	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	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	JN	JN	JN	KE	KE	KE	KE	KF	KJ	KJ
18,000 pF	183	J	K	M	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			
62,000 pF	623	J	K	M	HG	HG	HG	HK				JE	JE	JE	JL				KF	KF	KF	KH			
68,000 pF	683	J	K	M	HG	HJ	HJ	HK				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	HK					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					
0.39 µF	394	J	K	M	HK							JN							KH	KJ					
0.47 µF	474	J	K	M								JN							KH	KJ					
0.56 µF	564	J	K	M															KJ						
Capacitance	Cap 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
		Voltage Code			C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		Case Size/ Series			C1825X							C2220X							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 Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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
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
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
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
GL	1812	1.90 ± 0.20	0	0	500	2,000
GM	1812	2.00 ± 0.20	0	0	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	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 Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[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

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		Packaging Quantities (pieces/unit packaging)	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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.*

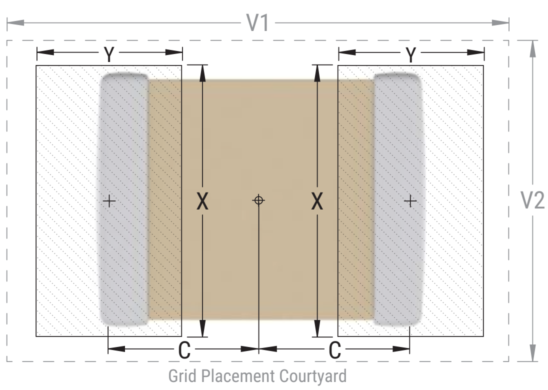
[2] *A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard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

Table 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)				
		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	
	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.

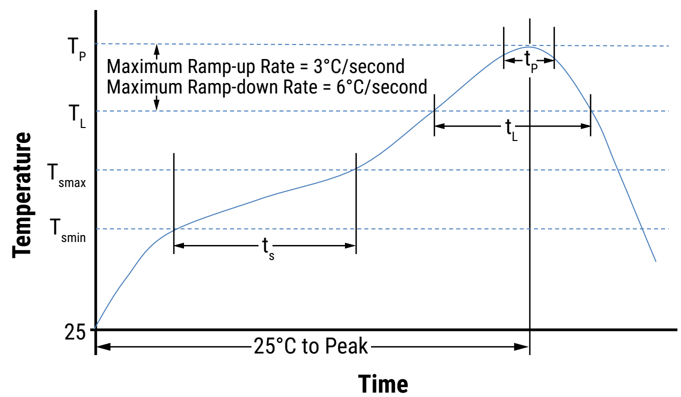


Table 4 – Performance & Reliability: Test Methods and Conditions

<table>
<tr><th>Stress</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Visual and Mechanical</td><td>KEMET Internal</td><td>No defects that may affect performance (10X)</td><td>Dimensions according KEMET Spec Sheet</td></tr>
<tr><td>Capacitance (Cap)</td><td>KEMET Internal</td><td>C ≤ 10 µF 1 kHz ±50 Hz and 1.0 ±0.2 V_{rms} or 0.5 ±0.2 V_{rms}*
C > 10 µF120 Hz ±10 Hz and 0.5 ±0.1 V_{rms}

* 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</td><td>Within Tolerance</td></tr>
<tr><td>Dissipation Factor (DF)</td><td>KEMET Internal</td><td>C ≤ 10 µF
Frequency: 1 kHz ±50 Hz
Voltage*:1.0 ±0.2 V_{rms}, 0.5 ±0.2 V_{rms},
C > 10 µF
Frequency: 120 Hz ±10 Hz
Voltage: 0.5 ±0.1 V_{rms}

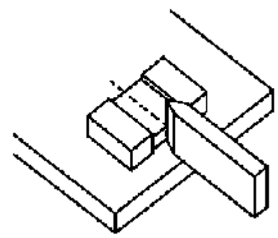
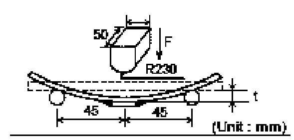
* See part number specification sheet for voltage</td><td>Within Specification
Dissipation factor (DF) maximum limit at 25°C = 2.5%</td></tr>
<tr><td>Insulation Resistance (IR)</td><td>KEMET Internal</td><td>500 VDC applied for 120 ±5 seconds at 25°C</td><td>Within Specification
To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ limit. Select the lower of the two limits.

<table>
<tr><th>EIA Case Size</th><th>1,000 Megohm Microfarads or 100 GΩ</th><th>100 Megohm Microfarads or 10 GΩ</th></tr>
<tr><td>0603</td><td>N/A</td><td>All</td></tr>
<tr><td>0805</td><td>< 0.0039 µF</td><td>≥ 0.0039 µF</td></tr>
<tr><td>1206</td><td>< 0.012 µF</td><td>≥ 0.012 µF</td></tr>
<tr><td>1210</td><td>< 0.033 µF</td><td>≥ 0.033 µF</td></tr>
<tr><td>1808</td><td>< 0.018 µF</td><td>≥ 0.018 µF</td></tr>
<tr><td>1812</td><td>< 0.027 µF</td><td>≥ 0.027 µF</td></tr>
<tr><td>1825</td><td>< 0.120 µF</td><td>≥ 0.120 µF</td></tr>
<tr><td>2220</td><td>< 0.150 µF</td><td>≥ 0.150 µF</td></tr>
<tr><td>2225</td><td>< 0.180 µF</td><td>≥ 0.180 µF</td></tr>
</table></td></tr>
<tr><td>Temperature Coefficient of Capacitance (TCC)</td><td>KEMET Internal</td><td>C ≤ 10 µF
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 µF
Frequency: 120 Hz ±10 Hz
Voltage: 0.5 ±0.1 V_{rms}
* See part number specification sheet for voltage

<table>
<tr><th>Step</th><th>Temperature (°C)</th></tr>
<tr><td>1</td><td>+25°C</td></tr>
<tr><td>2</td><td>−55°C</td></tr>
<tr><td>3</td><td>+25°C (Reference Temperature)</td></tr>
<tr><td>4</td><td>+125°C</td></tr>
</table></td><td>Capacitance ±15% over −55°C to +125°C</td></tr>
</table>

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

<table>
<tr><th>Stress</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Dielectric Withstanding Voltage (DWV)</td><td>KEMET Internal</td><td>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)</td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit

Withstand test voltage without insulation breakdown or damage.</td></tr>
<tr><td>Aging Rate (Maximum % Capacitance Loss/Decade Hour)</td><td>KEMET Internal</td><td>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.</td><td>Please refer to a part number specification sheet for specific Aging rate</td></tr>
<tr><td>Terminal Strength</td><td>KEMET Internal</td><td>Shear stress test per specific case size,
Time: 60 ±1 second.
<table><tr><th>Case Size</th><th>Force</th></tr><tr><td>0603</td><td>5N</td></tr><tr><td>0805</td><td>9N</td></tr><tr><td>≥ 1206</td><td>18N</td></tr></table></td><td>No evidence of mechanical damage</td></tr>
<tr><td>Board Flex</td><td>AEC-Q200-005</td><td>Standard Termination System 2.0 mm
Flexible Termination System 3.0 mm
Test Time: 60± 5 seconds
Ramp Time: 1 mm/second

</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Solderability</td><td>J-STD-002</td><td>Condition: 4 hours ±15 minutes at 155°C dry bake apply all methods
Test 245 ±5°C (SnPb & Pb-Free)</td><td>Visual Inspection.
95% coverage on termination.
No leaching</td></tr>
<tr><td>Temperature Cycling</td><td>JESD22 Method JA-104</td><td>1,000 cycles (−55°C to +125°C)
2 - 3 cycles per hour
Soak Time: 1 or 5 minute</td><td>Measurement at 24 hours ±4 hours after test conclusion.
Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit</td></tr>
<tr><td>Biased Humidity</td><td>MIL-STD-202 Method 103</td><td>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.</td><td>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%</td></tr>
<tr><td>Moisture Resistance</td><td>MIL-STD-202 Method 106</td><td>Number of Cycles Required: 10, 24 hours per cycle.
Steps 7a and 7b not required</td><td>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%</td></tr>
</table>

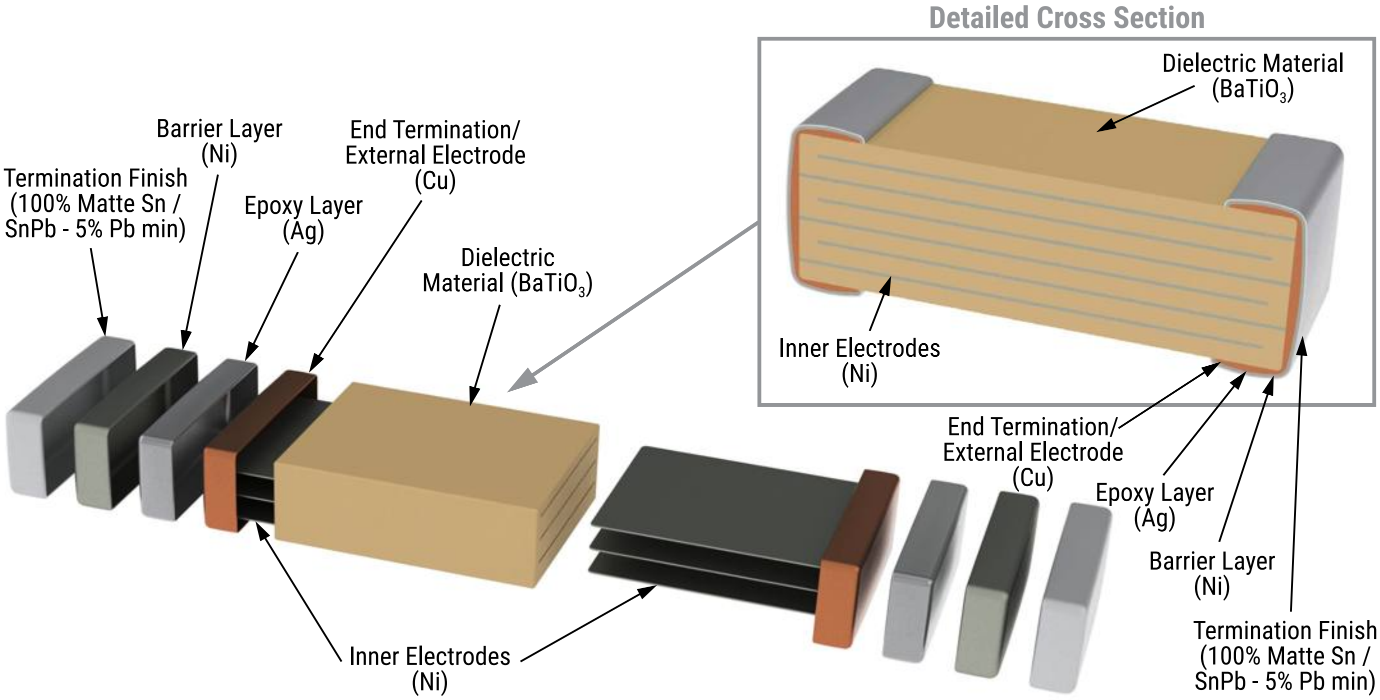
Table 4 – Performance & Reliability: Test Methods and Conditions

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	MIL-STD-202 Method 108	1,000 hours at 125°C with 1.2 X rated voltage applied.	Within Post Environmental Limits Cap: ±20% shift IR: 10% of Initial Limit DF Limit Maximum: 3.0%
Storage Life		1,000 hours at 150°C, Unpowered	
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 40ºC 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)

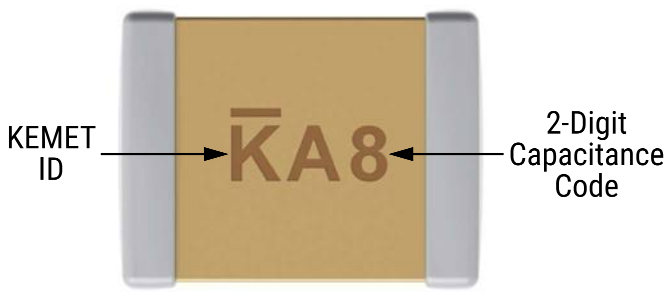
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic 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:

- C0G, 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 µF. Orientation of marking is vendor optional.

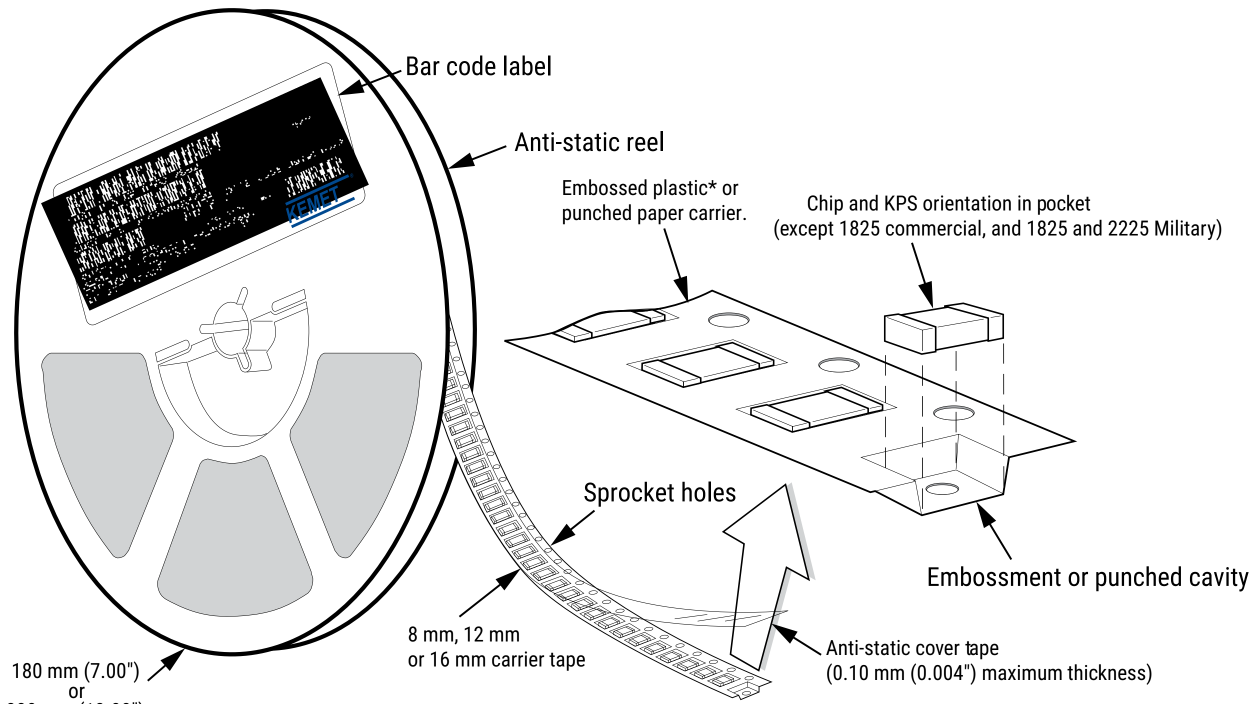


Capacitor Marking (Optional) cont.

Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.10	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

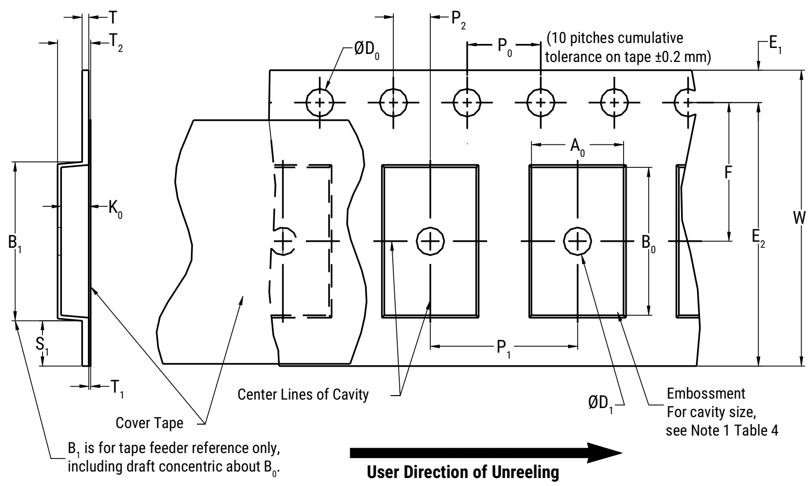


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +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)			
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)	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 S_1 < 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_0, B_0 and K_0 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

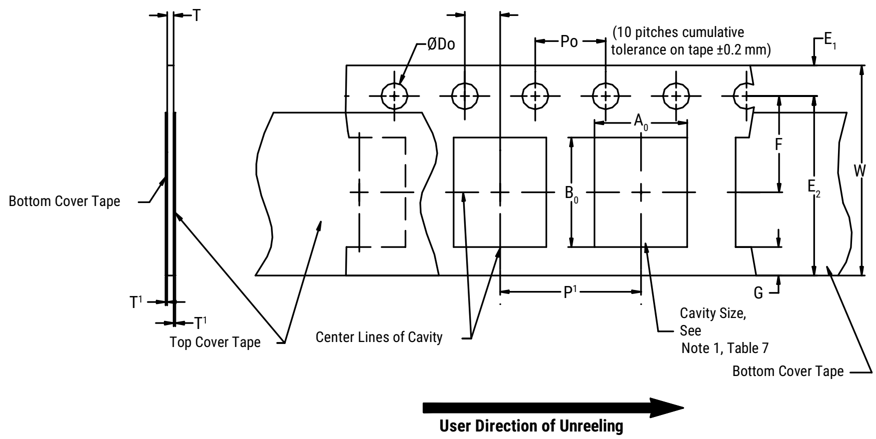


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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

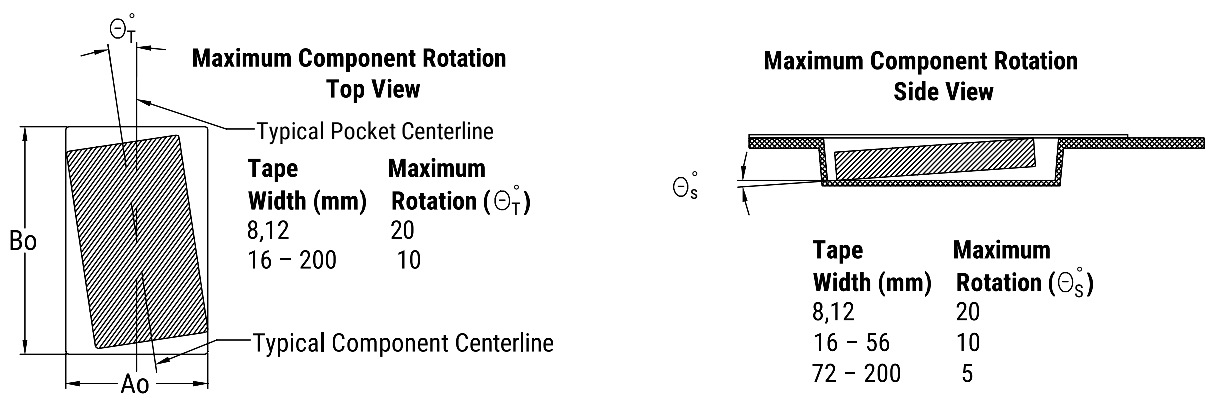


Figure 4 – Maximum Lateral Movement

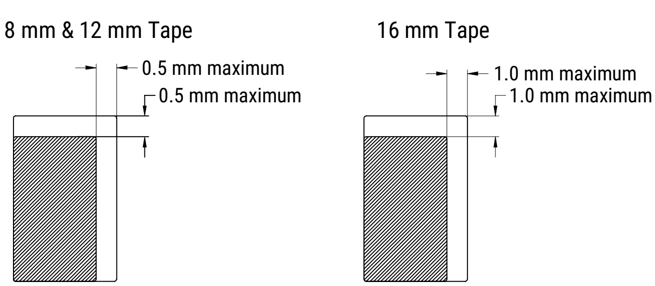


Figure 5 – Bending Radius

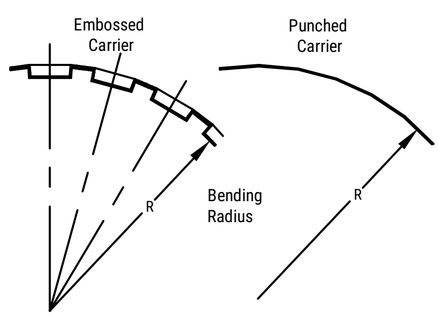
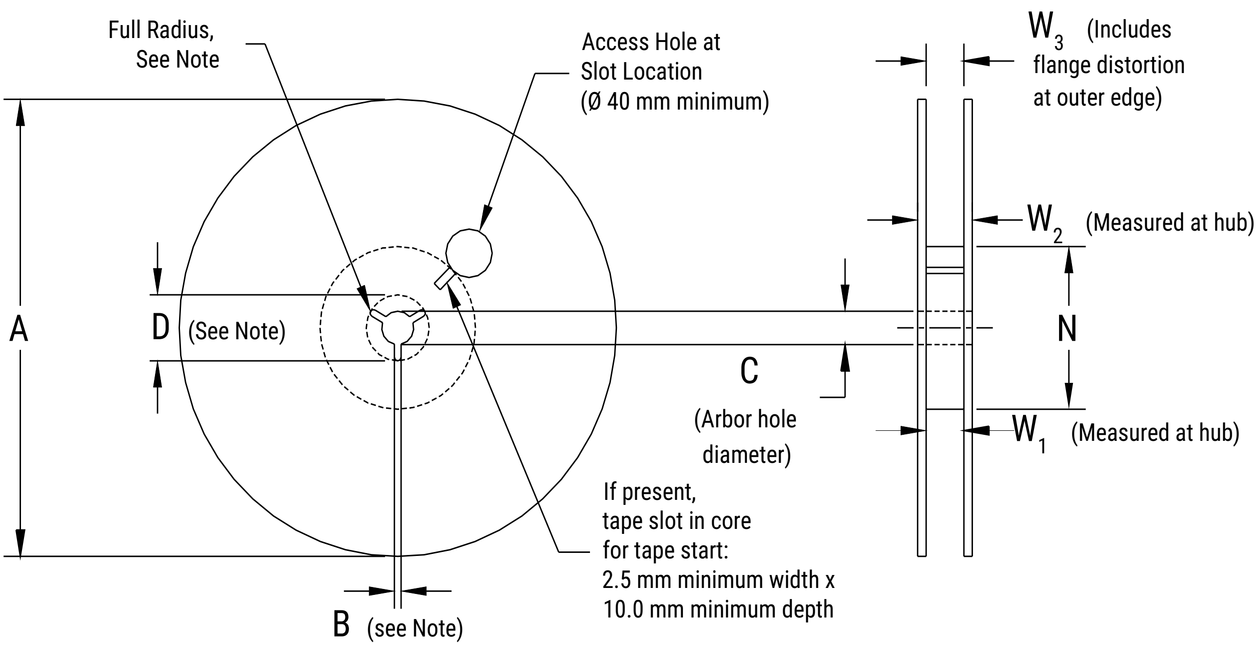


Figure 6 – Reel Dimensions



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	A	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

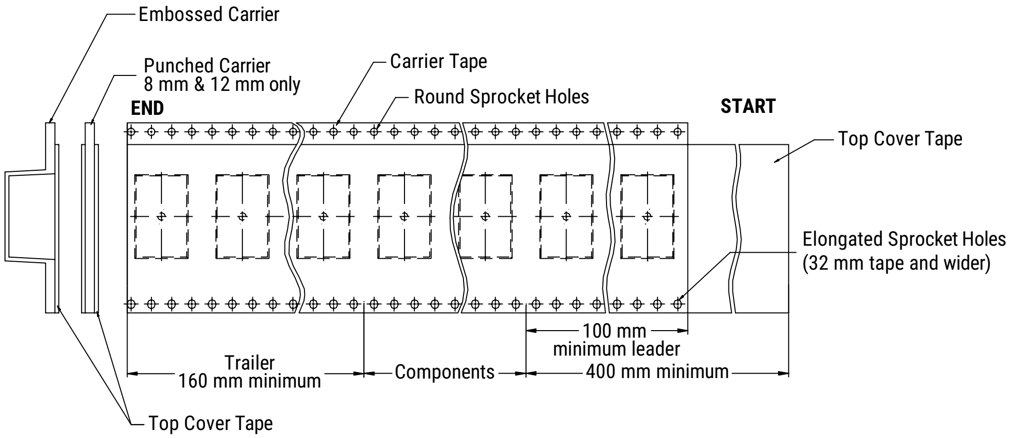
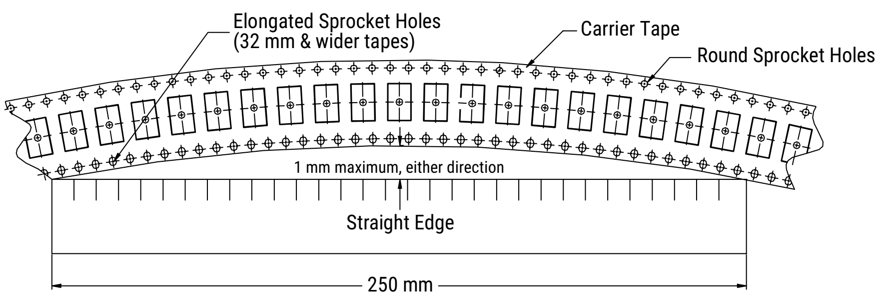


Figure 8 – Maximum Camber



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

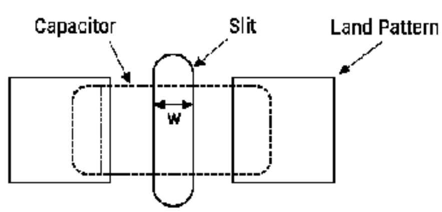
For MLCC ratings ≥1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

Dielectric	CTE (ppm/°C)
Class II $BaTiO_3$	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.



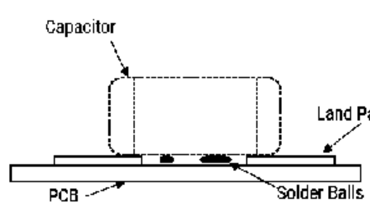
Solder Resist

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.



Commercial Off-The-Shelf (COTS) for Higher Reliability Applications, C0G Dielectric, 10 – 250 VDC

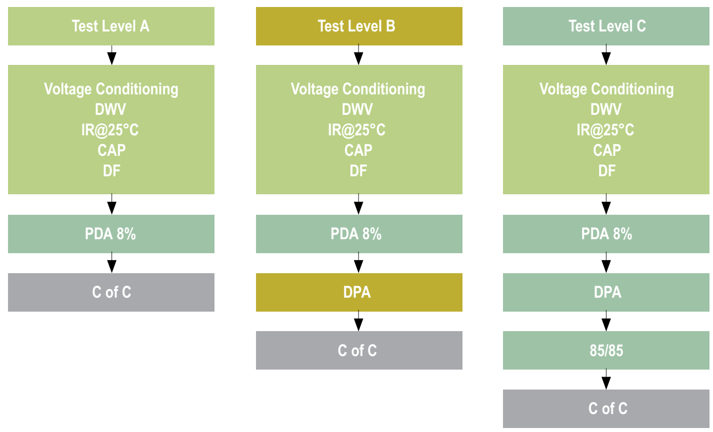
KEMET
a YAGEO company

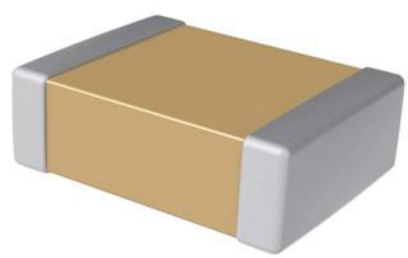
Overview

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 C0G dielectric features a 125°C maximum operating temperature and is considered "stable." The Electronics Components, Assemblies & Materials Association (EIA) characterizes C0G 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. C0G 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/ºC from −55°C to +125°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

C	1206	T	104	K	5	G	A	C	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 0.5 – .99 pF e.g., 2.2 pF = 229 e.g., 0.5 pF = 508	B = ±0.10 pF C = ±0.25 pF D = ±0.5 pF F = ± 1% G = ±2% J = ±5% K = ±10% M = ±20%	8 = 10 4 = 16 3 = 25 6 = 35 5 = 50 1 = 100 2 = 200 A = 250	G = C0G	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)
- 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%
- 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".

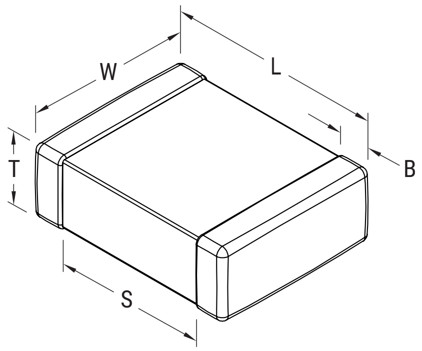
[2] The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".

Packaging C-Spec Ordering Options Table (Gold Termination)

Termination Finish Options	Packaging Type/Options	Packaging Ordering Code (C-Spec)
Standard Packaging – Unmarked[3]		
G = Gold (Au) 100 µin minimum	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)
	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	T1K0

[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)	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)		
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 ≤ 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 MΩ-µF value by the capacitance and compare to GΩ 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
C0G	All	All	0.5	0.3% or ±0.25 pF	10% of Initial Limit

Table 1A – Capacitance Range/Selection Waterfall (0402 – 0805 Case Sizes)

Capacitance	Cap Code	Case Size/Series								C0402T							C0603T							C0805T						
		Voltage Code								8	4	3	5	1	2	A	8	4	3	5	1	2	A	8	4	3	5	1	2	A
		Rated Voltage (VDC)								10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Table 2 for Chip 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
1.0 - 9.1 pF*	109 - 919*	B	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	M	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	K	M	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	M	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	K	M	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	M	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	M	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	M	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	M	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	M	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	M	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	M	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	M	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	M	BB	BB	BB	BB				CF	CF	CF	CF	CF	CH	CH	DN	DN	DN	DN	DN	DN	DN
1,200 pF	122				F	G	J	K	M	BB	BB	BB	BB				CF	CF	CF	CF	CF	CH	CH	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	CH	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	BB	BB					CF	CF	CF	CF	CF	CH	CH	DP	DP	DP	DP	DP	DN	DN
2,000 pF	202				F	G	J	K	M	BB	BB	BB					CF	CF	CF	CF	CF	CH	CH	DN	DN	DN	DN	DN	DN	DN
2,200 pF	222				F	G	J	K	M	BB	BB	BB					CF	CF	CF	CF	CF	CH	CH	DN	DN	DN	DN	DN	DN	DN
2,400 pF	242				F	G	J	K	M								CF	CF	CF	CF	CF			DN	DN	DN	DN	DN	DN	DN
2,700 pF	272				F	G	J	K	M								CF	CF	CF	CF	CF			DN	DN	DN	DN	DN	DN	DN
3,000 pF	302				F	G	J	K	M								CF	CF	CF	CF	CF			DP	DP	DP	DP	DN	DN	DN
3,300 pF	332				F	G	J	K	M								CF	CF	CF	CF	CF			DP	DP	DP	DP	DN	DN	DN
3,600 pF	362				F	G	J	K	M								CF	CF	CF	CF	CF			DP	DP	DP	DP	DN	DP	DP
3,900 pF	392				F	G	J	K	M								CF	CF	CF	CF	CF			DE	DE	DE	DE	DN	DP	DP
4,300 pF	432				F	G	J	K	M								CF	CF	CF	CF	CF			DE	DE	DE	DE	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	K	M								CF	CF	CF	CF				DN	DN	DN	DN	DN	DG	DG
6,800 pF	682				F	G	J	K	M								CF	CF	CF	CF				DN	DN	DN	DN	DN	DG	DG
7,500 pF	752				F	G	J	K	M								CF	CF	CF					DN	DN	DN	DN	DN	DG	DG
8,200 pF	822				F	G	J	K	M								CF	CF	CF					DN	DN	DN	DN	DN	DG	DG
9,100 pF	912				F	G	J	K	M								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	M								CF	CF	CF					DN	DN	DN	DN	DE		
15,000 pF	153				F	G	J	K	M								CF	CF	CF					DN	DN	DN	DP	DG		
18,000 pF	183				F	G	J	K	M															DN	DN	DN	DP			
22,000 pF	223				F	G	J	K	M															DP	DP	DP	DF			
27,000 pF	273				F	G	J	K	M															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	473				F	G	J	K	M															DG	DG	DG				
Capacitance	Cap Code	Rated Voltage (VDC)								10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250
		Voltage Code								8	4	3	5	1	2	A	8	4	3	5	1	2	A	8	4	3	5	1	2	A
		Case Size/Series								C0402T							C0603T							C0805T						

**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)

Capacitance	Cap Code	Case Size/Series								C1206T							C1210T							C1812T				C2220T		
		Voltage Code								8	4	3	5	1	2	A	8	4	3	5	1	2	A	5	1	2	A	5	1	2
		Rated Voltage (VDC)								10	16	25	50	100	200	250	10	16	25	50	100	200	250	50	100	200	250	50	100	200
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																				
1.0 - 9.1 pF*	109 - 919*	B	C	D						EB	EB	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB	FB	FB							
10 - 91 pF*	100 - 910*				F	G	J	K	M	EB	EB	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB	FB	FB							
100 - 430 pF*	101 - 431*				F	G	J	K	M	EB	EB	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB	FB	FB							
470 - 910 pF*	471 - 911*				F	G	J	K	M	EB	EB	EB	EB	EB	EB	EB	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	M	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	M	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	M	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	M	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	M	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	M	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	M	EB	EB	EB	EB	EC	EC	EC	FB	FB	FB	FB	FC	FC	FC							
2,700 pF	272				F	G	J	K	M	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	M	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							
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	752				F	G	J	K	M	EB	EB	EB	EB	EB	EB	EB	FC	FC	FC	FC	FC	FB	FB							
8,200 pF	822				F	G	J	K	M	EC	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	G	J	K	M	EC	EC	EC	EC	EB	EC	EC	FE	FE	FE	FE	FE	FB	FB							
10,000 pF	103				F	G	J	K	M	ED	ED	ED	ED	EB	EC	EC	FF	FF	FF	FF	FF	FB	FB	GB	GH	GB	GB	JE	JE	JB
12,000 pF	123				F	G	J	K	M	EB	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	G	J	K	M	EB	EB	EB	EB	EB	EF	EF	FG	FG	FG	FG	FB	FC	FC	GB	GB	GB	GB	JE	JE	JB
18,000 pF	183				F	G	J	K	M	EB	EB	EB	EB	EB	EH	EH	FB	FB	FB	FB	FB	FC	FC	GB	GB	GB	GB	JE	JE	JB
22,000 pF	223				F	G	J	K	M	EB	EB	EB	EB	EC	EH	EH	FB	FB	FB	FB	FB	FF	FF	GB	GB	GB	GB	JE	JB	JB
27,000 pF	273				F	G	J	K	M	EB	EB	EB	EB	EE			FB	FB	FB	FB	FB	FG	FG	GB	GB	GB	GB	JE	JB	JB
33,000 pF	333				F	G	J	K	M	EB	EB	EB	EB	EE			FB	FB	FB	FB	FB	FH	FH	GB	GB	GB	GB	JB	JB	JB
39,000 pF	393				F	G	J	K	M	EC	EC	EC	EE	EH			FB	FB	FB	FB	FE	FH	FH	GB	GB	GB	GB	JB	JB	JB
47,000 pF	473				F	G	J	K	M	EC	EC	EC	EE	EH			FB	FB	FB	FB	FE	FJ	FJ	GB	GB	GD	GD	JB	JB	JB
56,000 pF	563				F	G	J	K	M	ED	ED	ED	EF				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	K	M	EH	EH	EH	EH				FC	FC	FC	FF	FH			GB	GB	GM	GM	JB	JB	JB
0.10 µF	104				F	G	J	K	M	EH	EH	EH					FE	FE	FE	FG	FM			GB	GD	GM	GM	JB	JB	JD
0.12 µF	124				F	G	J	K	M								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	M								FJ	FJ	FJ					GH				JB	JD	JG
0.22 µF	224				F	G	J	K	M								FK	FK	FK					GK				JB	JD	JL
0.27 µF	274				F	G	J	K	M																			JB	JF	
0.33 µF	334				F	G	J	K	M																			JD	JG	
0.39 µF	394				F	G	J	K	M																			JG		
0.47 µF	474				F	G	J	K	M																			JG		
Capacitance	Cap Code	Rated Voltage (VDC)								10	16	25	50	100	200	250	10	16	25	50	100	200	250	50	100	200	250	50	100	200
		Voltage Code								8	4	3	5	1	2	A	8	4	3	5	1	2	A	5	1	2	A	5	1	2
		Case Size/Series								C1206T							C1210T							C1812T				C2220T		

*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 Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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	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
FK	1210	2.10 ± 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 Code	**Case Size1**	**Thickness ± Range (mm)**	**7" Reel**	**13" Reel**	**7" Reel**	**13" Reel**
			Paper Quantity[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

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		Packaging Quantities (pieces/unit packaging)	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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 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)				
		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

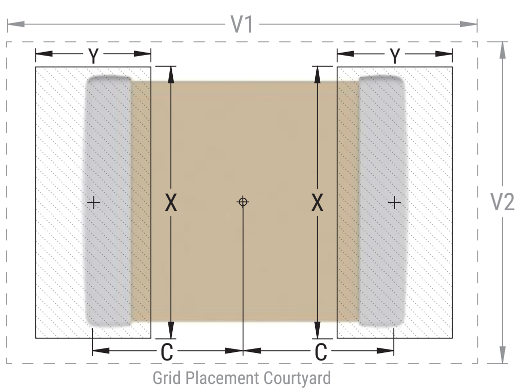
[1] *Only for capacitance values ≥ 22 µF*

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	
	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.

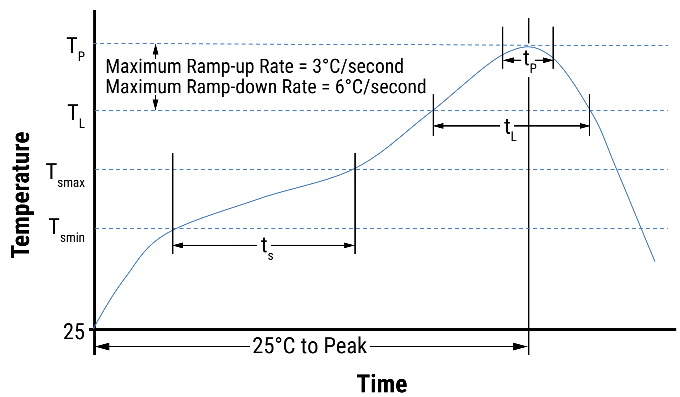


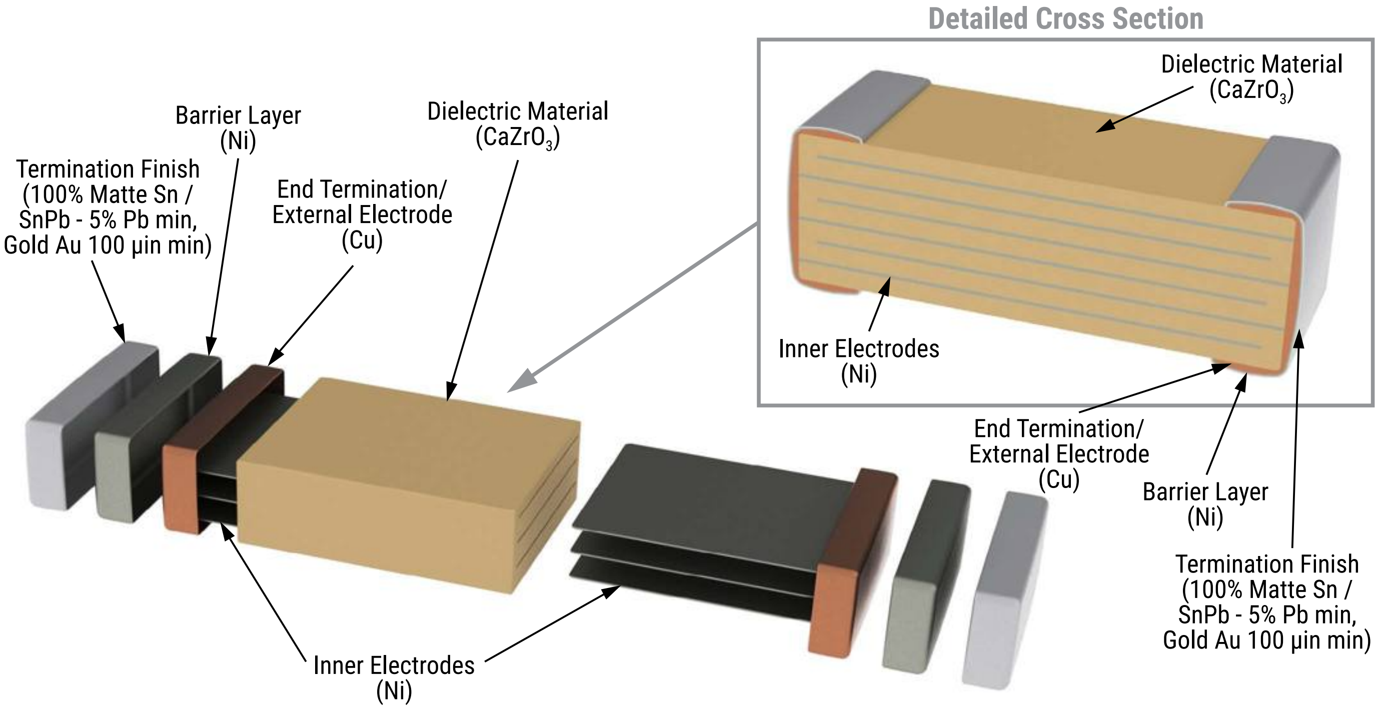
Table 4 – Performance & Reliability: Test Methods and Conditions

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 C0G. 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. 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 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 40ºC 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)

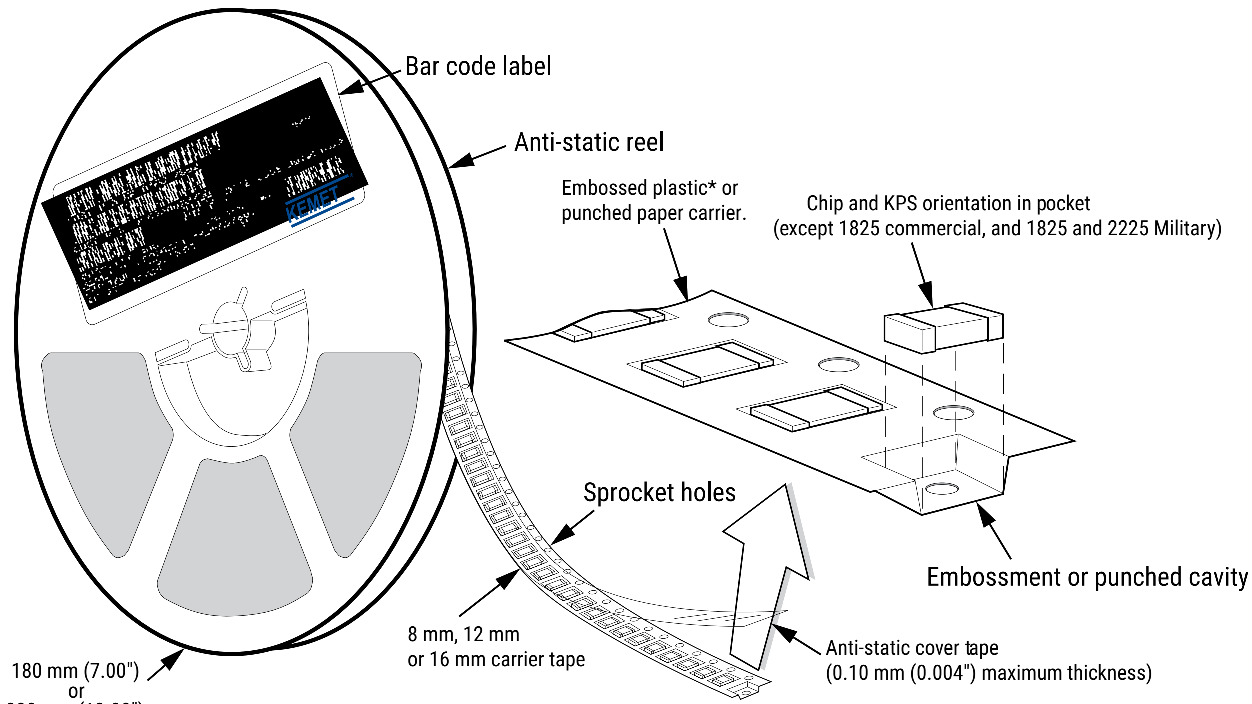
Laser marking option is not available on:

- C0G, 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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

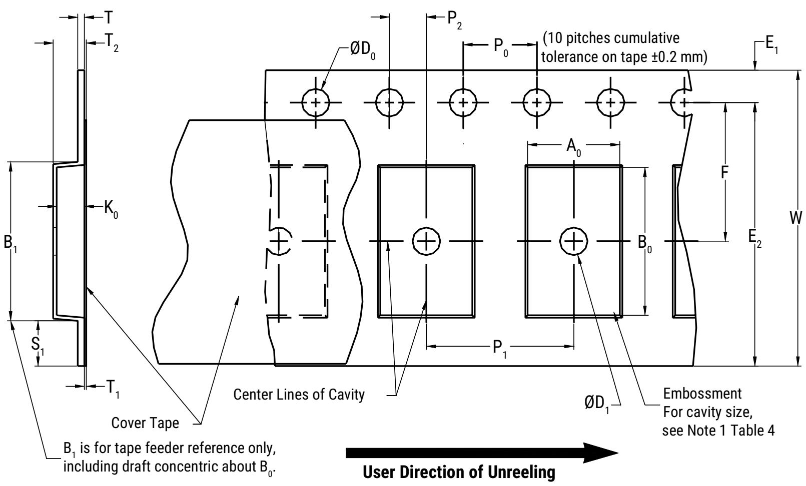


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +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)			
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)	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 S_1 < 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_0, B_0 and K_0 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

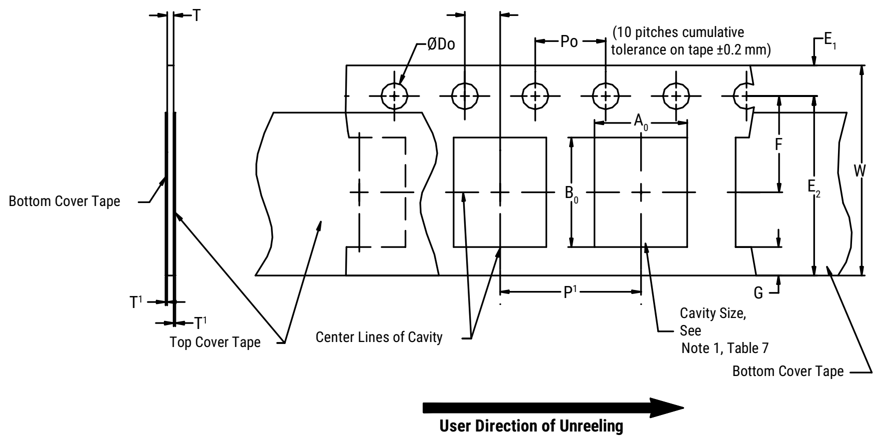


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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.)

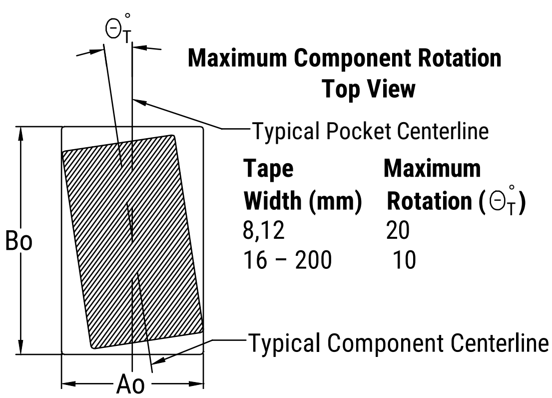
Packaging Information Performance Notes

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



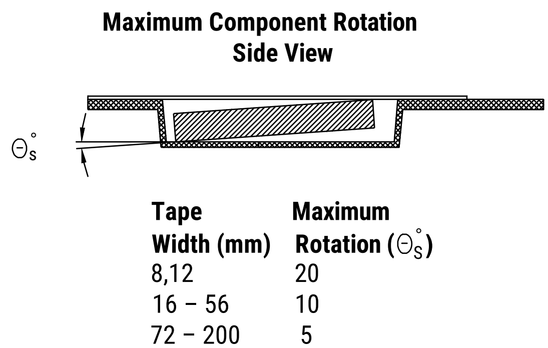


Figure 4 – Maximum Lateral Movement

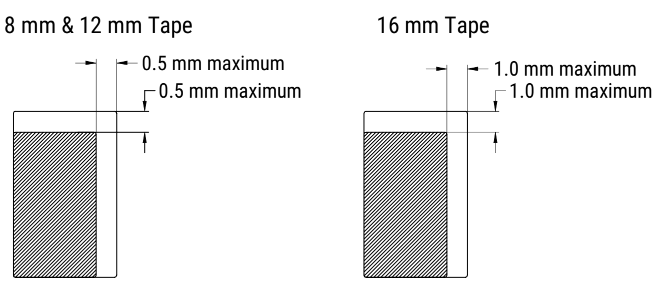


Figure 5 – Bending Radius

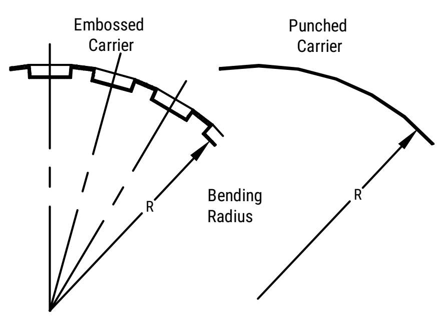
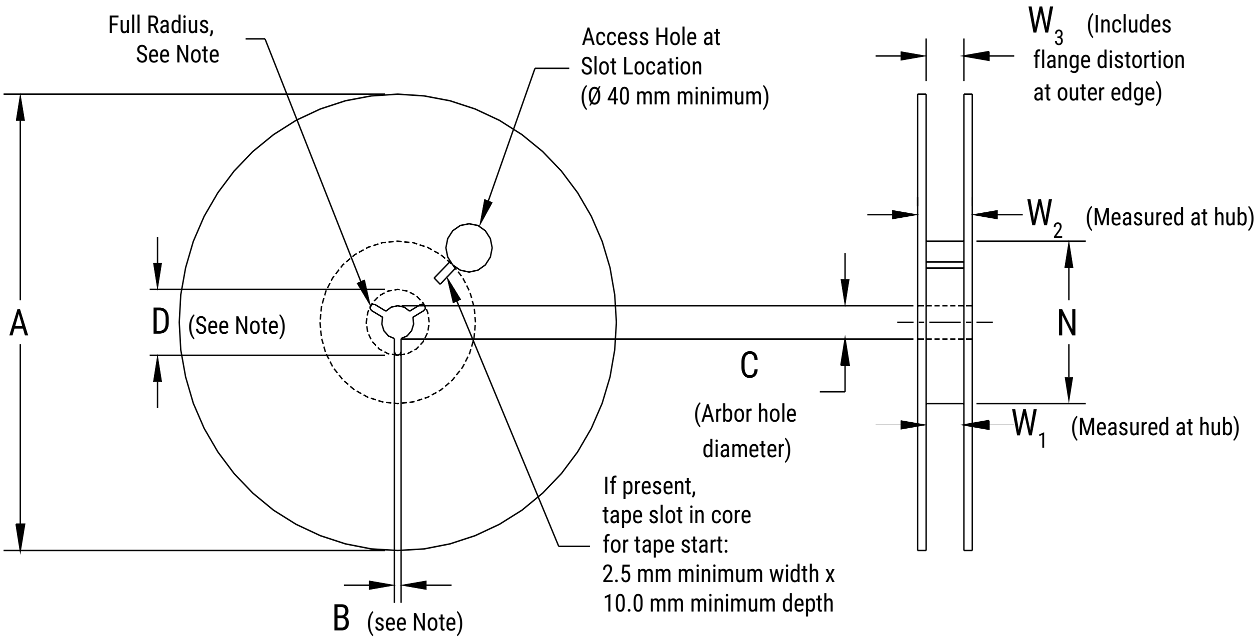


Figure 6 – Reel Dimensions



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	A	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

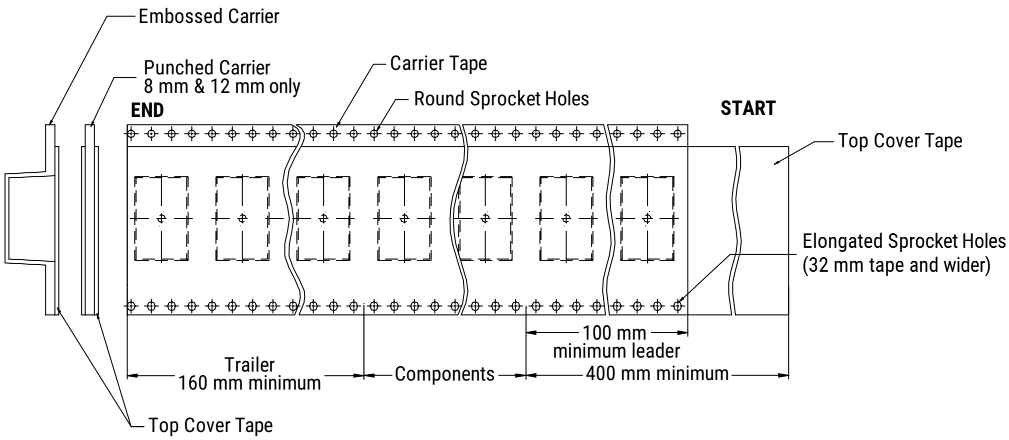
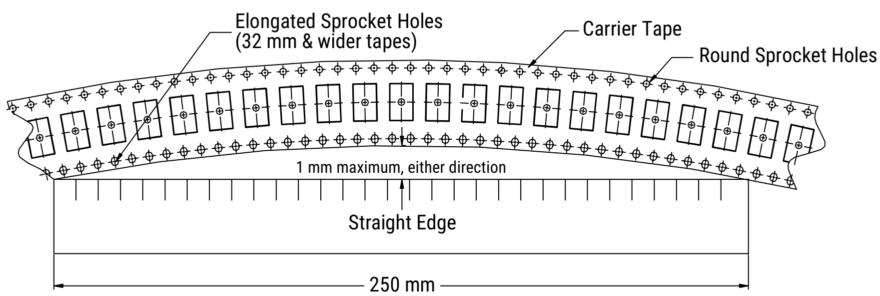


Figure 8 – Maximum Camber



Commercial Off-The-Shelf (COTS) for Higher Reliability Applications, X7R Dielectric, 6.3 – 250 VDC

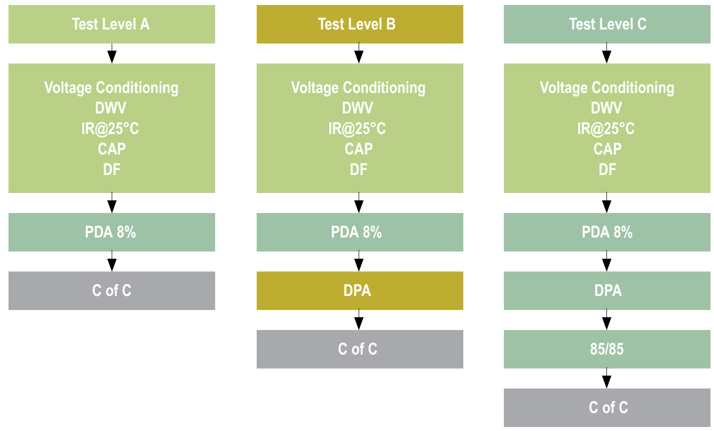
KEMET a YAGEO company

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 ±15% from −55°C to +125°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

C	1210	T	104	K	5	R	A	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.*

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 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]		
G = Gold (Au) 100 µin minimum	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)
	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	T1K0

[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).*

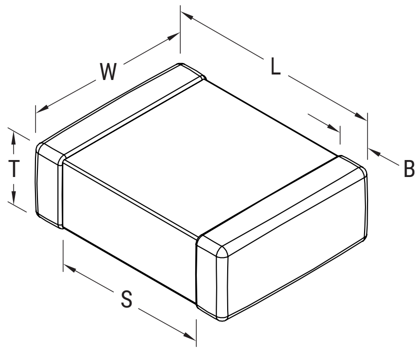
[3] *The terms “Marked” and “Unmarked” pertain to laser marking option of components. All packaging options labeled as “Unmarked” will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices.*

[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)



<table>
<tr><th>EIA Size Code</th><th>Metric Size Code</th><th>L
Length</th><th>W
Width</th><th>T
Thickness</th><th>B
Bandwidth</th><th>S
Separation Minimum</th><th>Mounting Technique</th></tr>
<tr><td>0402</td><td>1005</td><td>1.00 (0.040)
±0.05 (0.002)</td><td>0.50 (0.020)
±0.05 (0.002)</td><td rowspan="9">See Table 2 for Thickness</td><td>0.30 (0.012)
±0.10 (0.004)</td><td>0.30 (0.012)</td><td>Solder Reflow Only</td></tr>
<tr><td>0603</td><td>1608</td><td>1.60 (0.063)
±0.15 (0.006)</td><td>0.80 (0.032)
±0.15 (0.006)</td><td>0.35 (0.014)
±0.15 (0.006)</td><td>0.70 (0.028)</td><td rowspan="3">Solder Wave or Solder Reflow</td></tr>
<tr><td>0805</td><td>2012</td><td>2.00 (0.079)
±0.20 (0.008)</td><td>1.25 (0.049)
+0.20 (0.008)</td><td>0.50 (0.02)
±0.25 (0.010)</td><td>0.75 (0.030)</td></tr>
<tr><td>1206</td><td>3216</td><td>3.20 (0.126)
±0.20 (0.008)</td><td>1.60 (0.063)
±0.20 (0.008)</td><td>0.50 (0.02)
±0.25 (0.010)</td><td rowspan="6">N/A</td></tr>
<tr><td>1210[1]</td><td>3225</td><td>3.20 (0.126)
+0.20 (0.008)</td><td>2.50 (0.098)
±0.20 (0.008)</td><td>0.50 (0.02)
±0.25 (0.010)</td><td rowspan="5">Solder Reflow Only</td></tr>
<tr><td>1805</td><td>4513</td><td>4.50 (0.177)
±0.50 (0.020)</td><td>1.27 (0.050)
±0.38 (0.015)</td><td>0.60 (0.024)
±0.35 (0.014)</td></tr>
<tr><td>1808</td><td>4520</td><td>4.70 (0.185)
±0.50 (0.020)</td><td>2.00 (0.079)
±0.20 (0.008)</td><td>0.60 (0.024)
±0.35 (0.014)</td></tr>
<tr><td>1812</td><td>4532</td><td>4.50 (0.177)
±0.30 (0.012)</td><td>3.20 (0.126)
±0.30 (0.012)</td><td>0.60 (0.024)
±0.35 (0.014)</td></tr>
<tr><td>2220</td><td>5650</td><td>5.70 (0.224)
±0.40 (0.016)</td><td>5.00 (0.197)
±0.40 (0.016)</td><td>0.60 (0.024)
±0.35 (0.014)</td></tr>
</table>

[1] For capacitance values ≥ 4.7 µF 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.*
[3] *Capacitance and dissipation factor (DF) measured under the following conditions:*
1kHz ± 50Hz and 1.0 ± 0.2 Vrms if capacitance ≤10µF
120Hz ± 10Hz and 0.5 ± 0.1 Vrms if capacitance >10µF
[4] *To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ 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	All	3.0	±20%	10% of Initial Limit
	16/25		5.0		
	< 16		7.5		

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

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

Capacitance	Cap Code	Case Size/ Series			C0402C					C0603C							C0805C								C1206C							
		Voltage Code			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
		Rated Voltage (VDC)			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
		Capacitance Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																											
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	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
1,500 pF	152	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
1,800 pF	182	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
2,200 pF	222	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
2,700 pF	272	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
3,300 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	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
4,700 pF	472	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
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	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	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
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	273	J	K	M	BB	BB	BB	BB		CF	CF	CF	CF	CF	CF		DN	DN	DN	DN	DN	DP	DE		EB	EB	EB	EB	EB	EB	EB	EB
33,000 pF	333	J	K	M	BB	BB	BB	BB		CF	CF	CF	CF	CF	CF		DN	DN	DN	DN	DN	DP	DE		EB	EB	EB	EB	EB	EB	EB	EB
39,000 pF	393	J	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	M	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	M	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	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	
0.15 µF	154	J	K	M						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	274	J	K	M						CF	CF	CF					DP	DP	DP	DP	DP				EB	EB	EB	EB	EC	EM		
0.33 µF	334	J	K	M						CF	CF	CF					DP	DP	DP	DP	DP				EB	EB	EB	EB	EC	EG		
0.39 µF	394	J	K	M						CF	CF	CF					DG	DG	DG	DG	DE				EB	EB	EB	EB	EC	EG		
0.47 µF	474	J	K	M						CF	CF	CF					DP	DP	DP	DP	DE				EC	EC	EC	EC	EC	EG		
0.56 µF	564	J	K	M													DP	DP	DP	DG	DH				ED	ED	ED	ED	EC			
0.68 µF	684	J	K	M													DP	DP	DP	DG	DH				EE	EE	EE	EE	ED			
0.82 µF	824	J	K	M													DP	DP	DP	DG					EF	EF	EF	EF	ED			
1.0 µF	105	J	K	M													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 µF	335	J	K	M																					ED	ED	ED	EH				
3.9 µF	395	J	K	M																					EF	EF	EF	EH				
4.7 µF	475	J	K	M																					EF	EF	EF	EH				
5.6 µF	565	J	K	M																					EH	EH	EH					
6.8 µF	685	J	K	M																					EH	EH	EH					
Capacitance	Cap Code	Rated Voltage (VDC)			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
		Voltage Code			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
		Case Size/ Series			C0402C					C0603C							C0805C								C1206C							

*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 1A – Capacitance Range/Selection Waterfall (0402 – 1206 Case Sizes) cont.

Capacitance	Cap Code	Case Size/ Series			C0402C					C0603C							C0805C								C1206C							
		Voltage Code			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
		Rated Voltage (VDC)			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
		Capacitance Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																											
8.2 µF	825	J	K	M																					EH	EH	EH					
10 µF	106	J	K	M																					EH	EH	EH					
Capacitance	Cap Code	Rated Voltage (VDC)			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
		Voltage Code			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
		Case Size/ Series			C0402C					C0603C							C0805C								C1206C							

*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)

Capacitance	Cap Code	Case Size/ Series			C1210C								C1805C			C1808C		
		Voltage Code			9	8	4	3	5	1	2	A	5	1	2	5	1	2
		Rated Voltage (VDC)			6.3	10	16	25	50	100	200	250	50	100	200	50	100	200
		Capacitance Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions													
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	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	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	
12,000 pF	123	J	K	M	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	
Capacitance	Cap Code	Rated Voltage (VDC)			6.3	10	16	25	50	100	200	250	50	100	200	50	100	200
		Voltage Code			9	8	4	3	5	1	2	A	5	1	2	5	1	2
		Case Size/Series			C1210C								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)

Table 1B – Capacitance Range/Selection Waterfall (1210 – 2220 Case Sizes) cont.

Capacitance	Cap Code	Case Size/Series			C1210C								C1805C			C1808C		
		Voltage Code			9	8	4	3	5	1	2	A	5	1	2	5	1	2
		Rated Voltage (VDC)			6.3	10	16	25	50	100	200	250	50	100	200	50	100	200
		Capacitance Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions													
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	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	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	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	M	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	M	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	M	FG	FG	FG	FM										
8.2 µF	825	J	K	M	FH	FH	FH	FK										
10 µF	106	J	K	M	FH	FH	FH	FS										
22 µF	226	J	K	M	FS	FS												
Capacitance	Cap Code	Rated Voltage (VDC)			6.3	10	16	25	50	100	200	250	50	100	200	50	100	200
		Voltage Code			9	8	4	3	5	1	2	A	5	1	2	5	1	2
		Case Size/Series			C1210C								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)*

Table 1C – Capacitance Range/Selection Waterfall (1812 – 2220 Case Sizes)

Capacitance	Cap Code	Case Size/ Series			C1812C					C1825C				C2220C				
		Voltage Code			3	5	1	2	A	5	1	2	A	3	5	1	2	A
		Rated Voltage (VDC)			25	50	100	200	250	50	100	200	250	25	50	100	200	250
		Capacitance Tolerance																
470 - 820 pF**	471 - 821**	J	K	M	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	K	M	GB	GB	GB	GB										
2,700 pF	272	J	K	M	GB	GB	GB	GB										
3,300 pF	332	J	K	M	GB	GB	GB	GB										
3,900 pF	392	J	K	M	GB	GB	GB	GB										
4,700 pF	472	J	K	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	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	K	M	GB	GB	GB	GB	GB	HB	HB	HB	HB	JE	JE	JE		
33,000 pF	333	J	K	M	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	HB	HB	HB	HB	JB	JB	JC	JC	JC
0.15 µF	154	J	K	M	GB	GB	GB	GE	GE	HB	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	HB	HB	HB	HB	JB	JB	JC	JC	JC
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	HB	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	K	M	GE	GE	GG			HF	HF	HF	HF	JC	JF	JF	JF	JF
1.2 µF	125	J	K	M										JC	JC			
1.5 µF	155	J	K	M										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	JO			
15 µF	156	J	K	M										JO				
22 µF	226	J	K	M										JO				
Capacitance	Cap Code	Rated Voltage (VDC)			25	50	100	200	250	50	100	200	250	25	50	100	200	250
		Voltage Code			3	5	1	2	A	5	1	2	A	3	5	1	2	A
		Case Size/Series			C1812C					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)

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

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1] 7" Reel	Paper Quantity[1] 13" Reel	Plastic Quantity 7" Reel	Plastic Quantity 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
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
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
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
Thickness Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[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

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		Packaging Quantities (pieces/unit packaging)	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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 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)				
		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

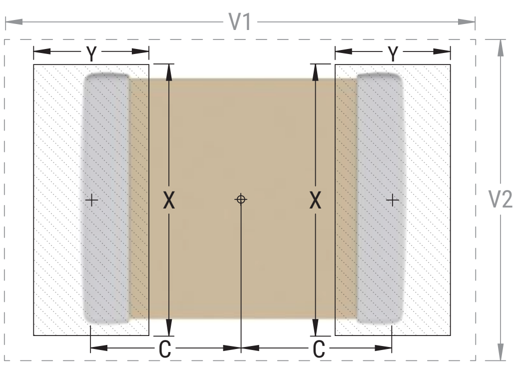
[1] *Only for capacitance values ≥ 22 µF*

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	
	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.

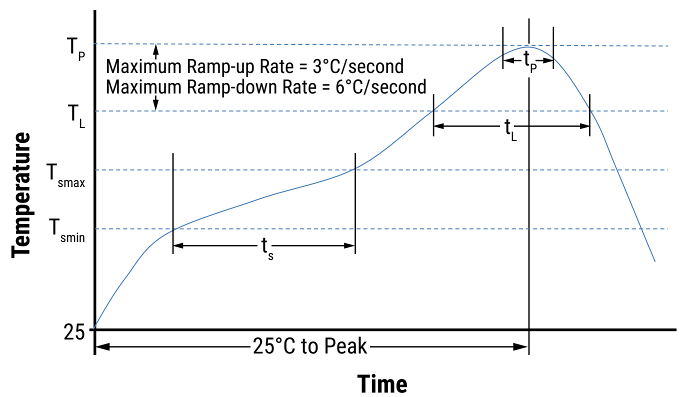


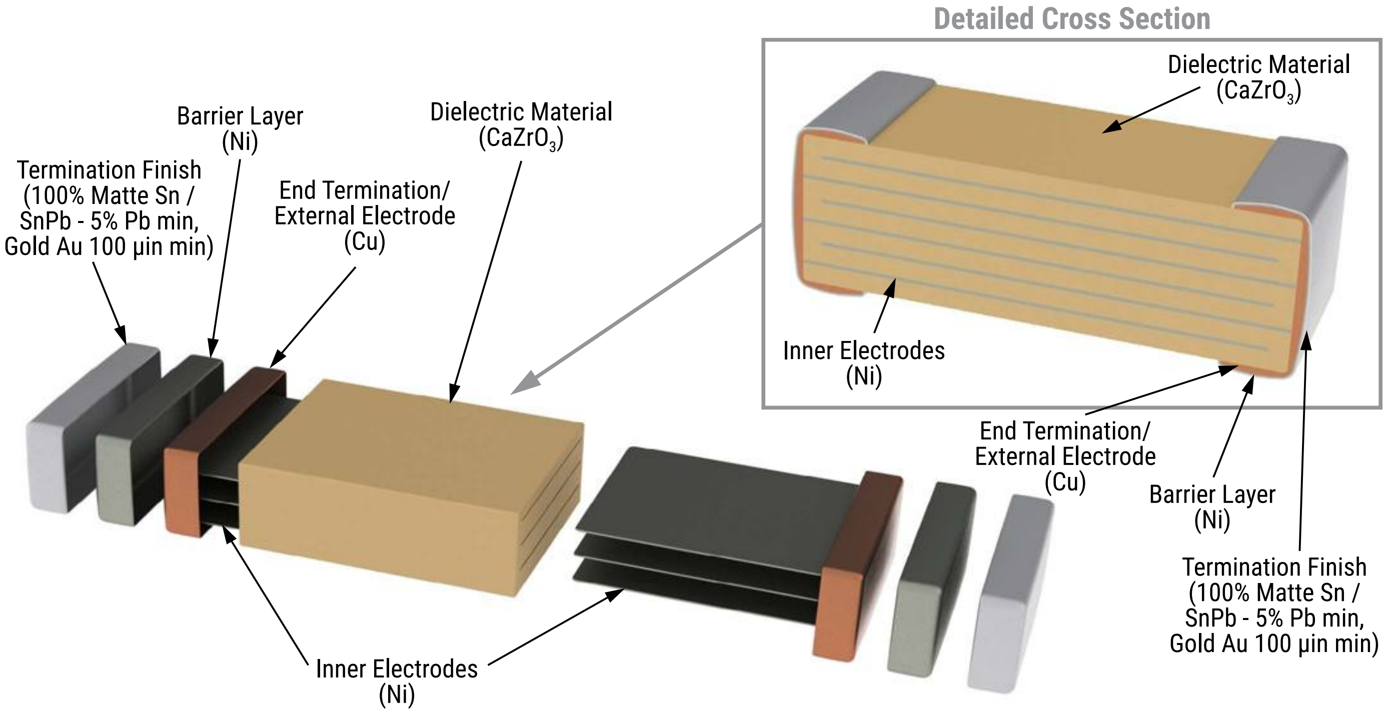
Table 4 – Performance & Reliability: Test Methods and Conditions

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 C0G. 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. 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 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 40ºC 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)

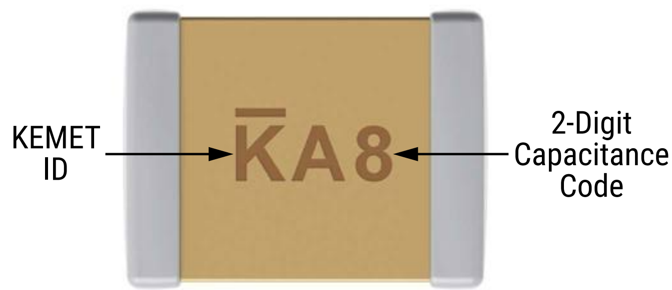
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic 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:

- C0G, 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 µF. Orientation of marking is vendor optional.

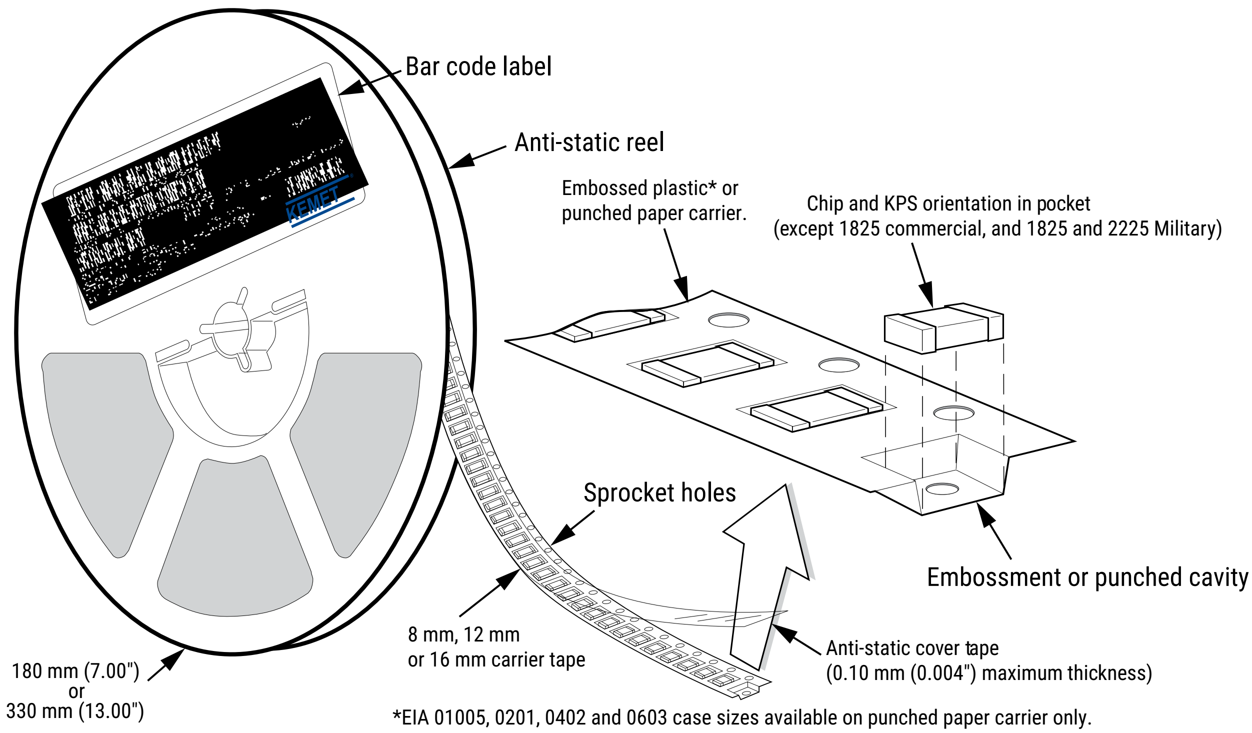


Capacitor Marking (Optional) cont.

Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.10	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

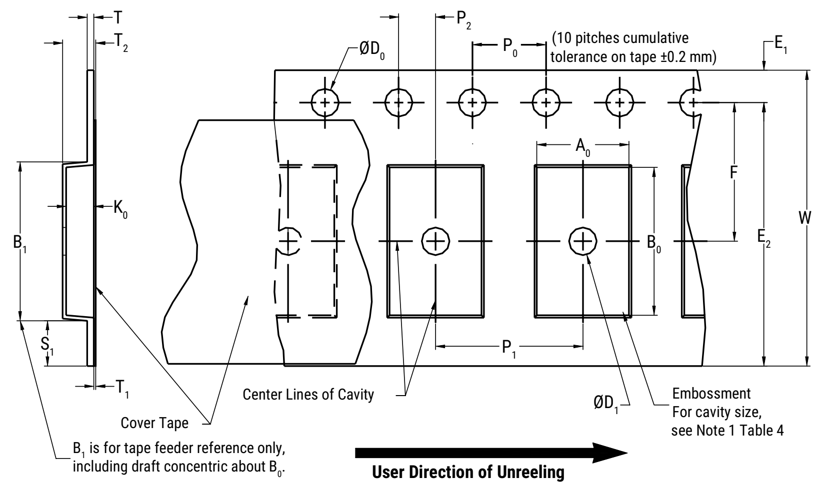


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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 (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)	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 S_1 < 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_0, B_0 and K_0 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

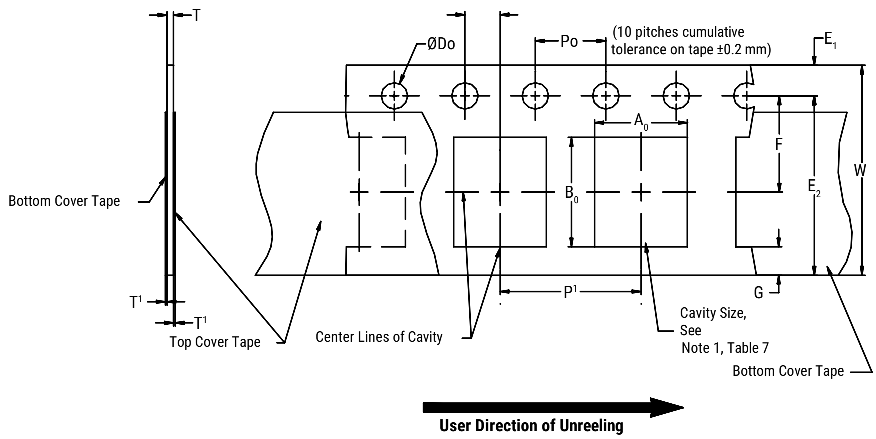


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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.)

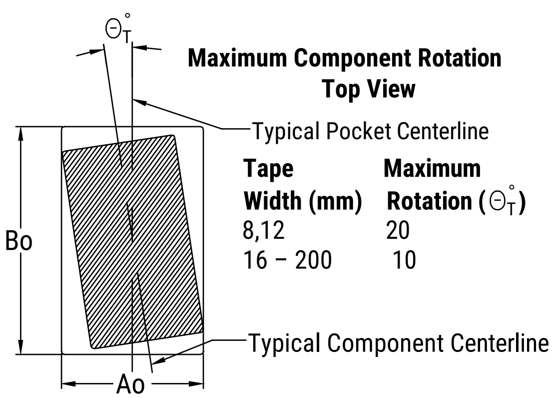
Packaging Information Performance Notes

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



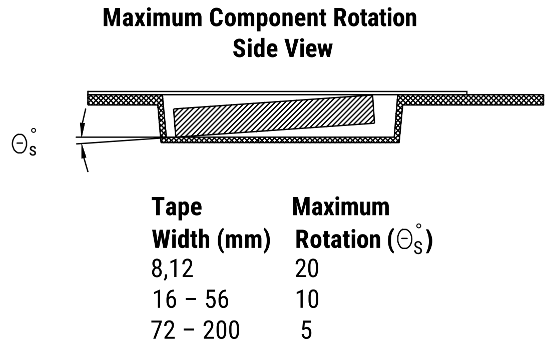


Figure 4 – Maximum Lateral Movement

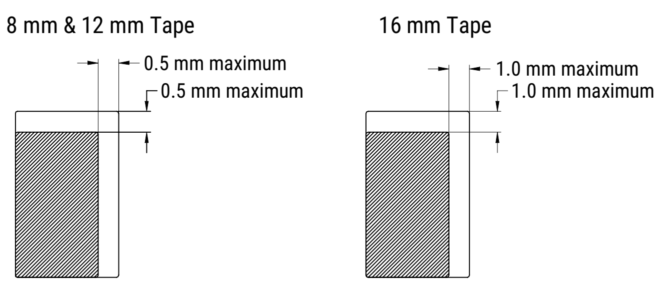


Figure 5 – Bending Radius

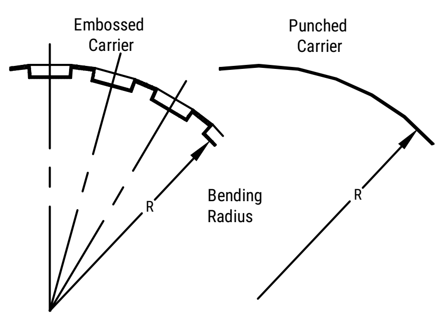
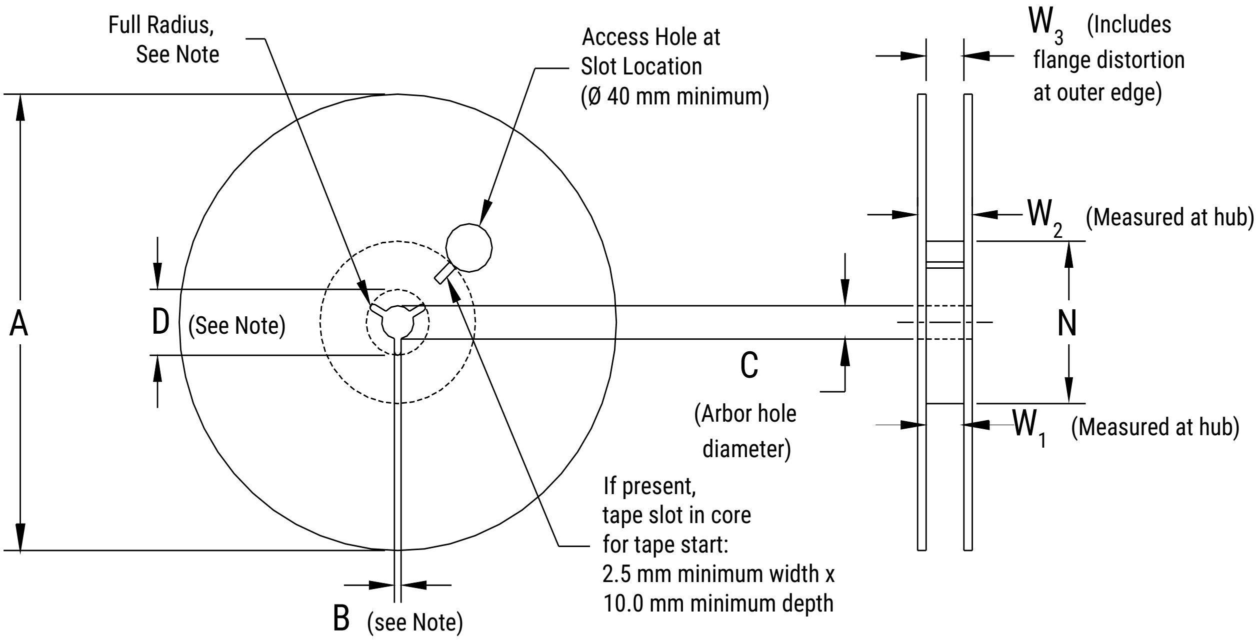


Figure 6 – Reel Dimensions



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	A	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

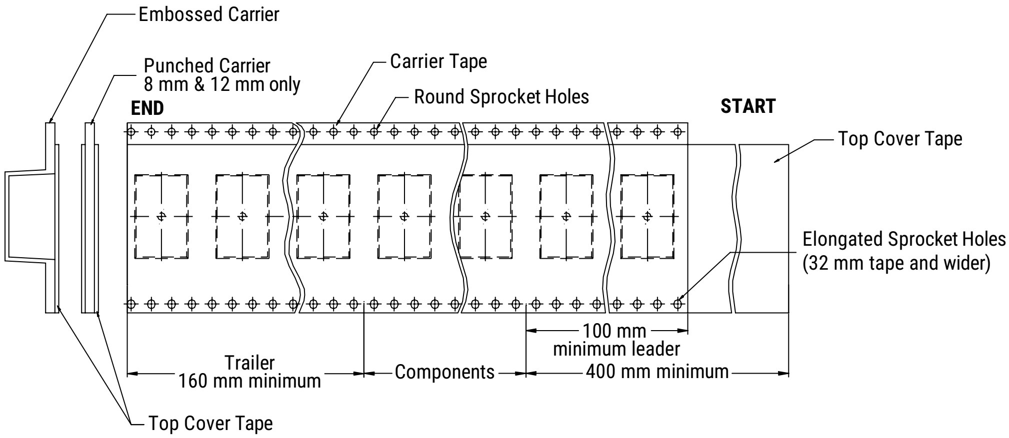
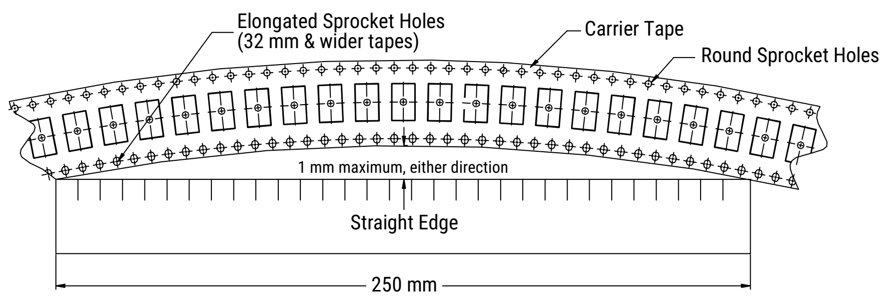


Figure 8 – Maximum Camber



KEMET
a YAGEO company

HiQ CBR Series, C0G Dielectric, Low ESR
6.3 – 500 VDC, 1 MHz – 50 GHz (RF & Microwave)

Overview

HiQ-CBR RF & MICROWAVE

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.

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, ±1%, ±2%, and ±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	A	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 = ±0.05 pF B = ±0.1 pF C = ±0.25 pF D = ±0.5 pF F = ±1% G = ±2% J = ±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 = C0G	A = N/A	C = 100% Matte Sn	See "Packaging C-Spec Ordering Options Table"

Tape & Reel Packaging Information

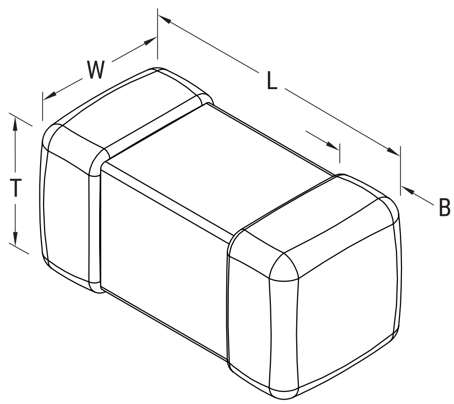
Packaging Type	Packaging Ordering Code (C-SPEC)
7" Reel	Blank
13" Reel	7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 case size)

Environmental Compliance

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

Lead-free RoHS REACH COMPLIANT

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 Reflow 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)	
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 or Solder Reflow
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)	

Electrical Characteristics

SRF (MHz) vs. Cap (pF)

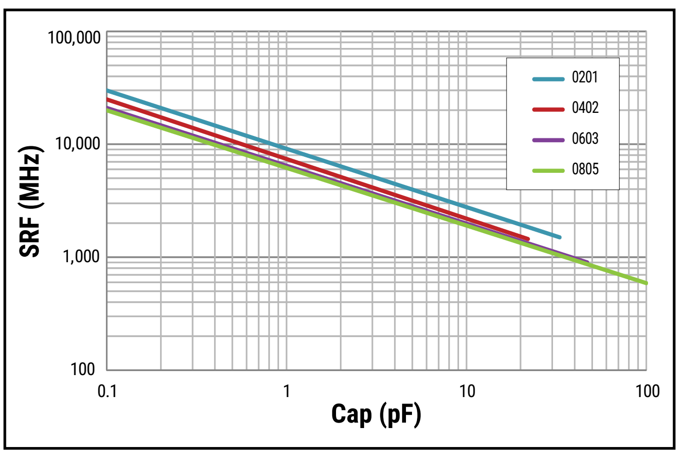


Table 1 – CBR Series, Capacitance Range Waterfall

Case Size – Inches (mm)		0201 (0603)					0402 (1005)					0603 (1608)			0805 (2012)			
Rated Voltage (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)																
0.1 pF	A = ±0.05 pF B = ±0.1 pF	108*	108*	108*	108*	108*	108*	108*	108*	108*	108*							
0.2 pF		208	208	208	208	208	208	208	208	208	208	208	208	208	208	208	208	208
0.3 pF		308	308	308	308	308	308	308	308	308	308	308	308	308	308	308	308	308
0.4 pF		408	408	408	408	408	408	408	408	408	408	408	408	408	408	408	408	408
0.5 pF	A = ±0.05 pF B = ±0.1 pF C = ±0.25 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 pF		119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119	119
1.2 pF		129	129	129	129	129	129	129	129	129	129	129	129	129	129	129	129	129
1.3 pF		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 pF		229	229	229	229	229	229	229	229	229	229	229	229	229	229	229	229	229
2.3 pF		239	239	239	239	239	239	239	239	239	239	239	239	239	239	239	239	239
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		279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279
2.8 pF		289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289	289
2.9 pF		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 pF		329	329	329	329	329	329	329	329	329	329	329	329	329	329	329	329	329
3.3 pF		339	339	339	339	339	339	339	339	339	339	339	339	339	339	339	339	339
3.4 pF		349	349	349	349	349	349	349	349	349	349	349	349	349	349	349	349	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 pF		439	439	439	439	439	439	439	439	439	439	439	439	439	439	439	439	439
4.4 pF		449	449	449	449	449	449	449	449	449	449	449	449	449	449	449	449	449
4.5 pF		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 Voltage (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

** Available only in "B" (±0.1pF) capacitance tolerance.*

Table 1 – CBR Series, Capacitance Range Waterfall cont.

Case Size – Inches (mm)		0201 (0603)					0402 (1005)					0603 (1608)			0805 (2012)			
Rated Voltage (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)																
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 pF		549	549	549	549	549	549	549	549	549	549	549	549	549	549	549	549	549
5.5 pF		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
6.5 pF		659	659	659	659	659	659	659	659	659	659	659	659	659	659	659	659	659
6.6 pF		669	669	669	669	669	669	669	669	669	669	669	669	669	669	669	669	669
6.7 pF		679	679	679	679	679	679	679	679	679	679	679	679	679	679	679	679	679
6.8 pF		689	689	689	689	689	689	689	689	689	689	689	689	689	689	689	689	689
6.9 pF		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	799	799	799	799	799	799	799	799	799	799	799	799	799	799	799
8.0 pF		809	809	809	809	809	809	809	809	809	809	809	809	809	809	809	809	809
8.1 pF		819	819	819	819	819	819	819	819	819	819	819	819	819	819	819	819	819
8.2 pF		829	829	829	829	829	829	829	829	829	829	829	829	829	829	829	829	829
8.3 pF		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 pF		949	949	949	949	949	949	949	949	949	949	949	949	949	949	949	949	949
9.5 pF		959	959	959	959	959	959	959	959	959	959	959	959	959	959	959	959	959
9.6 pF		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 Voltage (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

Table 1 – CBR Series, Capacitance Range Waterfall cont.

Case Size – Inches (mm)		0201 (0603)					0402 (1005)					0603 (1608)			0805 (2012)			
Rated Voltage (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	270	270	270	270	270	270	270	270
30 pF	F = ±1%	300	300	300	300		300	300	300	300	300	300	300	300	300	300	300	300
33 pF	G = ±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
47 pF							470	470	470	470	470	470	470	470	470	470	470	470
51 pF							510	510	510	510	510	510	510	510	510	510	510	510
56 pF							560	560	560	560	560	560	560	560	560	560	560	560
62 pF							620	620	620	620	620	620	620	620	620	620	620	620
68 pF							680	680	680	680	680	680	680	680	680	680	680	680
75 pF							750	750	750	750	750	750	750	750	750	750	750	
82 pF							820	820	820	820	820	820	820	820	820	820	820	
91 pF							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 Voltage (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

Table 2 – Chip Thickness/Reeling Quantities

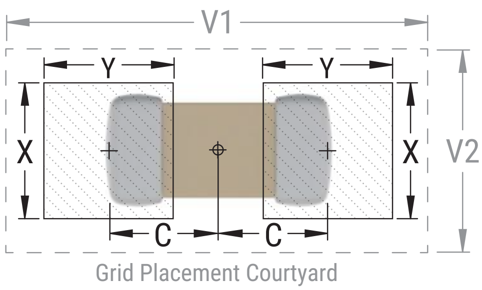
Chip Size Inches (mm)	Chip Thickness (mm)	Reel Quantity	
		7" Paper	13" Paper
0201 (0603)	0.30 ±0.03	15,000	50,000
0402 (1005)	0.50 ±0.05	10,000	50,000
0603 (1608)	0.80 ±0.10	4,000	15,000
0805 (2012)	0.85 ±0.10	4,000	15,000

Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC–7351 (mm)

Case Size (Inches)	Case Size (mm)	Density Level A: Maximum (Most) Land Protrusion					Density Level B: Median (Nominal) Land Protrusion					Density Level C: Minimum (Least) Land Protrusion				
		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.



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
	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.

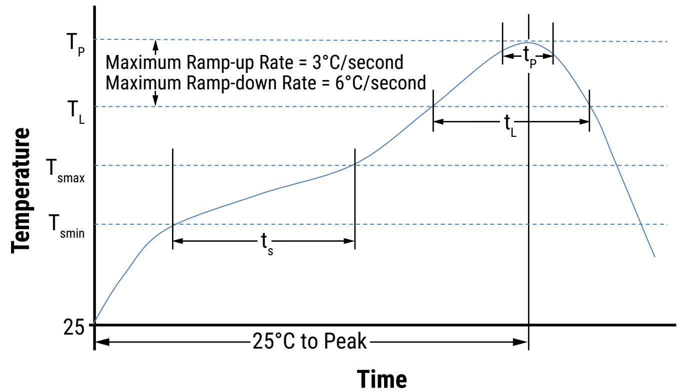


Table 4 – Performance & Reliability: Test Methods & Conditions

<table>
<tr><th>Test</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Capacitance (Cap)</td><td>1 MHz ±100 kHz and 1.0 ±0.2 V_{RMS}</td><td>Within Tolerance</td></tr>
<tr><td>Quality Factor (Q)</td><td>1 MHz ±100 kHz and 1.0 ±0.2 V_{RMS}</td><td>≥ 1,000 for capacitance values ≥ 30 pF
≥ 400 + 20C for capacitance values < 30 pF
(C = Capacitance in pF)</td></tr>
<tr><td>Insulation Resistance</td><td>Apply rated voltage for 120 seconds at 25°C</td><td>10 GΩ minimum</td></tr>
<tr><td>Temperature Coefficient of Capacitance (TCC)</td><td>1 MHz ±100 kHz and 1.0 ±0.2 V_{RMS}</td><td>0 ± 30 PPM/°C
(0 ± 60PPM/°C for 0201 case size product ≥ 22 pF)</td></tr>
<tr><td>Dielectric Withstanding Voltage (DWV)</td><td><table><tr><th>Voltage</th><th>DWV Voltage</th></tr><tr><td><100 V</td><td>250%</td></tr><tr><td>200 V</td><td>200%</td></tr><tr><td>250 V</td><td>200%</td></tr><tr><td>500 V</td><td>150%</td></tr></table>(5 ±1 seconds and charge/discharge not exceeding 50 mA)</td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit

Withstand test voltage without insulation breakdown or damage</td></tr>
<tr><td>Aging Rate</td><td>Capacitance measurements are indexed to a referee time of 1,000 hours.</td><td>0%</td></tr>
<tr><td>Terminal Strength</td><td><table><tr><th>Case Size</th><th>Force</th></tr><tr><td>0201</td><td>2N</td></tr><tr><td>0402</td><td>5N</td></tr><tr><td>0603</td><td>5N</td></tr><tr><td>0805</td><td>10N</td></tr></table>Terminal strength test per specific case size,
Time: 10±1 seconds</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Solderability</td><td>Solder Temperature: 245 ±5°C
Dipping Time: 3 ±0.5 seconds</td><td>95% minimum coverage of termination finish.</td></tr>
<tr><td>Board Flex</td><td>Capacitor is mounted to a substrate which is flexed by means of ram at a rate of 1 mm per second until the deflection becomes 1 mm. (Deflection is maintained for 5 ±1 second)
Store at room temperature for 24 ±2 hours before measuring electrical properties.</td><td>No visible damage.
Capacitance change: within ±5.0% or ±0.5 pF, whichever is larger.
(Capacitance change is monitored during flexure.)</td></tr>
<tr><td>Resistance to Soldering Heat</td><td>Solder Temperature: 260 ±5°C
Dipping Time: 10 ±1 second
Preheating: 120 to 150°C for 1 minute before immerse the capacitor in a eutectic solder.
Store at room temperature for 24 ±2 hours before measuring electrical properties.</td><td>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.</td></tr>
</table>

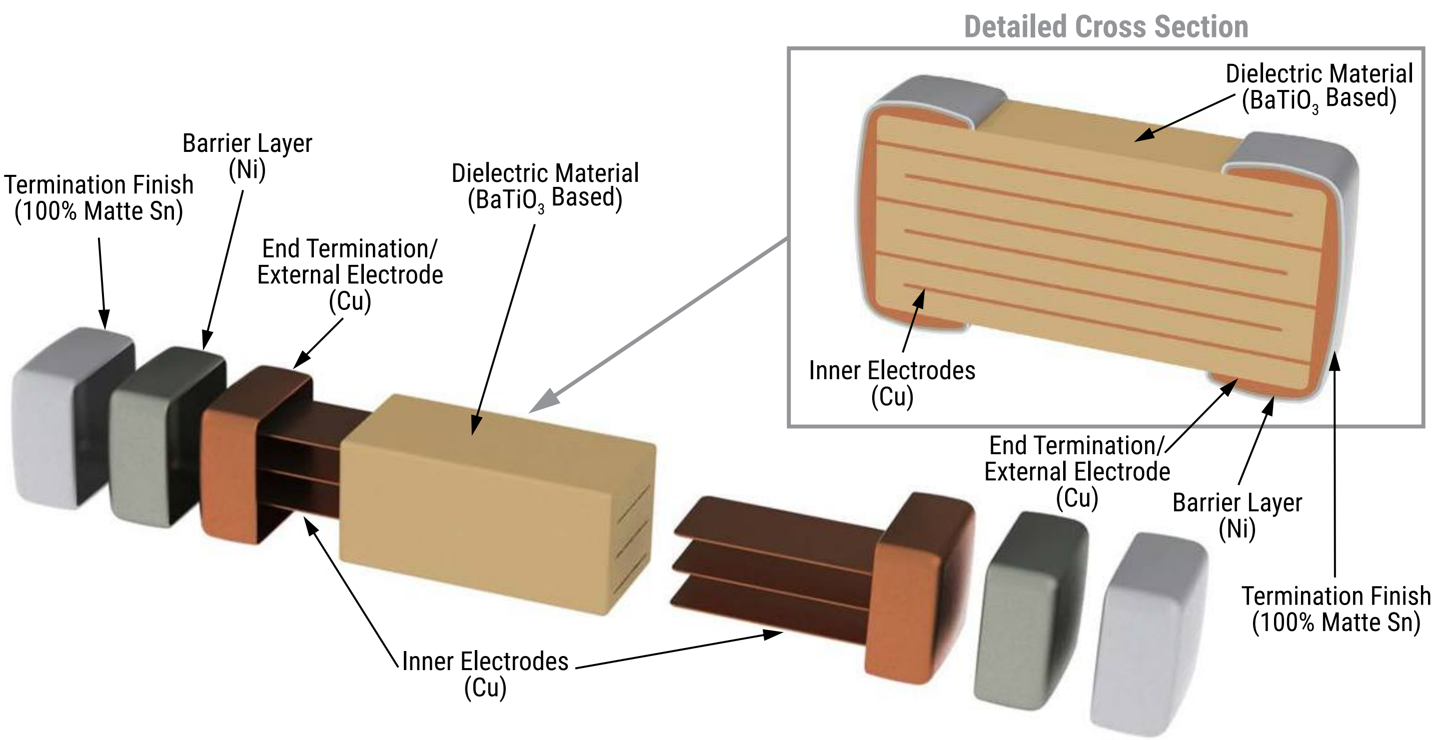
Table 4 – Performance & Reliability: Test Methods & Conditions cont.

<table>
<tr><th>Test</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Temperature Cycling</td><td>5 cycles of steps 1 - 4:
<table>
<tr><th>Step</th><th>Temperature (°C)</th><th>Time (min.)</th></tr>
<tr><td>1</td><td>Minimum operating temperature +0/−3</td><td>30 ±3</td></tr>
<tr><td>2</td><td>Room temperature</td><td>2 ~ 3</td></tr>
<tr><td>3</td><td>Maximum operating temperature +3/−0</td><td>30 ±3</td></tr>
<tr><td>4</td><td>Room temperature (25°C)</td><td>2 ~ 3</td></tr>
</table>
Store at room temperature for 24 ±2 hours before measuring electrical properties.</td><td>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.</td></tr>
<tr><td>Humidity (Damp Heat) Load</td><td>Test temperature: 40 ±2°C
Humidity: 90 ~ 95% RH
Test Time: 500 +24/−0 hours
Applied Voltage: Rated voltage
Store at room temperature for 24 ±2 hours before measuring electrical properties.</td><td>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
IR: ≥ 500 MΩ</td></tr>
<tr><td>High Temperature Life</td><td>Test temperature: 125 ±3°C
Applied Voltage:
200% of rated voltage (6.3 VDC – 100 VDC)
150% of rated voltage (200 VDC and 500 VDC)
Test Time: 1,000 +24/−0 hours
Store at room temperature for 24 ±2 hours before measuring electrical properties.</td><td>No visible damage.
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</td></tr>
<tr><td rowspan="2">ESR</td><td>The ESR should be measured at room temperature and tested at frequency 1 ±0.1 GHz.</td><td>
<table>
<tr><th>0201 Case Size</th><th>0402 Case Size</th></tr>
<tr><td>0.1 pF ≤ Capacitance ≤ 1 pF: < 350 mΩ/pF</td><td>0.1 pF ≤ Capacitance ≤ 1 pF: < 350 mΩ/pF</td></tr>
<tr><td>1.0 pF < Capacitance ≤ 5.0 pF: < 300 mΩ</td><td>1.0 pF < Capacitance ≤ 5.0 pF: < 300 mΩ</td></tr>
<tr><td>5.0 pF < Capacitance ≤ 22.0 pF: < 250 mΩ</td><td>5.0 pF < Capacitance ≤ 100 pF: < 250 mΩ</td></tr>
<tr><th>0603 Case Size</th><th>0805 Case Size</th></tr>
<tr><td>0.3 pF ≤ Capacitance ≤ 1 pF: < 1,500 mΩ</td><td>0.3 pF ≤ Capacitance ≤ 1 pF: < 1,500 mΩ</td></tr>
<tr><td>1 pF < Capacitance ≤ 10 pF: < 250 mΩ</td><td>1 pF < Capacitance ≤ 10 pF: < 250 mΩ</td></tr>
<tr><td>10 pF < Capacitance ≤ 100 pF: < 200 mΩ</td><td>Capacitance > 10 pF: < 200 mΩ</td></tr>
</table></td></tr>
<tr><td>The ESR should be measured at room temperature and tested at frequency 500 ±50 MHz.</td><td>0201 case size, 22 pF ≤ Cap ≤ 33 pF: < 300 mΩ</td></tr>
</table>

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.

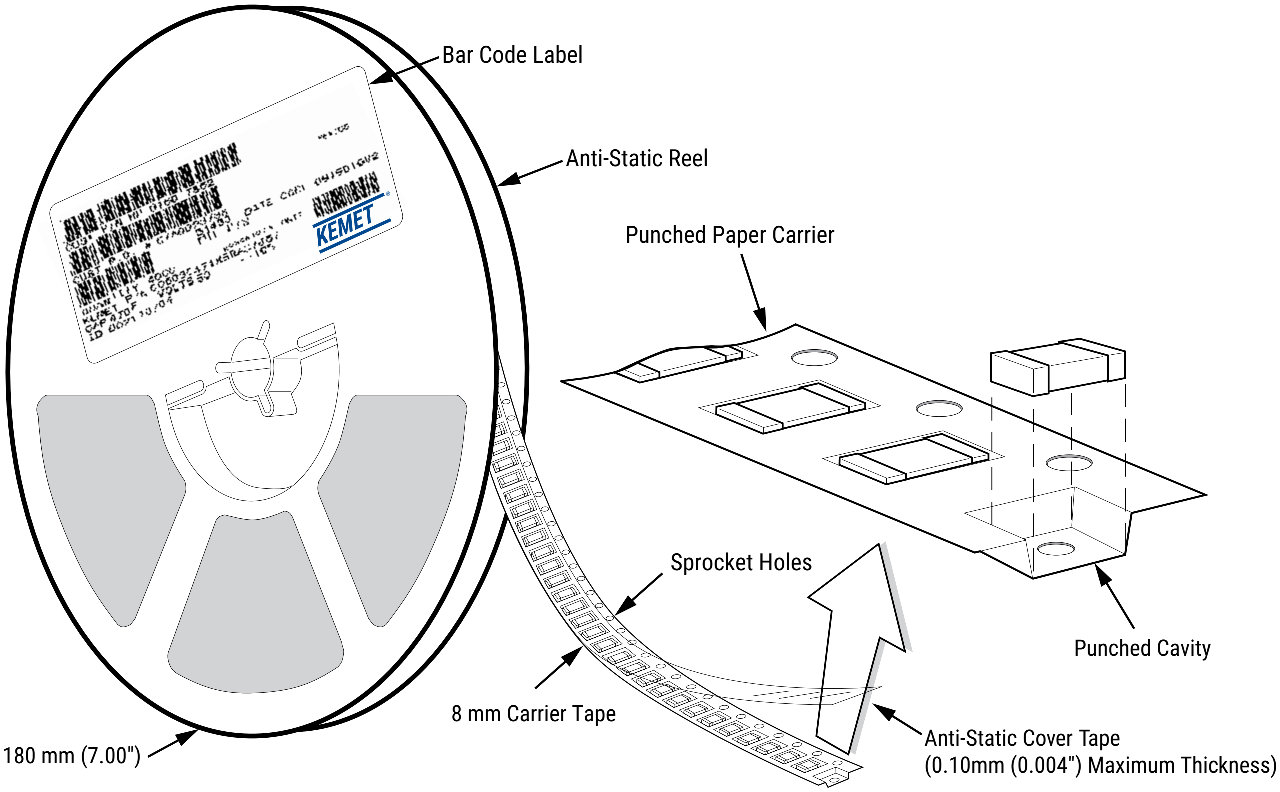
Construction



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 P_1 carrier tape reference locations.*
**Refer to Table 6 for tolerance specifications.*

Figure 1 – Punched (Paper) Carrier Tape Dimensions

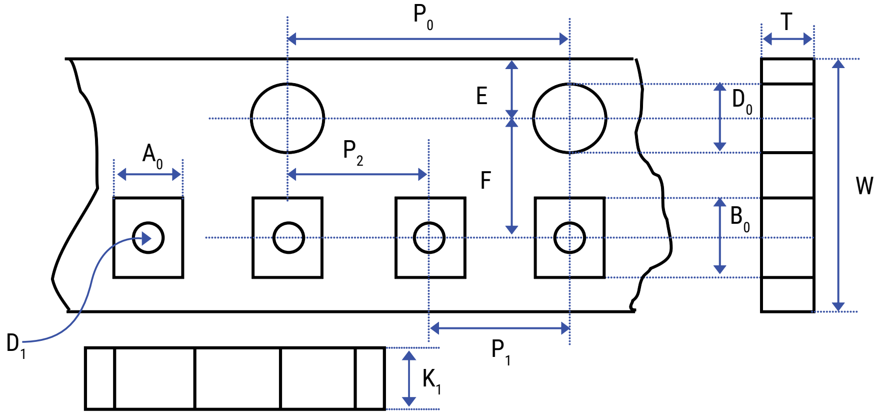


Table 6 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

<table>
<tr><th colspan="9">Constant Dimensions — Millimeters (Inches)</th></tr>
<tr><td>Tape Size</td><td>D_0</td><td>E_1</td><td>P_0</td><td>P_2</td><td>R Reference Note 2</td><td colspan="3">K_0</td></tr>
<tr><td>8 mm</td><td>1.55+0.05 (0.061+0.002)</td><td>1.55±0.05 (0.061±0.002)</td><td>4.0±0.10 (0.157±0.004)</td><td>2.0±0.05 (0.079±0.002)</td><td>25.0 (0.984)</td><td colspan="3">-</td></tr>
<tr><th colspan="9">Variable Dimensions — Millimeters (Inches)</th></tr>
<tr><td>Tape Size</td><td>Pitch</td><td>A_0</td><td>B_0</td><td>F</td><td>P_1</td><td>T</td><td>W</td><td>D_1</td></tr>
<tr><td rowspan="2">8 mm</td><td rowspan="2">Half (2 mm)</td><td>0.37±0.03 (0.015±0.001)</td><td>0.67±0.03 (0.03±0.001)</td><td rowspan="4">3.5±0.05 (0.138±0.002)</td><td rowspan="2">2.0±0.05 (0.079±0.002)</td><td>0.42±0.03 (0.017±0.001)</td><td rowspan="4">8.0±0.10 (0.315±0.004)</td><td rowspan="4">-</td></tr>
<tr><td>0.62±0.05 (0.025±0.002)</td><td>1.12±0.05 (0.04±0.002)</td><td>0.60±0.05 (0.024±0.002)</td></tr>
<tr><td rowspan="2">8 mm</td><td rowspan="2">Single (4 mm)</td><td>1.00±0.10 (0.040±0.004)</td><td>1.80±0.10 (0.07±0.004)</td><td rowspan="2">4.0±0.10 (0.157±0.004)</td><td>0.95±0.05 (0.037±0.002)</td></tr>
<tr><td>1.50±0.10 (0.06±0.004)</td><td>2.30±0.10 (0.09±0.004)</td><td>0.95±0.05 (0.037±0.002)</td></tr>
</table>

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 ±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 – Bending Radius

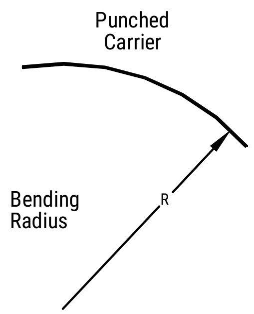


Figure 3 – Tape Leader & Trailer Dimensions

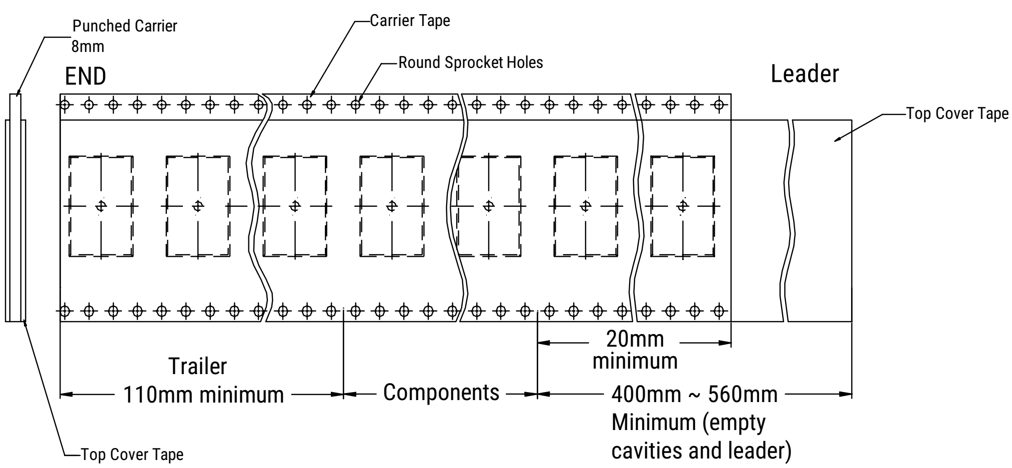


Figure 4 – Maximum Camber

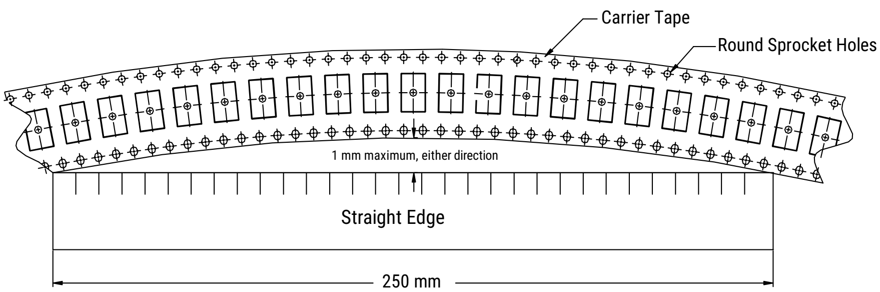


Figure 5 – Reel Dimensions

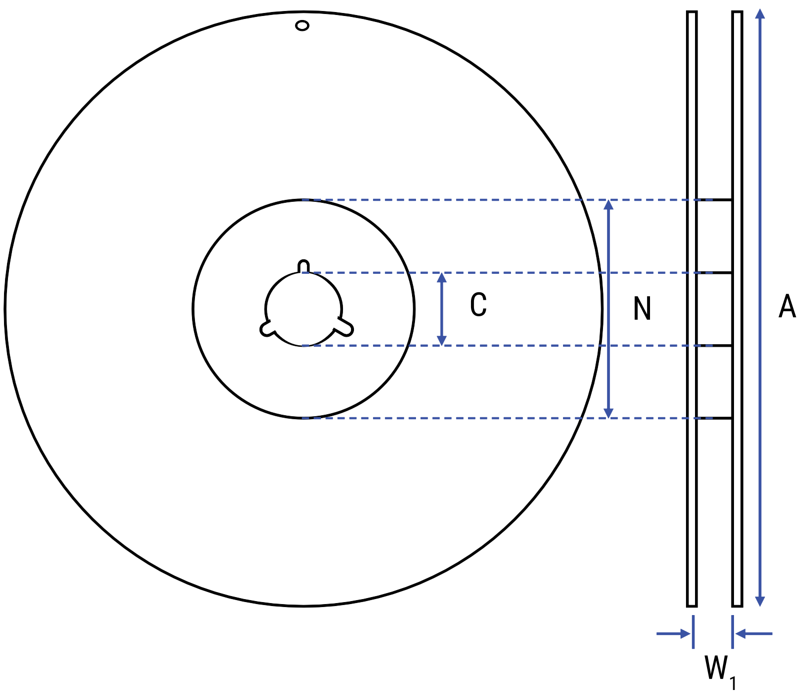


Table 7 – Reel Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)			
Tape Size	Reel Size	A	C
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)	

KPS MIL Series, SMPS Stacked Capacitors, MIL–PRF–49470, DSCC 87106, 25 – 1,000 VDC (Commercial, Military and Space Grades)

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.

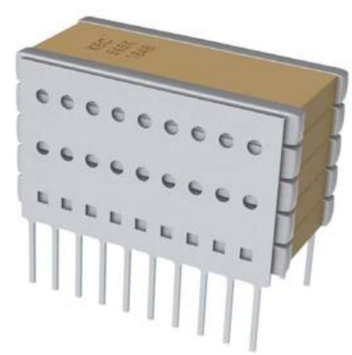
Available in BX, BR, BQ, and X7R dielectrics, these devices are available in unencapsulated styles in both surface mountable and through-hole configurations. Their low Equivalent Series Resistance (ESR) and Equivalent Series Inductance (ESL) make them ideally suited for input and output filtering of 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 Configuration[4]
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.*

[4] *Lead 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	12	
Product Family[1]	Dielectric Classification/ Characteristic[2]	Lead Configuration[3]	Case Size/ Case Code (CC)	Rated Voltage (VDC)	Capacitance Code (pF)	Capacitance Tolerance	Testing Option[4]	Maximum Height Dimension (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

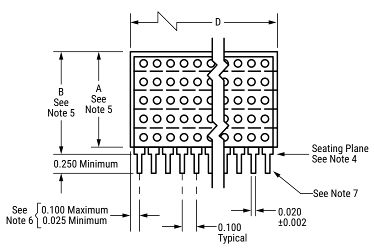
DSCC Drawing 87106 was cancelled on 01/03/2005. Customers can continue to order per 87106 requirements using the original DSCC ordering code,i.e., 87106–001.

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.

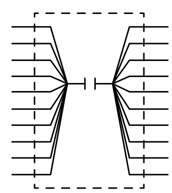
(M49470/1 & L1) Product Dimensions – Inches (Millimeters)

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 1A and 1C for specific maximum A dimension	0.055 (1.40)	10	Solder reflow only
4	0.400 (10.16)	0.440 (11.18)	0.350 (8.89)	0.425 (10.80)			4	
5	0.250 (6.35)	0.300 (7.62)	0.224 (5.69)	0.275 (6.98)			3	

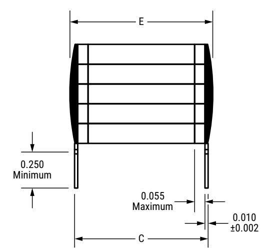
[1] *Only applies to lead style "N" (straight).*



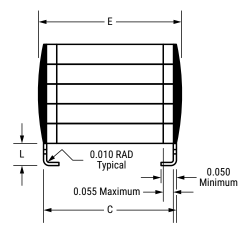
Circuit Diagram



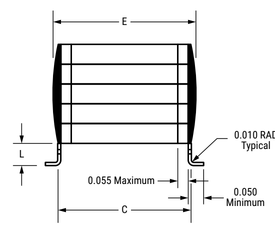
Lead Style N



Lead Style J



Lead Style L



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
Group I	
Thermal shock and voltage conditioning	4.8.5
Group 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
Group V	
Shock, specified pulse	4.8.16
Resistance to soldering heat	4.8.17
Moisture resistance	4.8.18
Group VI	
DPA (T level only)	4.8.19
Group VII	
Humidity, steady state, low voltage (T level only)	4.8.21
Group 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 25ºC	2.5%
Insulation Resistance (IR) Limit at 25°C	1,000 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 1,000 hours.
To obtain IR limit, divide MΩ-μF value by the capacitance and compare to GΩ 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 25ºC	2.5%
Insulation Resistance (IR) Limit at 25°C	1,000 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 1,000 hours.
To obtain IR limit, divide MΩ-μF value by the capacitance and compare to GΩ 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 MΩ-µF value by the capacitance and compare to GΩ 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 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 1000 hours.
To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ 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 ≤ 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."

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)	K, M	N, L, J	L1X(3)505105(2)(4)12
(1)49470X01125(2)A(3)	1.2	5	0.120 (3.05)	K, M	N, L, J	L1X(3)505125(2)(4)12
(1)49470X01155(2)A(3)	1.5	5	0.240 (6.10)	K, M	N, L, J	L1X(3)505155(2)(4)24
(1)49470X01185(2)A(3)	1.8	5	0.240 (6.10)	K, M	N, L, J	L1X(3)505185(2)(4)24
(1)49470X01225(2)A(3)	2.2	5	0.240 (6.10)	K, M	N, L, J	L1X(3)505225(2)(4)24
(1)49470X01275(2)A(3)	2.7	5	0.360 (9.14)	K, M	N, L, J	L1X(3)505275(2)(4)36
(1)49470X01335(2)A(3)	3.3	5	0.360 (9.14)	K, M	N, L, J	L1X(3)505335(2)(4)36
(1)49470X01475(2)A(3)	3.9	5	0.480 (12.19)	K, M	N, L, J	L1X(3)505475(2)(4)48
(1)49470X01395(2)A(3)	3.9	5	0.480 (12.19)	K, M	N, L, J	L1X(3)505395(2)(4)48
(1)49470X01565(2)A(3)	5.6	5	0.650 (16.51)	K, M	N, L, J	L1X(3)505565(2)(4)65
(1)49470X01685(2)A(3)	6.8	4	0.360 (9.14)	K, M	N, L, J	L1X(3)405685(2)(4)36
(1)49470X01825(2)A(3)	8.2	4	0.360 (9.14)	K, M	N, L, J	L1X(3)405825(2)(4)36
(1)49470X01106(2)A(3)	10	4	0.480 (12.19)	K, M	N, L, J	L1X(3)405106(2)(4)48
(1)49470X01126(2)A(3)	12	4	0.480 (12.19)	K, M	N, L, J	L1X(3)405126(2)(4)48
(1)49470X01156(2)A(3)	15	4	0.650 (16.51)	K, M	N, L, J	L1X(3)405156(2)(4)65
(1)49470X01186(2)A(3)	18	3	0.240 (6.10)	K, M	N, L, J	L1X(3)305186(2)(4)24
(1)49470X01226(2)A(3)	22	3	0.360 (9.14)	K, M	N, L, J	L1X(3)305226(2)(4)36
(1)49470X01276(2)A(3)	27	3	0.360 (9.14)	K, M	N, L, J	L1X(3)305276(2)(4)36
(1)49470X01336(2)A(3)	33	3	0.360 (9.14)	K, M	N, L, J	L1X(3)305336(2)(4)36
(1)49470X01396(2)A(3)	39	3	0.480 (12.19)	K, M	N, L, J	L1X(3)305396(2)(4)48
(1)49470X01476(2)A(3)	47	3	0.650 (16.51)	K, M	N, L, J	L1X(3)305476(2)(4)65
100 VDC – BX Dielectric						
(1)49470X01684(2)B(3)	0.68	5	0.120 (3.05)	K, M	N, L, J	L1X(3)501684(2)(4)12
(1)49470X01824(2)B(3)	0.82	5	0.240 (6.10)	K, M	N, L, J	L1X(3)501824(2)(4)24
(1)49470X01105(2)B(3)	1	5	0.240 (6.10)	K, M	N, L, J	L1X(3)501105(2)(4)24
(1)49470X01125(2)B(3)	1.2	5	0.240 (6.10)	K, M	N, L, J	L1X(3)501125(2)(4)24
(1)49470X01155(2)B(3)	1.5	5	0.360 (9.14)	K, M	N, L, J	L1X(3)501155(2)(4)36
(1)49470X01185(2)B(3)	1.8	5	0.360 (9.14)	K, M	N, L, J	L1X(3)501185(2)(4)36
(1)49470X01225(2)B(3)	2.2	5	0.480 (12.19)	K, M	N, L, J	L1X(3)501225(2)(4)48
(1)49470X01275(2)B(3)	2.7	5	0.480 (12.19)	K, M	N, L, J	L1X(3)501275(2)(4)48
(1)49470X01335(2)B(3)	3.3	5	0.650 (16.51)	K, M	N, L, J	L1X(3)501335(2)(4)65
(1)49470X01395(2)B(3)	3.9	4	0.360 (9.14)	K, M	N, L, J	L1X(3)401395(2)(4)36
(1)49470X01475(2)B(3)	4.7	4	0.360 (9.14)	K, M	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)	K, M	N, L, J	L1X(3)401685(2)(4)48
(1)49470X01825(2)B(3)	8.2	4	0.650 (16.51)	K, M	N, L, J	L1X(3)401825(2)(4)65
(1)49470X01106(2)B(3)	10	3	0.240 (6.10)	K, M	N, L, J	L1X(3)301106(2)(4)24
(1)49470X01126(2)B(3)	12	3	0.240 (6.10)	K, M	N, L, J	L1X(3)301126(2)(4)24
(1)49470X01156(2)B(3)	15	3	0.360 (9.14)	K, M	N, L, J	L1X(3)301156(2)(4)36
(1)49470X01186(2)B(3)	18	3	0.360 (9.14)	K, M	N, L, J	L1X(3)301186(2)(4)36
(1)49470X01226(2)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)	K, M	N, L, J	L1X(3)301276(2)(4)65
200 VDC – BR Dielectric						
(1)49470R01474(2)C(3)	0.47	5	0.240 (6.10)	K, M	N, L, J	L1R(3)502474(2)(4)24
(1)49470R01564(2)C(3)	0.56	5	0.240 (6.10)	K, M	N, L, J	L1R(3)502564(2)(4)24
(1)49470R01684(2)C(3)	0.68	5	0.360 (9.14)	K, M	N, L, J	L1R(3)502684(2)(4)36
(1)49470R01824(2)C(3)	0.82	5	0.360 (9.14)	K, M	N, L, J	L1R(3)502824(2)(4)36
(1)49470R01105(2)C(3)	1	5	0.480 (12.19)	K, M	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)	K, M	N, L, J	L1R(3)502125(2)(4)48
(1)49470R01155(2)C(3)	1.5	5	0.650 (16.51)	K, M	N, L, J	L1R(3)502155(2)(4)65
(1)49470R01185(2)C(3)	1.8	4	0.360 (9.14)	K, M	N, L, J	L1R(3)402185(2)(4)36
(1)49470R01225(2)C(3)	2.2	4	0.360 (9.14)	K, M	N, L, J	L1R(3)402225(2)(4)36
(1)49470R01275(2)C(3)	2.7	4	0.480 (12.19)	K, M	N, L, J	L1R(3)402275(2)(4)48
(1)49470R01335(2)C(3)	3.3	4	0.480 (12.19)	K, M	N, L, J	L1R(3)402335(2)(4)48
(1)49470R01395(2)C(3)	3.9	4	0.650 (16.51)	K, M	N, L, J	L1R(3)402395(2)(4)65
(1)49470R01475(2)C(3)	4.7	3	0.240 (6.10)	K, M	N, L, J	L1R(3)302475(2)(4)24
(1)49470R01565(2)C(3)	5.6	3	0.240 (6.10)	K, M	N, L, J	L1R(3)302565(2)(4)24
(1)49470R01685(2)C(3)	6.8	3	0.360 (9.14)	K, M	N, L, J	L1R(3)302685(2)(4)36
(1)49470R01825(2)C(3)	8.2	3	0.360 (9.14)	K, M	N, L, J	L1R(3)302825(2)(4)36
(1)49470R01106(2)C(3)	10	3	0.480 (12.19)	K, M	N, L, J	L1R(3)302106(2)(4)48
(1)49470R01126(2)C(3)	12	3	0.650 (16.51)	K, M	N, L, J	L1R(3)302126(2)(4)65
500 VDC – BQ Dielectric						
(1)49470Q01154(2)E(3)	0.15	5	0.120 (3.05)	K, M	N, L, J	L1Q(3)50C154(2)(4)12
(1)49470Q01184(2)E(3)	0.18	5	0.240 (6.10)	K, M	N, L, J	L1Q(3)50C184(2)(4)24
(1)49470Q01224(2)E(3)	0.22	5	0.240 (6.10)	K, M	N, L, J	L1Q(3)50C224(2)(4)24
(1)49470Q01274(2)E(3)	0.27	5	0.240 (6.10)	K, M	N, L, J	L1Q(3)50C274(2)(4)24
(1)49470Q01334(2)E(3)	0.33	5	0.360 (9.14)	K, M	N, L, J	L1Q(3)50C334(2)(4)36
(1)49470Q01394(2)E(3)	0.39	5	0.360 (9.14)	K, M	N, L, J	L1Q(3)50C394(2)(4)36
(1)49470Q01474(2)E(3)	0.47	5	0.360 (9.14)	K, M	N, L, J	L1Q(3)50C474(2)(4)36
(1)49470Q01564(2)E(3)	0.56	5	0.480 (12.19)	K, M	N, L, J	L1Q(3)50C564(2)(4)48
(1)49470Q01684(2)E(3)	0.68	5	0.650 (16.51)	K, M	N, L, J	L1Q(3)50C684(2)(4)65
(1)49470Q01824(2)E(3)	0.82	4	0.360 (9.14)	K, M	N, L, J	L1Q(3)40C824(2)(4)36
(1)49470Q01105(2)E(3)	1	4	0.360 (9.14)	K, M	N, L, J	L1Q(3)40C105(2)(4)36
(1)49470Q01125(2)E(3)	1.2	4	0.360 (9.14)	K, M	N, L, J	L1Q(3)40C125(2)(4)36
(1)49470Q01155(2)E(3)	1.5	4	0.480 (12.19)	K, M	N, L, J	L1Q(3)40C155(2)(4)48
(1)49470Q01185(2)E(3)	1.8	4	0.650 (16.51)	K, M	N, L, J	L1Q(3)40C185(2)(4)65
(1)49470Q01225(2)E(3)	2.2	3	0.240 (6.10)	K, M	N, L, J	L1Q(3)30C225(2)(4)24
(1)49470Q01275(2)E(3)	2.7	3	0.360 (9.14)	K, M	N, L, J	L1Q(3)30C275(2)(4)36
(1)49470Q01335(2)E(3)	3.3	3	0.360 (9.14)	K, M	N, L, J	L1Q(3)30C335(2)(4)36
(1)49470Q01395(2)E(3)	3.9	3	0.360 (9.14)	K, M	N, L, J	L1Q(3)30C395(2)(4)36
(1)49470Q01475(2)E(3)	4.7	3	0.480 (12.19)	K, M	N, L, J	L1Q(3)30C475(2)(4)48
(1)49470Q01565(2)E(3)	5.6	3	0.650 (16.51)	K, M	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 (µF)	Case Code	Height A inch (mm)	Capacitance Tolerance	Lead Configuration
25 VDC – BX Dielectric					
L1X(1)503824(2)(3)12	0.82	5	0.120 (3.05)	K, M	N, L, J
L1X(1)503105(2)(3)12	1	5	0.120 (3.05)	K, M	N, L, J
L1X(1)503125(2)(3)12	1.2	5	0.120 (3.05)	K, M	N, L, J
L1X(1)503155(2)(3)12	1.5	5	0.120 (3.05)	K, M	N, L, J
L1X(1)503185(2)(3)24	1.8	5	0.240 (6.10)	K, M	N, L, J
L1X(1)403225(2)(3)12	2.2	4	0.120 (3.05)	K, M	N, L, J
L1X(1)503225(2)(3)24	2.2	5	0.240 (6.10)	K, M	N, L, J
L1X(1)503255(2)(3)24	2.5	5	0.240 (6.10)	K, M	N, L, J
L1X(1)403275(2)(3)12	2.7	4	0.120 (3.05)	K, M	N, L, J
L1X(1)503275(2)(3)24	2.7	5	0.240 (6.10)	K, M	N, L, J
L1X(1)403335(2)(3)12	3.3	4	0.120 (3.05)	K, M	N, L, J
L1X(1)503335(2)(3)36	3.3	5	0.360 (9.14)	K, M	N, L, J
L1X(1)403395(2)(3)12	3.9	4	0.120 (3.05)	K, M	N, L, J
L1X(1)503395(2)(3)36	3.9	5	0.360 (9.14)	K, M	N, L, J
L1X(1)403475(2)(3)12	4.7	4	0.120 (3.05)	K, M	N, L, J
L1X(1)503475(2)(3)36	4.7	5	0.360 (9.14)	K, M	N, L, J
L1X(1)403565(2)(3)24	5.6	4	0.240 (6.10)	K, M	N, L, J
L1X(1)503565(2)(3)48	5.6	5	0.480 (12.19)	K, M	N, L, J
L1X(1)403605(2)(3)24	6	4	0.240 (6.10)	K, M	N, L, J
L1X(1)503605(2)(3)48	6	5	0.480 (12.19)	K, M	N, L, J
L1X(1)303685(2)(3)12	6.8	3	0.120 (3.05)	K, M	N, L, J
L1X(1)403685(2)(3)24	6.8	4	0.240 (6.10)	K, M	N, L, J
L1X(1)503685(2)(3)65	6.8	5	0.650 (16.51)	K, M	N, L, J
L1X(1)403755(2)(3)24	7.5	4	0.240 (6.10)	K, M	N, L, J
L1X(1)503755(2)(3)65	7.5	5	0.650 (16.51)	K, M	N, L, J
L1X(1)303825(2)(3)12	8.2	3	0.120 (3.05)	K, M	N, L, J
L1X(1)403825(2)(3)24	8.2	4	0.240 (6.10)	K, M	N, L, J
L1X(1)303106(2)(3)12	10	3	0.120 (3.05)	K, M	N, L, J
L1X(1)403106(2)(3)24	10	4	0.240 (6.10)	K, M	N, L, J
L1X(1)303116(2)(3)12	11	3	0.120 (3.05)	K, M	N, L, J
L1X(1)303126(2)(3)12	12	3	0.120 (3.05)	K, M	N, L, J
L1X(1)403126(2)(3)36	12	4	0.360 (9.14)	K, M	N, L, J
L1X(1)303156(2)(3)12	15	3	0.120 (3.05)	K, M	N, L, J
L1X(1)403156(2)(3)36	15	4	0.360 (9.14)	K, M	N, L, J
L1X(1)303166(2)(3)24	16	3	0.240 (6.10)	K, M	N, L, J
L1X(1)403166(2)(3)48	16	4	0.480 (12.19)	K, M	N, L, J
L1X(1)303186(2)(3)24	18	3	0.240 (6.10)	K, M	N, L, J
L1X(1)403186(2)(3)48	18	4	0.480 (12.19)	K, M	N, L, J
L1X(1)303206(2)(3)24	20	3	0.240 (6.10)	K, M	N, L, J
L1X(1)403206(2)(3)48	20	4	0.480 (12.19)	K, M	N, L, J
L1X(1)303226(2)(3)24	22	3	0.240 (6.10)	K, M	N, L, J
L1X(1)403226(2)(3)65	22	4	0.650 (16.51)	K, M	N, L, J
L1X(1)403246(2)(3)65	24	4	0.650 (16.51)	K, M	N, L, J
L1X(1)303276(2)(3)24	27	3	0.240 (6.10)	K, M	N, L, J
L1X(1)303306(2)(3)24	30	3	0.240 (6.10)	K, M	N, L, J
L1X(1)303306(2)(3)36	30	3	0.360 (9.14)	K, M	N, L, J
L1X(1)303336(2)(3)36	33	3	0.360 (9.14)	K, M	N, L, J
L1X(1)303396(2)(3)36	39	3	0.360 (9.14)	K, M	N, L, J
L1X(1)303456(2)(3)36	45	3	0.360 (9.14)	K, M	N, L, J
L1X(1)303506(2)(3)48	50	3	0.480 (12.19)	K, M	N, L, J
L1X(1)303546(2)(3)48	54	3	0.480 (12.19)	K, M	N, L, J
L1X(1)303606(2)(3)48	60	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", "M", "J", or "K".
(2) Capacitance tolerance character " K" or " M".
(3) Testing option character "S" for Commercial, or "X" for non-standard (customer specific).

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)	K, M	N, L, J
L1X(1)303726(2)(3)65	72	3	0.650 (16.51)	K, M	N, L, J
L1X(1)303756(2)(3)65	75	3	0.650 (16.51)	K, M	N, L, J
50VDC - BX Dielectric					
L1X(1)505824(2)(3)12	0.82	5	0.120 (3.05)	K, M	N, L, J
L1X(1)505105(2)(3)12	1	5	0.120 (3.05)	K, M	N, L, J
L1X(1)505125(2)(3)12	1.2	5	0.120 (3.05)	K, M	N, L, J
L1X(1)505155(2)(3)12	1.5	5	0.120 (3.05)	K, M	N, L, J
L1X(1)505185(2)(3)24	1.8	5	0.240 (6.10)	K, M	N, L, J
L1X(1)405225(2)(3)12	2.2	4	0.120 (3.05)	K, M	N, L, J
L1X(1)505225(2)(3)24	2.2	5	0.240 (6.10)	K, M	N, L, J
L1X(1)505255(2)(3)24	2.5	5	0.240 (6.10)	K, M	N, L, J
L1X(1)405275(2)(3)12	2.7	4	0.120 (3.05)	K, M	N, L, J
L1X(1)505275(2)(3)24	2.7	5	0.240 (6.10)	K, M	N, L, J
L1X(1)505275(2)(3)36	2.7	5	0.360 (9.14)	K, M	N, L, J
L1X(1)405335(2)(3)12	3.3	4	0.120 (3.05)	K, M	N, L, J
L1X(1)505335(2)(3)36	3.3	5	0.360 (9.14)	K, M	N, L, J
L1X(1)405395(2)(3)12	3.9	4	0.120 (3.05)	K, M	N, L, J
L1X(1)505395(2)(3)36	3.9	5	0.360 (9.14)	K, M	N, L, J
L1X(1)405475(2)(3)12	4.7	4	0.120 (3.05)	K, M	N, L, J
L1X(1)505475(2)(3)36	4.7	5	0.360 (9.14)	K, M	N, L, J
L1X(1)405565(2)(3)24	5.6	4	0.240 (6.10)	K, M	N, L, J
L1X(1)505565(2)(3)48	5.6	5	0.480 (12.19)	K, M	N, L, J
L1X(1)405605(2)(3)24	6	4	0.240 (6.10)	K, M	N, L, J
L1X(1)505605(2)(3)48	6	5	0.480 (12.19)	K, M	N, L, J
L1X(1)305685(2)(3)12	6.8	3	0.120 (3.05)	K, M	N, L, J
L1X(1)405685(2)(3)24	6.8	4	0.240 (6.10)	K, M	N, L, J
L1X(1)505685(2)(3)65	6.8	5	0.650 (16.51)	K, M	N, L, J
L1X(1)405755(2)(3)24	7.5	4	0.240 (6.10)	K, M	N, L, J
L1X(1)505755(2)(3)65	7.5	5	0.650 (16.51)	K, M	N, L, J
L1X(1)305825(2)(3)12	8.2	3	0.120 (3.05)	K, M	N, L, J
L1X(1)405825(2)(3)24	8.2	4	0.240 (6.10)	K, M	N, L, J
L1X(1)305106(2)(3)12	10	3	0.120 (3.05)	K, M	N, L, J
L1X(1)405106(2)(3)24	10	4	0.240 (6.10)	K, M	N, L, J
L1X(1)305116(2)(3)12	11	3	0.120 (3.05)	K, M	N, L, J
L1X(1)305126(2)(3)12	12	3	0.120 (3.05)	K, M	N, L, J
L1X(1)405126(2)(3)36	12	4	0.360 (9.14)	K, M	N, L, J
L1X(1)305156(2)(3)12	15	3	0.120 (3.05)	K, M	N, L, J
L1X(1)405156(2)(3)36	15	4	0.360 (9.14)	K, M	N, L, J
L1X(1)305166(2)(3)24	16	3	0.240 (6.10)	K, M	N, L, J
L1X(1)405166(2)(3)48	16	4	0.480 (12.19)	K, M	N, L, J
L1X(1)305186(2)(3)24	18	3	0.240 (6.10)	K, M	N, L, J
L1X(1)405186(2)(3)48	18	4	0.480 (12.19)	K, M	N, L, J
L1X(1)305206(2)(3)24	20	3	0.240 (6.10)	K, M	N, L, J
L1X(1)405206(2)(3)48	20	4	0.480 (12.19)	K, M	N, L, J
L1X(1)305226(2)(3)24	22	3	0.240 (6.10)	K, M	N, L, J
L1X(1)405226(2)(3)65	22	4	0.650 (16.51)	K, M	N, L, J
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)	K, M	N, L, J
L1X(1)305306(2)(3)24	30	3	0.240 (6.10)	K, M	N, L, J
L1X(1)305336(2)(3)36	33	3	0.360 (9.14)	K, M	N, L, J
L1X(1)305396(2)(3)36	39	3	0.360 (9.14)	K, M	N, L, J
L1X(1)305456(2)(3)36	45	3	0.360 (9.14)	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".
(3) Testing option character "S" for Commercial, or "X" for non-standard (customer specific).

Table 1B – Commercial/Non-Standard – Product Selection 50 – 100 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)305506(2)(3)48	50	3	0.480 (12.19)	K, M	N, L, J
L1X(1)305546(2)(3)48	54	3	0.480 (12.19)	K, M	N, L, J
L1X(1)305606(2)(3)48	60	3	0.480 (12.19)	K, M	N, L, J
L1X(1)305666(2)(3)65	66	3	0.650 (16.51)	K, M	N, L, J
L1X(1)305726(2)(3)65	72	3	0.650 (16.51)	K, M	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)	K, M	N, L, J
L1R(1)501684(2)(3)12	0.68	5	0.120 (3.05)	K, M	N, L, J
L1R(1)501754(2)(3)12	0.75	5	0.120 (3.05)	K, M	N, L, J
L1R(1)501824(2)(3)12	0.82	5	0.120 (3.05)	K, M	N, L, J
L1R(1)501105(2)(3)12	1	5	0.120 (3.05)	K, M	N, L, J
L1R(1)501125(2)(3)12	1.2	5	0.120 (3.05)	K, M	N, L, J
L1R(1)401155(2)(3)12	1.5	4	0.120 (3.05)	K, M	N, L, J
L1R(1)501155(2)(3)24	1.5	5	0.240 (6.10)	K, M	N, L, J
L1R(1)401185(2)(3)12	1.8	4	0.120 (3.05)	K, M	N, L, J
L1R(1)501185(2)(3)24	1.8	5	0.240 (6.10)	K, M	N, L, J
L1R(1)401225(2)(3)12	2.2	4	0.120 (3.05)	K, M	N, L, J
L1R(1)501225(2)(3)24	2.2	5	0.240 (6.10)	K, M	N, L, J
L1R(1)501255(2)(3)24	2.5	5	0.240 (6.10)	K, M	N, L, J
L1R(1)401275(2)(3)12	2.7	4	0.120 (3.05)	K, M	N, L, J
L1R(1)501275(2)(3)36	2.7	5	0.360 (9.14)	K, M	N, L, J
L1R(1)401335(2)(3)12	3.3	4	0.120 (3.05)	K, M	N, L, J
L1R(1)501335(2)(3)36	3.3	5	0.360 (9.14)	K, M	N, L, J
L1R(1)401395(2)(3)12	3.9	4	0.120 (3.05)	K, M	N, L, J
L1R(1)501395(2)(3)48	3.9	5	0.480 (12.19)	K, M	N, L, J
L1R(1)401475(2)(3)24	4.7	4	0.240 (6.10)	K, M	N, L, J
L1R(1)501475(2)(3)48	4.7	5	0.480 (12.19)	K, M	N, L, J
L1R(1)301565(2)(3)12	5.6	3	0.120 (3.05)	K, M	N, L, J
L1R(1)401565(2)(3)24	5.6	4	0.240 (6.10)	K, M	N, L, J
L1R(1)501565(2)(3)65	5.6	5	0.650 (16.51)	K, M	N, L, J
L1R(1)301605(2)(3)12	6	3	0.120 (3.05)	K, M	N, L, J
L1R(1)401605(2)(3)24	6	4	0.240 (6.10)	K, M	N, L, J
L1R(1)501605(2)(3)65	6	5	0.650 (16.51)	K, M	N, L, J
L1R(1)301685(2)(3)12	6.8	3	0.120 (3.05)	K, M	N, L, J
L1R(1)401685(2)(3)24	6.8	4	0.240 (6.10)	K, M	N, L, J
L1R(1)401755(2)(3)24	7.5	4	0.240 (6.10)	K, M	N, L, J
L1R(1)301825(2)(3)12	8.2	3	0.120 (3.05)	K, M	N, L, J
L1R(1)401825(2)(3)36	8.2	4	0.360 (9.14)	K, M	N, L, J
L1R(1)301106(2)(3)12	10	3	0.120 (3.05)	K, M	N, L, J
L1R(1)401106(2)(3)36	10	4	0.360 (9.14)	K, M	N, L, J
L1R(1)301116(2)(3)12	11	3	0.120 (3.05)	K, M	N, L, J
L1R(1)301126(2)(3)24	12	3	0.240 (6.10)	K, M	N, L, J
L1R(1)401126(2)(3)48	12	4	0.480 (12.19)	K, M	N, L, J
L1R(1)301156(2)(3)24	15	3	0.240 (6.10)	K, M	N, L, J
L1R(1)401156(2)(3)48	15	4	0.480 (12.19)	K, M	N, L, J
L1R(1)301166(2)(3)24	16	3	0.240 (6.10)	K, M	N, L, J
L1R(1)401166(2)(3)65	16	4	0.650 (16.51)	K, M	N, L, J
L1R(1)301186(2)(3)24	18	3	0.240 (6.10)	K, M	N, L, J
L1R(1)401186(2)(3)65	18	4	0.650 (16.51)	K, M	N, L, J
L1R(1)301206(2)(3)24	20	3	0.240 (6.10)	K, M	N, L, J
L1R(1)301226(2)(3)36	22	3	0.360 (9.14)	K, M	N, L, J
L1R(1)301276(2)(3)36	27	3	0.360 (9.14)	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".
(3) Testing option character "S" for Commercial, or "X" for non-standard (customer specific).

Table 1B – Commercial/Non-Standard – Product Selection 100 – 200 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
L1R(1)301306(2)(3)36	30	3	0.360 (9.14)	K, M	N, L, J
L1R(1)301336(2)(3)48	33	3	0.480 (12.19)	K, M	N, L, J
L1R(1)301396(2)(3)48	39	3	0.480 (12.19)	K, M	N, L, J
L1R(1)301456(2)(3)65	45	3	0.650 (16.51)	K, M	N, L, J
L1R(1)301506(2)(3)65	50	3	0.650 (16.51)	K, M	N, L, J
200 VDC – BQ Dielectric					
L1Q(1)502334(2)(3)12	0.33	5	0.120 (3.05)	K, M	N, L, J
L1Q(1)502394(2)(3)12	0.39	5	0.120 (3.05)	K, M	N, L, J
L1Q(1)502474(2)(3)12	0.47	5	0.120 (3.05)	K, M	N, L, J
L1Q(1)502564(2)(3)12	0.56	5	0.120 (3.05)	K, M	N, L, J
L1Q(1)502684(2)(3)12	0.68	5	0.120 (3.05)	K, M	N, L, J
L1Q(1)502754(2)(3)12	0.75	5	0.120 (3.05)	K, M	N, L, J
L1Q(1)402824(2)(3)12	0.82	4	0.120 (3.05)	K, M	N, L, J
L1Q(1)502824(2)(3)24	0.82	5	0.240 (6.10)	K, M	N, L, J
L1Q(1)402105(2)(3)12	1	4	0.120 (3.05)	K, M	N, L, J
L1Q(1)502105(2)(3)24	1	5	0.240 (6.10)	K, M	N, L, J
L1Q(1)402125(2)(3)12	1.2	4	0.120 (3.05)	K, M	N, L, J
L1Q(1)502125(2)(3)24	1.2	5	0.240 (6.10)	K, M	N, L, J
L1Q(1)402155(2)(3)12	1.5	4	0.120 (3.05)	K, M	N, L, J
L1Q(1)502155(2)(3)36	1.5	5	0.360 (9.14)	K, M	N, L, J
L1Q(1)402185(2)(3)12	1.8	4	0.120 (3.05)	K, M	N, L, J
L1Q(1)502185(2)(3)36	1.8	5	0.360 (9.14)	K, M	N, L, J
L1Q(1)402225(2)(3)24	2.2	4	0.240 (6.10)	K, M	N, L, J
L1Q(1)502225(2)(3)48	2.2	5	0.480 (12.19)	K, M	N, L, J
L1Q(1)302245(2)(3)12	2.4	3	0.120 (3.05)	K, M	N, L, J
L1Q(1)502255(2)(3)48	2.5	5	0.480 (12.19)	K, M	N, L, J
L1Q(1)302275(2)(3)12	2.7	3	0.120 (3.05)	K, M	N, L, J
L1Q(1)402275(2)(3)24	2.7	4	0.240 (6.10)	K, M	N, L, J
L1Q(1)502275(2)(3)48	2.7	5	0.480 (12.19)	K, M	N, L, J
L1Q(1)302335(2)(3)12	3.3	3	0.120 (3.05)	K, M	N, L, J
L1Q(1)402335(2)(3)24	3.3	4	0.240 (6.10)	K, M	N, L, J
L1Q(1)502335(2)(3)65	3.3	5	0.650 (16.51)	K, M	N, L, J
L1Q(1)302365(2)(3)12	3.6	3	0.120 (3.05)	K, M	N, L, J
L1Q(1)302395(2)(3)12	3.9	3	0.120 (3.05)	K, M	N, L, J
L1Q(1)402395(2)(3)24	3.9	4	0.240 (6.10)	K, M	N, L, J
L1Q(1)302475(2)(3)12	4.7	3	0.120 (3.05)	K, M	N, L, J
L1Q(1)402475(2)(3)36	4.7	4	0.360 (9.14)	K, M	N, L, J
L1Q(1)302565(2)(3)12	5.6	3	0.120 (3.05)	K, M	N, L, J
L1Q(1)402565(2)(3)36	5.6	4	0.360 (9.14)	K, M	N, L, J
L1Q(1)302605(2)(3)12	6	3	0.120 (3.05)	K, M	N, L, J
L1Q(1)402605(2)(3)36	6	4	0.360 (9.14)	K, M	N, L, J
L1Q(1)302685(2)(3)24	6.8	3	0.240 (6.10)	K, M	N, L, J
L1Q(1)402685(2)(3)48	6.8	4	0.480 (12.19)	K, M	N, L, J
L1Q(1)402755(2)(3)48	7.5	4	0.480 (12.19)	K, M	N, L, J
L1Q(1)302825(2)(3)24	8.2	3	0.240 (6.10)	K, M	N, L, J
L1Q(1)402825(2)(3)65	8.2	4	0.650 (16.51)	K, M	N, L, J
L1Q(1)302106(2)(3)24	10	3	0.240 (6.10)	K, M	N, L, J
L1Q(1)402106(2)(3)65	10	4	0.650 (16.51)	K, M	N, L, J
L1Q(1)302116(2)(3)24	11	3	0.240 (6.10)	K, M	N, L, J
L1Q(1)302126(2)(3)36	12	3	0.360 (9.14)	K, M	N, L, J
L1Q(1)302156(2)(3)36	15	3	0.360 (9.14)	K, M	N, L, J
L1Q(1)302166(2)(3)36	16	3	0.360 (9.14)	K, M	N, L, J
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".
(3) Testing option character "S" for Commercial, or "X" for non-standard (customer specific).

Table 1B – Commercial/Non-Standard – Product Selection 200 – 630 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
L1Q(1)302206(2)(3)48	20	3	0.480 (12.19)	K, M	N, L, J
L1Q(1)302226(2)(3)48	22	3	0.480 (12.19)	K, M	N, L, J
L1Q(1)302276(2)(3)65	27	3	0.650 (16.51)	K, M	N, L, J
500VDC - X7R Dielectric					
L1W(1)50C124(2)(3)12	0.12	5	0.120 (3.05)	K, M	N, L, J
L1W(1)50C154(2)(3)12	0.15	5	0.120 (3.05)	K, M	N, L, J
L1W(1)50C184(2)(3)12	0.18	5	0.120 (3.05)	K, M	N, L, J
L1W(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, M	N, L, J
L1W(1)50C334(2)(3)24	0.33	5	0.240 (6.10)	K, M	N, L, J
L1W(1)40C394(2)(3)12	0.39	4	0.120 (3.05)	K, M	N, L, J
L1W(1)50C394(2)(3)24	0.39	5	0.240 (6.10)	K, M	N, L, J
L1W(1)40C474(2)(3)12	0.47	4	0.120 (3.05)	K, M	N, L, J
L1W(1)50C474(2)(3)24	0.47	5	0.240 (6.10)	K, M	N, L, J
L1W(1)50C564(2)(3)24	0.56	5	0.240 (6.10)	K, M	N, L, J
L1W(1)40C684(2)(3)12	0.68	4	0.120 (3.05)	K, M	N, L, J
L1W(1)50C684(2)(3)36	0.68	5	0.360 (9.14)	K, M	N, L, J
L1W(1)50C754(2)(3)36	0.75	5	0.360 (9.14)	K, M	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)	K, M	N, L, J
L1W(1)30C105(2)(3)12	1	3	0.120 (3.05)	K, M	N, L, J
L1W(1)40C105(2)(3)24	1	4	0.240 (6.10)	K, M	N, L, J
L1W(1)50C105(2)(3)48	1	5	0.480 (12.19)	K, M	N, L, J
L1W(1)30C125(2)(3)12	1.2	3	0.120 (3.05)	K, M	N, L, J
L1W(1)40C125(2)(3)24	1.2	4	0.240 (6.10)	K, M	N, L, J
L1W(1)50C125(2)(3)65	1.2	5	0.650 (16.51)	K, M	N, L, J
L1W(1)30C155(2)(3)12	1.5	3	0.120 (3.05)	K, M	N, L, J
L1W(1)40C155(2)(3)24	1.5	4	0.240 (6.10)	K, M	N, L, J
L1W(1)50C155(2)(3)65	1.5	5	0.650 (16.51)	K, M	N, L, J
L1W(1)40C185(2)(3)36	1.8	4	0.360 (9.14)	K, M	N, L, J
L1W(1)30C225(2)(3)12	2.2	3	0.120 (3.05)	K, M	N, L, J
L1W(1)40C225(2)(3)36	2.2	4	0.360 (9.14)	K, M	N, L, J
L1W(1)30C245(2)(3)12	2.4	3	0.120 (3.05)	K, M	N, L, J
L1W(1)30C275(2)(3)12	2.7	3	0.120 (3.05)	K, M	N, L, J
L1W(1)40C275(2)(3)48	2.7	4	0.480 (12.19)	K, M	N, L, J
L1W(1)30C335(2)(3)24	3.3	3	0.240 (6.10)	K, M	N, L, J
L1W(1)40C335(2)(3)48	3.3	4	0.480 (12.19)	K, M	N, L, J
L1W(1)30C365(2)(3)24	3.6	3	0.240 (6.10)	K, M	N, L, J
L1W(1)30C395(2)(3)24	3.9	3	0.240 (6.10)	K, M	N, L, J
L1W(1)40C395(2)(3)65	3.9	4	0.650 (16.51)	K, M	N, L, J
L1W(1)30C475(2)(3)24	4.7	3	0.240 (6.10)	K, M	N, L, J
L1W(1)30C565(2)(3)24	5.6	3	0.240 (6.10)	K, M	N, L, J
L1W(1)30C605(2)(3)24	6	3	0.240 (6.10)	K, M	N, L, J
L1W(1)30C685(2)(3)36	6.8	3	0.360 (9.14)	K, M	N, L, J
L1W(1)30C825(2)(3)36	8.2	3	0.360 (9.14)	K, M	N, L, J
L1W(1)30C106(2)(3)48	10	3	0.480 (12.19)	K, M	N, L, J
L1W(1)30C116(2)(3)65	11	3	0.650 (16.51)	K, M	N, L, J
L1W(1)30C126(2)(3)65	12	3	0.650 (16.51)	K, M	N, L, J
630VDC - X7R Dielectric					
L1W(1)50B683(2)(3)12	0.068	5	0.120 (3.05)	K, M	N, L, J
L1W(1)40B104(2)(3)12	0.1	4	0.120 (3.05)	K, M	N, L, J
L1W(1)50B104(2)(3)12	0.1	5	0.120 (3.05)	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".
(3) Testing option character "S" for Commercial, or "X" for non-standard (customer specific).

Table 1B – Commercial/Non-Standard – Product Selection 630 – 1,000 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
L1W(1)50B124(2)(3)12	0.12	5	0.120 (3.05)	K, M	N, L, J
L1W(1)50B154(2)(3)12	0.15	5	0.120 (3.05)	K, M	N, L, J
L1W(1)50B184(2)(3)24	0.18	5	0.240 (6.10)	K, M	N, L, J
L1W(1)30B224(2)(3)12	0.22	3	0.120 (3.05)	K, M	N, L, J
L1W(1)40B224(2)(3)12	0.22	4	0.120 (3.05)	K, M	N, L, J
L1W(1)50B224(2)(3)24	0.22	5	0.240 (6.10)	K, M	N, L, J
L1W(1)50B274(2)(3)24	0.27	5	0.240 (6.10)	K, M	N, L, J
L1W(1)30B334(2)(3)12	0.33	3	0.120 (3.05)	K, M	N, L, J
L1W(1)50B334(2)(3)36	0.33	5	0.360 (9.14)	K, M	N, L, J
L1W(1)40B394(2)(3)12	0.39	4	0.120 (3.05)	K, M	N, L, J
L1W(1)50B394(2)(3)36	0.39	5	0.360 (9.14)	K, M	N, L, J
L1W(1)30B474(2)(3)12	0.47	3	0.120 (3.05)	K, M	N, L, J
L1W(1)40B474(2)(3)24	0.47	4	0.240 (6.10)	K, M	N, L, J
L1W(1)50B474(2)(3)36	0.47	5	0.360 (9.14)	K, M	N, L, J
L1W(1)50B564(2)(3)48	0.56	5	0.480 (12.19)	K, M	N, L, J
L1W(1)30B684(2)(3)12	0.68	3	0.120 (3.05)	K, M	N, L, J
L1W(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)	K, M	N, L, J
L1W(1)50B754(2)(3)65	0.75	5	0.650 (16.51)	K, M	N, L, J
L1W(1)40B824(2)(3)24	0.82	4	0.240 (6.10)	K, M	N, L, J
L1W(1)30B105(2)(3)12	1	3	0.120 (3.05)	K, M	N, L, J
L1W(1)40B105(2)(3)36	1	4	0.360 (9.14)	K, M	N, L, J
L1W(1)30B125(2)(3)12	1.2	3	0.120 (3.05)	K, M	N, L, J
L1W(1)40B125(2)(3)36	1.2	4	0.360 (9.14)	K, M	N, L, J
L1W(1)30B155(2)(3)12	1.5	3	0.120 (3.05)	K, M	N, L, J
L1W(1)40B155(2)(3)48	1.5	4	0.480 (12.19)	K, M	N, L, J
L1W(1)40B185(2)(3)48	1.8	4	0.480 (12.19)	K, M	N, L, J
L1W(1)30B225(2)(3)24	2.2	3	0.240 (6.10)	K, M	N, L, J
L1W(1)40B225(2)(3)65	2.2	4	0.650 (16.51)	K, M	N, L, J
L1W(1)30B245(2)(3)24	2.4	3	0.240 (6.10)	K, M	N, L, J
L1W(1)30B275(2)(3)24	2.7	3	0.240 (6.10)	K, M	N, L, J
L1W(1)30B335(2)(3)36	3.3	3	0.360 (9.14)	K, M	N, L, J
L1W(1)30B365(2)(3)36	3.6	3	0.360 (9.14)	K, M	N, L, J
L1W(1)30B395(2)(3)36	3.9	3	0.360 (9.14)	K, M	N, L, J
L1W(1)30B475(2)(3)36	4.7	3	0.360 (9.14)	K, M	N, L, J
L1W(1)30B565(2)(3)48	5.6	3	0.480 (12.19)	K, M	N, L, J
L1W(1)30B605(2)(3)65	6	3	0.650 (16.51)	K, M	N, L, J
L1W(1)30B685(2)(3)65	6.8	3	0.650 (16.51)	K, M	N, L, J
1000VDC - X7R Dielectric					
L1W(1)50D473(2)(3)12	0.047	5	0.120 (3.05)	K, M	N, L, J
L1W(1)50D683(2)(3)12	0.068	5	0.120 (3.05)	K, M	N, L, J
L1W(1)30D104(2)(3)12	0.1	3	0.120 (3.05)	K, M	N, L, J
L1W(1)40D104(2)(3)12	0.1	4	0.120 (3.05)	K, M	N, L, J
L1W(1)50D104(2)(3)24	0.1	5	0.240 (6.10)	K, M	N, L, J
L1W(1)50D124(2)(3)24	0.12	5	0.240 (6.10)	K, M	N, L, J
L1W(1)50D154(2)(3)36	0.15	5	0.360 (9.14)	K, M	N, L, J
L1W(1)50D184(2)(3)36	0.18	5	0.360 (9.14)	K, M	N, L, J
L1W(1)30D224(2)(3)12	0.22	3	0.120 (3.05)	K, M	N, L, J
L1W(1)40D224(2)(3)12	0.22	4	0.120 (3.05)	K, M	N, L, J
L1W(1)50D224(2)(3)36	0.22	5	0.360 (9.14)	K, M	N, L, J
L1W(1)50D274(2)(3)48	0.27	5	0.480 (12.19)	K, M	N, L, J
L1W(1)30D334(2)(3)12	0.33	3	0.120 (3.05)	K, M	N, L, J
L1W(1)50D334(2)(3)65	0.33	5	0.650 (16.51)	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".
(3) Testing option character "S" for Commercial, or "X" for non-standard (customer specific).

Table 1B – Commercial/Non-Standard – Product Selection 1,000 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**
L1W(1)40D394(2)(3)24	0.39	4	0.240 (6.10)	K, M	N, L, J
L1W(1)50D394(2)(3)65	0.39	5	0.650 (16.51)	K, M	N, L, J
L1W(1)30D474(2)(3)12	0.47	3	0.120 (3.05)	K, M	N, L, J
L1W(1)40D474(2)(3)24	0.47	4	0.240 (6.10)	K, M	N, L, J
L1W(1)30D684(2)(3)12	0.68	3	0.120 (3.05)	K, M	N, L, J
L1W(1)40D684(2)(3)36	0.68	4	0.360 (9.14)	K, M	N, L, J
L1W(1)40D824(2)(3)48	0.82	4	0.480 (12.19)	K, M	N, L, J
L1W(1)30D105(2)(3)24	1	3	0.240 (6.10)	K, M	N, L, J
L1W(1)40D105(2)(3)65	1	4	0.650 (16.51)	K, M	N, L, J
L1W(1)30D125(2)(3)24	1.2	3	0.240 (6.10)	K, M	N, L, J
L1W(1)30D155(2)(3)36	1.5	3	0.360 (9.14)	K, M	N, L, J
L1W(1)30D225(2)(3)36	2.2	3	0.360 (9.14)	K, M	N, L, J
L1W(1)30D245(2)(3)48	2.4	3	0.480 (12.19)	K, M	N, L, J
L1W(1)30D275(2)(3)48	2.7	3	0.480 (12.19)	K, M	N, L, J
L1W(1)30D335(2)(3)65	3.3	3	0.650 (16.51)	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".
(3) Testing option character "S" for Commercial, or "X" for non-standard (customer specific).

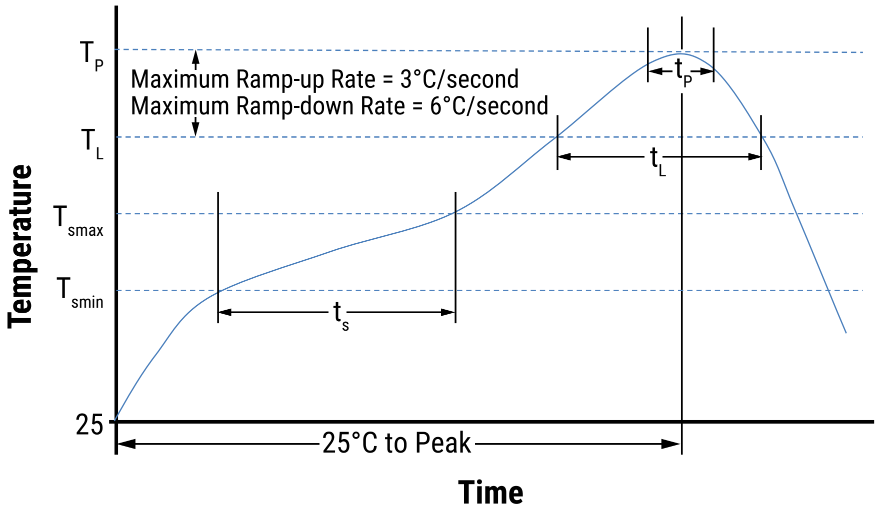
Soldering Process

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:



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 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.

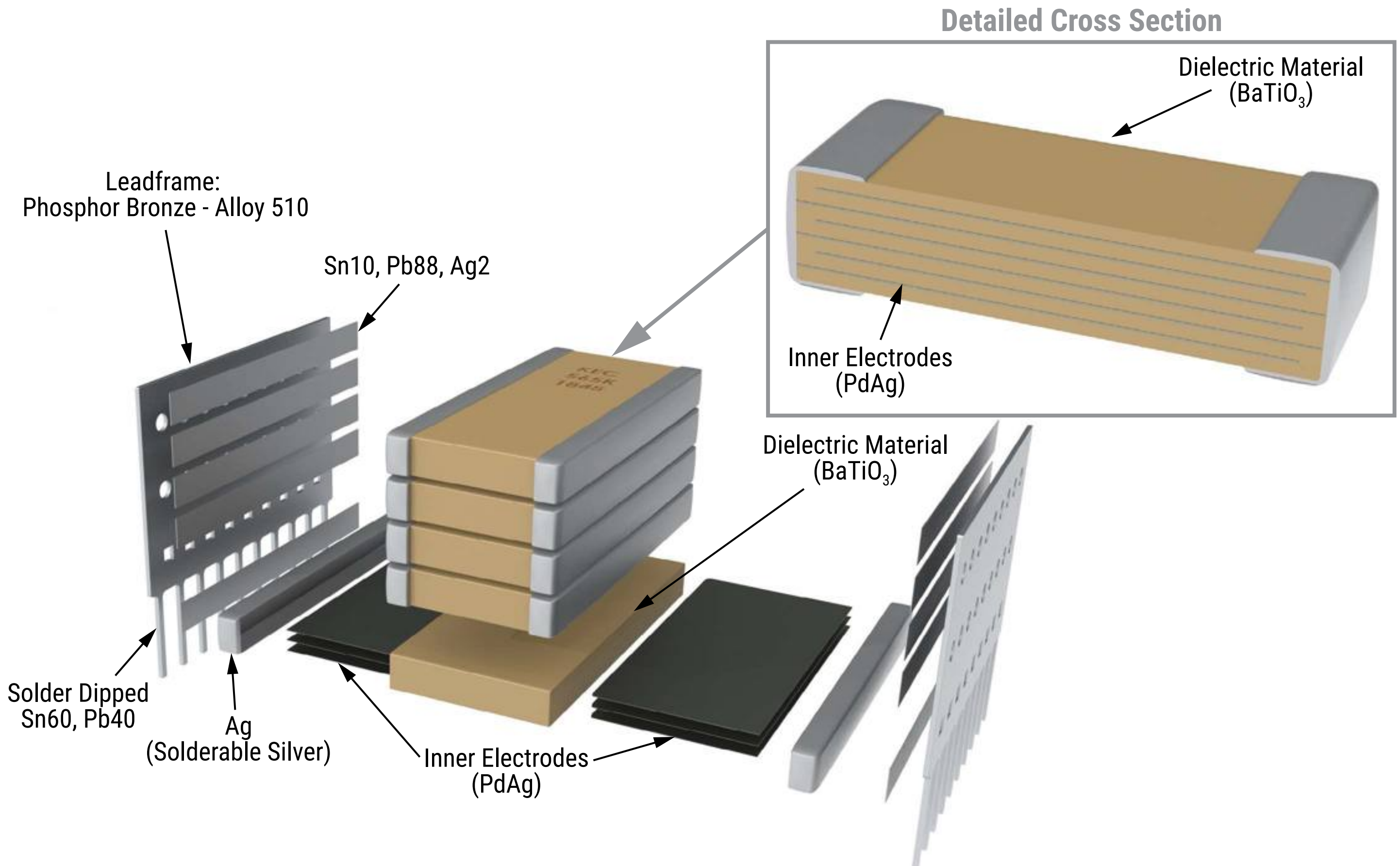
Table 4 – Performance & Reliability: Test Methods and Conditions

<table>
<tr><th rowspan="2">Inspection</th><th rowspan="2">Test Method</th><th colspan="5">Test Level Option</th></tr>
<tr><th>MIL–PRF–49470 B Level (B)</th><th>MIL–PRF–49470 T Level (T)</th><th>DSSC Drawing 87106 (C)[1]</th><th>Commercial (S)</th><th>Non-Standard (X)[2]</th></tr>
<tr><td colspan="7"></td></tr>
<tr><td>Ultrasonic Scanning (C-SAM)</td><td>Meet EIA–469 Criteria</td><td rowspan="3">Not required</td><td rowspan="3">Yes (per lot)</td><td rowspan="3">Not required</td><td rowspan="3">Not required</td><td rowspan="3">Optional per Source Controlled Drawing (SCD)</td></tr>
<tr><td>DPA Analysis</td><td>EIA–469</td></tr>
<tr><td>In-Process Visual Inspection</td><td>MIL–PRF–49470 Method 4.8.3</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td>Thermal Shock</td><td>MIL–STD–202 Method 107</td><td>Yes (5 cycles)</td><td>Yes (20 cycles)</td><td>Yes (5 cycles)</td><td rowspan="5">Not required</td><td rowspan="2">Optional per Source Controlled Drawing (SCD)</td></tr>
<tr><td>Voltage Conditioning
≤ 200 V
500 V</td><td>MIL–PRF–49470 Method 4.8.5.2
200%V_R at125°C
120%V_R at125°C</td><td>Yes (96 hours minimum)</td><td>Yes (168 hours minimum)</td><td>Yes (96 hours minimum)</td></tr>
<tr><td>Visual and Mechanical Inspection</td><td>MIL–PRF–49470 Method 4.8.4</td><td>Yes (per lot)</td><td rowspan="3">Yes (per lot)</td><td>Yes (per lot)</td><td>Yes (per lot)</td></tr>
<tr><td>Solderability</td><td>MIL–STD–202 Method 208</td><td>Yes (per Inspection lot)</td><td>Yes (per inspection lot)</td><td rowspan="2">Optional per Source Controlled Drawing (SCD)</td></tr>
<tr><td>DPA Analysis</td><td>EIA–469</td><td>Not required</td><td>Not required</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td>Voltage–Temperature Limits (TCVC)</td><td>MIL–PRF–49470 Method 4.8.13.2</td><td rowspan="6">Yes (periodic)</td><td rowspan="9">Yes (per lot)</td><td rowspan="6">Yes (periodic)</td><td rowspan="9">Not required</td><td rowspan="9">Optional per Source Controlled Drawing (SCD)</td></tr>
<tr><td>Resistance to Solvents</td><td>MIL–STD–202 Method 215</td></tr>
<tr><td>Terminal Strength</td><td>MIL–STD–202 Method 211</td></tr>
<tr><td>Resistance to Soldering Heat</td><td>MIL–STD–202 Method 210</td></tr>
<tr><td>Moisture Resistance</td><td>MIL–STD–202 Method 106</td></tr>
<tr><td>Marking Legibility</td><td>MIL–PRF–49470 Method 4.8.4.1</td></tr>
<tr><td>Low Voltage Humidity Testing</td><td>MIL–STD–202 Method 103</td><td>Not required</td><td>Not required</td></tr>
<tr><td>Life Test
≤ 200 V
500 V</td><td>MIL–STD–202 Method 108
200%V_R at125°C
120%V_R at125°C</td><td>Yes (periodic)</td><td>Yes (periodic)</td></tr>
<tr><td>Thermal Shock</td><td>MIL–STD–202 Method 107</td><td>Not required</td><td>Not required</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td>Visual and Mechanical Inspection (100%)</td><td rowspan="2">KEMET Standard</td><td rowspan="2">Yes</td><td rowspan="2">Yes</td><td rowspan="2">Yes</td><td rowspan="2">Yes</td><td rowspan="2">Yes</td></tr>
<tr><td>Voltage Conditioning</td></tr>
</table>

[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*

[2] *Non-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

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.

JT 12345 106K 1103

Case code 4 or 5 example

MIL–PRF–49470
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 40ºC 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
4	N/L	1, 2, 3	50
		4, 5	25
	J	1, 2, 3, 4, 5	50
5	N	1, 2, 3	50
		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.

Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs)

KPS HV, Large Case, SM Series, C0G Dielectric, 500 – 10,000 VDC (Industrial Grade)

KEMET
a YAGEO company

Overview

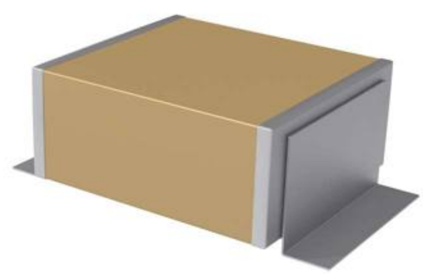
KPS HV (KEMET Power Solutions, High Voltage), Large Case (≥ 1515), SM Series capacitors in C0G dielectric are designed to meet robust performance standards required in higher reliability industrial applications. Utilizing lead-frame technology, SM Series devices isolate the multilayer ceramic chip component 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 C0G 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/ºC 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

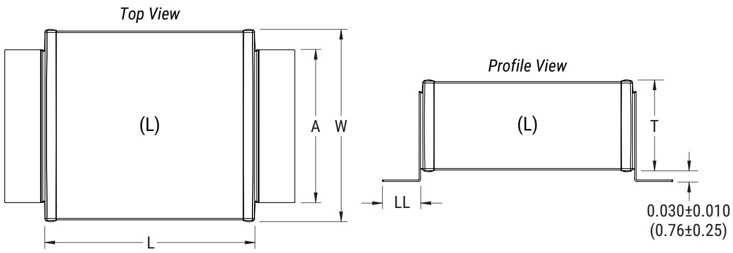
SM20		N	472	J	501	B	M
Style/Size		Dielectric	Capacitance Code (pF)	Capacitance Tolerance	Rated Voltage (VDC)	Lead Configuration[1]	Testing/ Inspection Option[2]
SM20 SM21 SM22 SM23 SM24 SM25 SM26	SM30 SM31 SM33 SM34 SM35 SM36	N = C0G	Two significant digits and number of zeros	J = ±5% K = ±10% M = ±20%	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".*

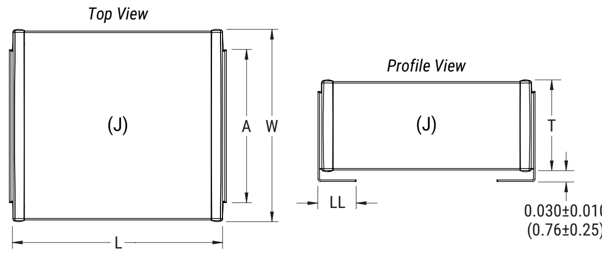
[2] *Group B testing/inspection option per MIL–PRF–49467 is available upon request. Please contact KEMET for ordering details.*

Dimensions – Inches (Millimeters)

FORMED LEAD (L)



FORMED LEAD (J)



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)	0.100 (2.54)	0.100±0.020 (2.54±0.51)	0.040±0.010 (1.02±0.25)
SM21	0.200±0.020 (5.08±0.51)	0.200±0.020 (5.08±0.51)	0.180 (4.57)			
SM22	0.250±0.020 (6.35±0.51)	0.200±0.020 (5.08±0.51)				
SM23	0.350±0.030 (8.89±0.76)	0.300±0.030 (7.62±0.76)	0.220 (5.59)	0.200 (5.08)		0.100±0.020 (2.54±0.51)
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)		0.400 (10.20)		
SM26	0.650±0.030 (16.50±0.76)	0.600±0.030 (15.20±0.76)		0.500 (12.70)		
SM30	0.300±0.030 (7.62±0.76)	0.150±0.015 (3.81±0.38)	0.140 (3.55)	0.100 (2.54)		
SM31	0.400±0.030 (10.20±0.76)	0.200±0.020 (5.08±0.51)	0.130 (3.30)			
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)	0.220 (5.59)	0.300 (7.62)		
SM35	1.100±0.030 (27.90±0.76)	0.500±0.030 (12.70±0.76)		0.400 (10.2)		
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 ≤ 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 MΩ-µF value by the capacitance and compare to GΩ 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 ≤ 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
C0G	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	SM20	SM21	SM22	SM23	SM24
Dimensions – inches (mm)					
Length	0.150 ± 0.015 (3.81 ± 0.38)	0.200 ± 0.020 (5.08 ± 0.51)	0.250 ± 0.020 (6.35 ± 0.51)	0.350 ± 0.030 (8.89 ± 0.76)	0.450 ± 0.030 (11.43 ± 0.76)
Width	0.150 ± 0.015 (3.81 ± 0.38)	0.200 ± 0.020 (5.08 ± 0.51)	0.200 ± 0.020 (5.08 ± 0.51)	0.300 ± 0.030 (7.62 ± 0.76)	0.400 ± 0.030 (10.20 ± 0.76)
Thickness Maximum	0.130 (3.30)	0.180 (4.57)	0.180 (4.57)	0.220 (5.59)	0.220 (5.59)
Lead Width Maximum	0.100 (2.54)	0.100 (2.54)	0.100 (2.54)	0.200 (5.08)	0.300 (7.62)
Lead Length "L"	0.100 ± 0.020 (2.54 ± 0.51)	0.100 ± 0.020 (2.54 ± 0.51)	0.100 ± 0.020 (2.54 ± 0.51)	0.100 ± 0.020 (2.54 ± 0.51)	0.100 ± 0.020 (2.54 ± 0.51)
Lead Length "J"	0.040 ± 0.010 (1.02 ± 0.25)	0.040 ± 0.010 (1.02 ± 0.25)	0.040 ± 0.010 (1.02 ± 0.25)	0.100 ± 0.020 (2.54 ± 0.51)	0.100 ± 0.020 (2.54 ± 0.51)

C0G Dielectric	SM20				SM21				SM22				SM23					SM24						
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 Tolerance**
Voltage DC	**500**	**1 K**	**2 K**	**3 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	Capacitance Code																							
22 pF							220	220																
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	
47 pF	470	470	470	470	470	470	470	470	470	470	470	470										470	470	
56 pF	560	560	560	560	560	560	560	560	560	560	560	560						560	560	560	560	560	560	
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 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	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	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			
3,900 pF					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			
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									153				153	153				153	153					
0.018 µF									183				183					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						
0.047 µF																		473						

Table 1B – Capacitance Range/Selection Waterfall SM25 – SM31 Style/Size

Style/Size	SM25						SM26						SM30					SM31						
Dimensions – inches (mm)																								
Length	0.550 ± 0.030 (14.00 ± 0.76)						0.650 ± 0.030 (16.50 ± 0.76)						0.300 ± 0.030 (7.62 ± 0.76)					0.400 ± 0.030 (10.20 ± 0.76)						
Width	0.500 ± 0.030 (12.70 ± 0.76)						0.600 ± 0.030 (15.20 ± 0.76)						0.150 ± 0.015 (3.81 ± 0.38)					0.200 ± 0.020 (5.08 ± 0.51)						
Thickness Maximum	0.220 (5.59)						0.220 (5.59)						0.140 (3.55)					0.130 (3.30)						
Lead Width Maximum	0.400 (10.20)						0.500 (12.70)						0.100 (2.54)					0.100 (2.54)						
Lead Length "L"	0.100 ± 0.020 (2.54 ± 0.51)						0.100 ± 0.020 (2.54 ± 0.51)						0.100 ± 0.020 (2.54 ± 0.51)					0.100 ± 0.020 (2.54 ± 0.51)						
Lead Length "J"	0.100 ± 0.020 (2.54 ± 0.51)						0.100 ± 0.020 (2.54 ± 0.51)						0.100 ± 0.020 (2.54 ± 0.51)					0.100 ± 0.020 (2.54 ± 0.51)						
C0G Dielectric																								
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**	**Capacitance Tolerance**
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	Capacitance Code																							
10 pF																	100							
12 pF																	120							
15 pF													150	150	150	150	150							
18 pF													180	180	180	180	180							
22 pF													220	220	220	220	220					220	220	
27 pF													270	270	270	270	270	270	270	270	270	270	270	
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													470	470	470	470	470	470	470	470	470	470	470	
56 pF													560	560	560	560	560	560	560	560	560	560	560	
68 pF													680	680	680	680	680	680	680	680	680	680	680	
82 pF													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	
120 pF											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	
180 pF			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			
270 pF	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			
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			
560 pF	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			
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	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			
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				
2,700 pF	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				
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				
5,600 pF	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					
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					
0.015 µF	153	153					153	153	153									153						
0.018 µF	183	183					183	183	183									183						
0.022 µF	223	223					223	223	223									223						
0.027 µF	273	273					273	273										273						
0.033 µF	333	333					333	333										333						
0.039 µF	393	393					393	393																
0.047 µF	473	473					473	473																
0.056 µF							563	563																
0.068 µF							683	683																

Table 1C – Capacitance Range/Selection Waterfall SM33 – SM35 Style/Size

Style/Size	SM33	SM34	SM35
Dimensions – inches (mm)			
Length	0.700 ± 0.030 (17.08 ± 0.76)	0.900 ± 0.030 (22.90 ± 0.76)	1.100 ± 0.030 (27.90 ± 0.76)
Width	0.300 ± 0.030 (7.62 ± 0.76)	0.400 ± 0.030 (10.20 ± 0.76)	0.500 ± 0.030 (12.70 ± 0.76)
Thickness Maximum	0.180 (4.57)	0.220 (5.59)	0.220 (5.59)
Lead Width Maximum	0.200 (5.08)	0.300 (7.62)	0.400 (10.2)
Lead Length "L"	0.100 ± 0.020 (2.54 ± 0.51)	0.100 ± 0.020 (2.54 ± 0.51)	0.100 ± 0.020 (2.54 ± 0.51)
Lead Length "J"	0.100 ± 0.020 (2.54 ± 0.51)	0.100 ± 0.020 (2.54 ± 0.51)	0.100 ± 0.020 (2.54 ± 0.51)

C0G Dielectric

	SM33							SM34								SM35								
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	**Capacitance Tolerance**
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 Code**																							
27 pF						270	270																	
33 pF						330	330																	
39 pF						390	390							390	390									
47 pF						470	470					470	470	470	470								470	
56 pF						560	560			560	560	560	560	560	560									
68 pF						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									
100 pF	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									
150 pF	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		
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	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 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	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	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		
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	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	272	272	272	272			272	272	272	272	272	272			J, K, M, P, Z
3,300 pF	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			
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					
6,800 pF	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					
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					
0.018 µF	183	183	183					183	183	183						183	183	183	183					
0.022 µF	223	223						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	393	393						393	393							393	393	393						
0.047 µF	473	473						473	473							473	473	473						
0.056 µF	563							563	563							563	563							
0.068 µF	683							683								683	683							
0.082 µF	823							823								823	823							
0.1 µF	104							104								104	104							
0.12 µF								124								124	124							
0.15 µF								154								154	154							
0.18 µF																184								
0.22 µF																224								
0.27 µF																274								

Table 1D – Capacitance Range/Selection Waterfall SM36 Style/Size

Style/Size	SM36								
Dimensions – inches (mm)									
Length	1.350 ± 0.030 (33.00 ± 0.76)								
Width	0.600 ± 0.030 (15.20 ± 0.76)								
Thickness Maximum	0.220 (5.59)								
Lead Width Maximum	0.500 (12.7)								
Lead Length "L"	0.100 ± 0.020 (2.54 ± 0.51)								
Lead Length "J"	0.100 ± 0.020 (2.54 ± 0.51)								
C0G Dielectric									
Voltage Code	**501**	**102**	**202**	**302**	**402**	**502**	**752**	**103**	**Capacitance Tolerance**
Voltage DC	**500**	**1K**	**2K**	**3K**	**4K**	**5K**	**7.5K**	**10K**	
Capacitance	Capacitance Code								
120 pF					121	121	121		
150 pF	151	151	151	151	151	151	151		
180 pF	181	181	181	181	181	181	181		
220 pF	221	221	221	221	221	221	221		
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	561	561	561	561	561	561	561		
680 pF	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		
1,500 pF	152	152	152	152	152	152	152	152	
1,800 pF	182	182	182	182	182	182	182		
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			
4,700 pF	472	472	472	472	472	472			
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	123	123	123	123					
0.015 µF	153	153	153	153					
0.018 µF	183	183	183	183					
0.022 µF	223	223	223	223					
0.027 µF	273	273	273	273					
0.033 µF	333	333	333	333					
0.039 µF	393	393	393						
0.047 µF	473	473	473						
0.056 µF	563	563	563						
0.068 µF	683	683							
0.082 µF	823	823							
0.1 µF	104	104							
0.12 µF	124	124							
0.15 µF	154	154							
0.18 µF	184								
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]
SM	SM20	1	50
	SM21		
	SM22		
	SM23		
	SM24		
	SM25		
	SM26		
	SM30		
	SM31		
	SM33		25
	SM34		10
	SM35		
	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_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.

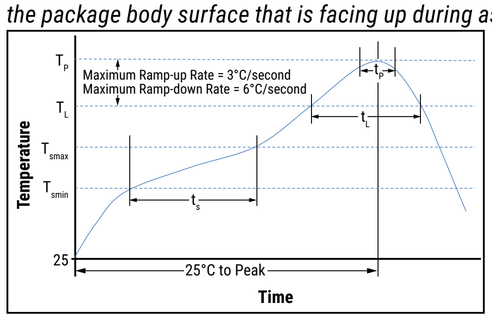


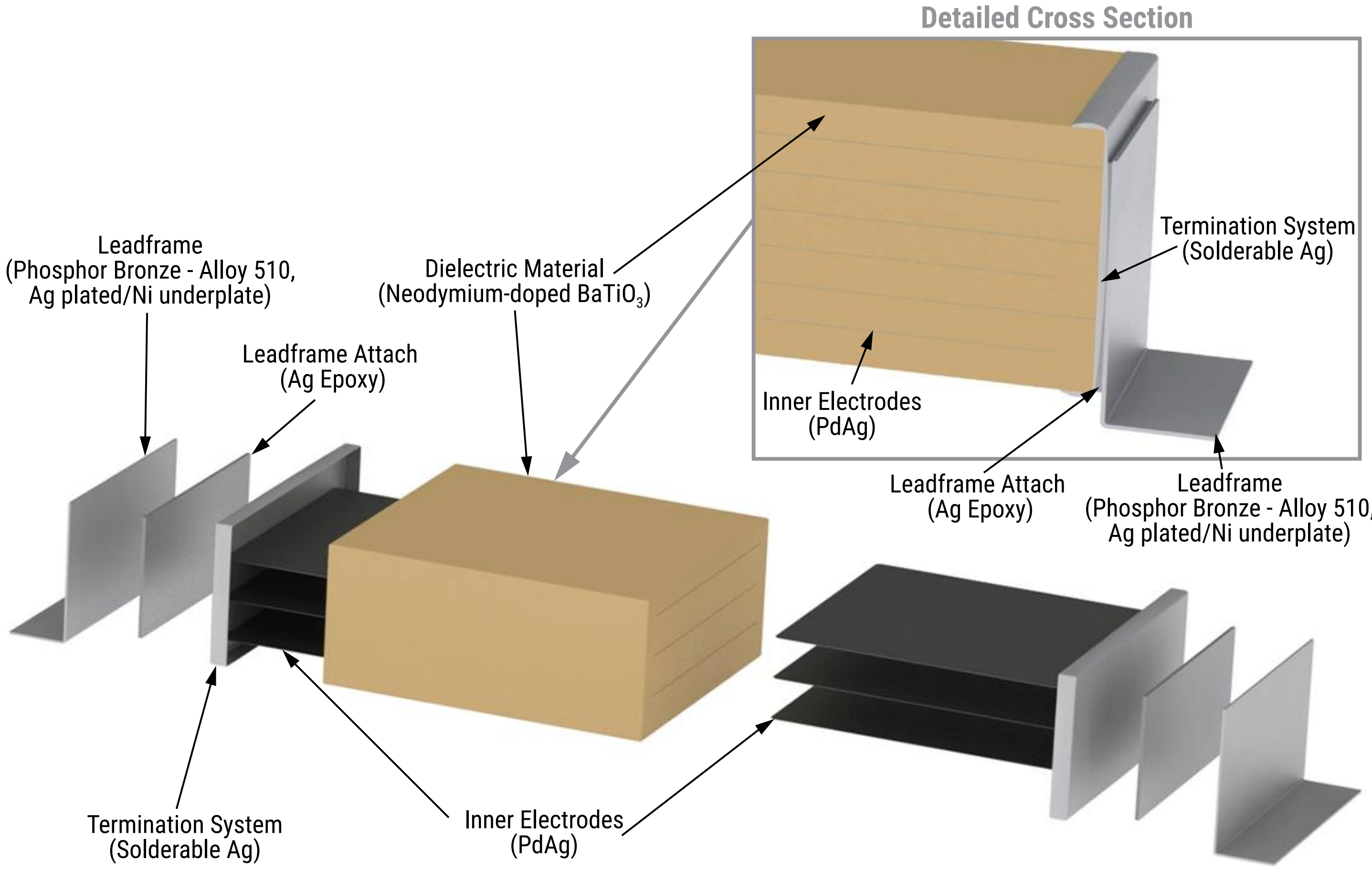
Table 3 – Performance & Reliability: Test Methods and Conditions

Stress	Reference	Test or Inspection Method
Board Flex	JIS–C–6429	Appendix 2, Note: 2 mm (minimum) for all except 3 mm for C0G.
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
		1,000 cycles (−55°C to +125°C). Measurement at 24 hours +/−2 hours after test conclusion.
Biased Humidity	MIL–STD–202 Method 103	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.
		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 40ºC 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 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 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 ±15% 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 150 pF up to 5.6 µF

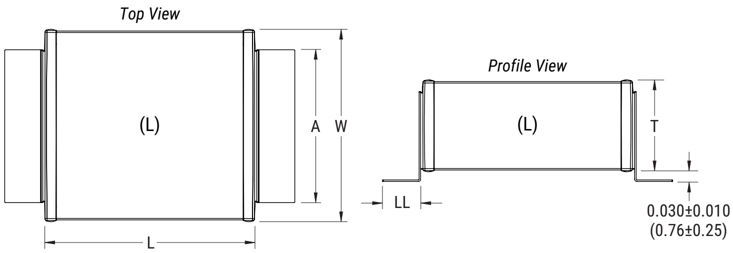
Ordering Information

SM20		B	153	K	501	B	M
Style/Size		Dielectric	Capacitance Code (pF)	Capacitance Tolerance	Rated Voltage (VDC)	Lead Configuration[1]	Testing/ Inspection Option[2]
SM20	SM30	B = X7R	Two significant digits and number of zeros	K = ±10%	501 = 500	A = Formed L	Blank = None
SM21	SM31			M = ±20%	102 = 1,000	B = Formed J	M = Group A per MIL-PRF-49467
SM22	SM33				202 = 2,000		
SM23	SM34				302 = 3,000		
SM24	SM35				402 = 4,000		
SM25	SM36				502 = 5,000		
SM26					752 = 7,500		
					103 = 10,000		

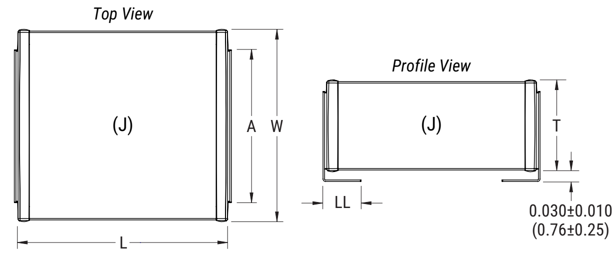
[1] Standard lead configuration is formed "J". If the appropriate character is excluded from the ordering code, the assumed lead configuration will be formed "J".
[2] Group B testing/inspection option per MIL–PRF–49467 is available upon request. Please contact KEMET for ordering details.

Dimensions – Inches (Millimeters)

FORMED LEAD (L)



FORMED LEAD (J)



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)	0.100 (2.54)	0.100±0.020 (2.54±0.51)	0.040±0.010 (1.02±0.25)
SM21	0.200±0.020 (5.08±0.51)	0.200±0.020 (5.08±0.51)	0.180 (4.57)			
SM22	0.250±0.020 (6.35±0.51)	0.200±0.020 (5.08±0.51)				
SM23	0.350±0.030 (8.89±0.76)	0.300±0.030 (7.62±0.76)	0.220 (5.59)	0.200 (5.08)		0.100±0.020 (2.54±0.51)
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)		0.400 (10.20)		
SM26	0.650±0.030 (16.50±0.76)	0.600±0.030 (15.20±0.76)		0.500 (12.70)		
SM30	0.300±0.030 (7.62±0.76)	0.150±0.015 (3.81±0.38)	0.140 (3.55)	0.100 (2.54)		
SM31	0.400±0.030 (10.20±0.76)	0.200±0.020 (5.08±0.51)	0.130 (3.30)			
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)	0.220 (5.59)	0.300 (7.62)		
SM35	1.100±0.030 (27.90±0.76)	0.500±0.030 (12.70±0.76)		0.400 (10.2)		
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 MΩ-µF value by the capacitance and compare to GΩ 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

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						
Dimensions – inches (mm)																							
Length	0.150 ± 0.015 (3.81 ± 0.38)			0.200 ± 0.020 (5.08 ± 0.51)				0.250 ± 0.020 (6.35 ± 0.51)				0.350 ± 0.030 (8.89 ± 0.76)					0.450 ± 0.030 (11.43 ± 0.76)						
Width	0.150 ± 0.015 (3.81 ± 0.38)			0.200 ± 0.020 (5.08 ± 0.51)				0.200 ± 0.020 (5.08 ± 0.51)				0.300 ± 0.030 (7.62 ± 0.76)					0.400 ± 0.030 (10.20 ± 0.76)						
Thickness Maximum	0.130 (3.30)			0.180 (4.57)				0.180 (4.57)				0.220 (5.59)					0.220 (5.59)						
Lead Width Maximum	0.100 (2.54)			0.100 (2.54)				0.100 (2.54)				0.200 (5.08)					0.300 (7.62)						
Lead Length "L"	0.100 ± 0.020 (2.54 ± 0.51)			0.100 ± 0.020 (2.54 ± 0.51)				0.100 ± 0.020 (2.54 ± 0.51)				0.100 ± 0.020 (2.54 ± 0.51)					0.100 ± 0.020 (2.54 ± 0.51)						
Lead Length "J"	0.040 ± 0.010 (1.02 ± 0.25)			0.040 ± 0.010 (1.02 ± 0.25)				0.040 ± 0.010 (1.02 ± 0.25)				0.100 ± 0.020 (2.54 ± 0.51)					0.100 ± 0.020 (2.54 ± 0.51)						
X7R Dielectric																							
Voltage Code	**501**	**102**	**202**	**501**	**102**	**202**	**302**	**501**	**102**	**202**	**302**	**501**	**102**	**202**	**302**	**402**	**501**	**102**	**202**	**302**	**402**	**502**	**Capacitance Tolerance**
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	Capacitance Code																						
330 pF	331	331	331																				
390 pF	391	391	391																				
470 pF	471	471	471																				
560 pF	561	561	561																				
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	272	272	272	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	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		
0.015 µF	153	153		153	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			
0.022 µF	223	223		223	223			223	223			223	223	223			223	223	223	223			K, M
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	473			473	473			473	473			473	473				473	473	473				
0.056 µF	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				
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								224				224	224				224	224					
0.27 µF								274				274	274				274	274					
0.33 µF												334					334	334					
0.39 µF												394					394	394					
0.47 µF												474					474	474					
0.56 µF												564					564						
0.68 µF																	684						
0.82 µF																	824						
1.0 µF																	105						
1.2 µF																	125						

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Table 1B – Capacitance Range/Selection Waterfall SM25 – SM31 Style/Size

Style/Size	SM25	SM26	SM30	SM31
Dimensions – inches (mm)				
Length	0.550 ± 0.030 (14.00 ± 0.76)	0.650 ± 0.030 (16.50 ± 0.76)	0.300 ± 0.030 (7.62 ± 0.76)	0.400 ± 0.030 (10.20 ± 0.76)
Width	0.500 ± 0.030 (12.70 ± 0.76)	0.600 ± 0.030 (15.20 ± 0.76)	0.150 ± 0.015 (3.81 ± 0.38)	0.200 ± 0.020 (5.08 ± 0.51)
Thickness Maximum	0.220 (5.59)	0.220 (5.59)	0.140 (3.55)	0.130 (3.30)
Lead Width Maximum	0.400 (10.20)	0.500 (12.70)	0.100 (2.54)	0.100 (2.54)
Lead Length "L"	0.100 ± 0.020 (2.54 ± 0.51)	0.100 ± 0.020 (2.54 ± 0.51)	0.100 ± 0.020 (2.54 ± 0.51)	0.100 ± 0.020 (2.54 ± 0.51)
Lead Length "J"	0.100 ± 0.020 (2.54 ± 0.51)	0.100 ± 0.020 (2.54 ± 0.51)	0.100 ± 0.020 (2.54 ± 0.51)	0.100 ± 0.020 (2.54 ± 0.51)

X7R Dielectric	SM25						SM26						SM30					SM31						
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**	**Capacitance Tolerance**
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	Capacitance Code																							
150 pF													151	151	151	151	151							
180 pF													181	181	181	181	181							
220 pF													221	221	221	221	221							
270 pF													271	271	271	271	271							
330 pF													331	331	331	331	331							
390 pF													391	391	391	391	391							
470 pF													471	471	471	471	471							
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													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	
1,800 pF													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		
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			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		
4,700 pF	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			
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				
0.012 µF	123	123	123	123	123		123	123	123	123	123	123	123	123				123	123	123				K, M
0.015 µF	153	153	153	153	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				
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	393	393	393	393			393	393	393	393			393	393				393	393					
0.047 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					
0.12 µF	124	124	124				124	124	124				124					124						
0.15 µF	154	154					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	274					274	274										274						
0.33 µF	334	334					334	334										334						
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	SM25						SM26						SM30						SM31						
Dimensions – inches (mm)																									
Length	0.550 ± 0.030 (14.00 ± 0.76)						0.650 ± 0.030 (16.50 ± 0.76)						0.300 ± 0.030 (7.62 ± 0.76)						0.400 ± 0.030 (10.20 ± 0.76)						
Width	0.500 ± 0.030 (12.70 ± 0.76)						0.600 ± 0.030 (15.20 ± 0.76)						0.150 ± 0.015 (3.81 ± 0.38)						0.200 ± 0.020 (5.08 ± 0.51)						
Thickness Maximum	0.220 (5.59)						0.220 (5.59)						0.140 (3.55)						0.130 (3.30)						
Lead Width Maximum	0.400 (10.20)						0.500 (12.70)						0.100 (2.54)						0.100 (2.54)						
Lead Length "L"	0.100 ± 0.020 (2.54 ± 0.51)						0.100 ± 0.020 (2.54 ± 0.51)						0.100 ± 0.020 (2.54 ± 0.51)						0.100 ± 0.020 (2.54 ± 0.51)						
Lead Length "J"	0.100 ± 0.020 (2.54 ± 0.51)						0.100 ± 0.020 (2.54 ± 0.51)						0.100 ± 0.020 (2.54 ± 0.51)						0.100 ± 0.020 (2.54 ± 0.51)						
X7R Dielectric																									
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**		**Capacitance Tolerance**
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	Capacitance Code																								
1.0 µF	105						105	105																	K, M
1.2 µF	125						125																		K, M
1.5 µF	155						155																		K, M
1.8 µF	185						185																		K, M
2.2 µF							225																		K, M
2.7 µF							275																		K, M
2.9 µF							295																		K, M

Table 1C – Capacitance Range/Selection Waterfall SM33 – SM35 Style/Size

Style/Size	SM33	SM34	SM35
Dimensions – inches (mm)			
Length	0.700 ± 0.030 (17.08 ± 0.76)	0.900 ± 0.030 (22.90 ± 0.76)	1.100 ± 0.030 (27.90 ± 0.76)
Width	0.300 ± 0.030 (7.62 ± 0.76)	0.400 ± 0.030 (10.20 ± 0.76)	0.500 ± 0.030 (12.70 ± 0.76)
Thickness Maximum	0.180 (4.57)	0.220 (5.59)	0.220 (5.59)
Lead Width Maximum	0.200 (5.08)	0.300 (7.62)	0.400 (10.2)
Lead Length "L"	0.100 ± 0.020 (2.54 ± 0.51)	0.100 ± 0.020 (2.54 ± 0.51)	0.100 ± 0.020 (2.54 ± 0.51)
Lead Length "J"	0.100 ± 0.020 (2.54 ± 0.51)	0.100 ± 0.020 (2.54 ± 0.51)	0.100 ± 0.020 (2.54 ± 0.51)

X7R Dielectric

Style/Size	SM33							SM34								SM35								Capacitance Tolerance
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 Code																							
820 pF	821	821	821	821	821	821	821																	K, M
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	
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								222	
2,700 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 pF	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		
0.012 μF	123	123	123	123	123			123	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	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	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	683					
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	184	184						184	184	184						184	184	184						
0.22 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						684	684							684	684							
0.82 μF	824							824	824							824	824							
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								
2.7 μF																275								
2.9 μF																295								
3.3 μF																335								
3.9 μF																395								

KEMET a YAGEO company

Table 1D – Capacitance Range/Selection Waterfall SM36 Style/Size

Style/Size	SM36								
Dimensions – inches (mm)									
Length	1.350 ± 0.030 (33.00 ± 0.76)								
Width	0.600 ± 0.030 (15.20 ± 0.76)								
Thickness Maximum	0.220 (5.59)								
Lead Width Maximum	0.500 (12.7)								
Lead Length "L"	0.100 ± 0.020 (2.54 ± 0.51)								
Lead Length "J"	0.100 ± 0.020 (2.54 ± 0.51)								
X7R Dielectric									
Voltage Code	501	102	202	302	402	502	752	103	Capacitance Tolerance
Voltage DC	500	1 K	2 K	3 K	4 K	5 K	7.5 K	10 K	
Capacitance	Capacitance Code								
1,500 pF								152	
1,800 pF								182	
2,200 pF								222	
2,700 pF								272	
3,300 pF								332	
3,900 pF								392	
4,700 pF	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	682	
8,200 pF	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		
0.015 µF	153	153	153	153	153	153	153		
0.018 µF	183	183	183	183	183	183	183		
0.022 µF	223	223	223	223	223	223	223		
0.027 µF	273	273	273	273	273	273			
0.033 µF	333	333	333	333	333	333			
0.039 µF	393	393	393	393	393				
0.047 µF	473	473	473	473	473				
0.056 µF	563	563	563	563	563				
0.068 µF	683	683	683	683	683				
0.082 µF	823	823	823	823					
0.1 µF	104	104	104	104					K, M, P, Z
0.12 µF	124	124	124	124					
0.15 µF	154	154	154	154					
0.18 µF	184	184	184						
0.22 µF	224	224	224						
0.27 µF	274	274	274						
0.33 µF	334	334	334						
0.39 µF	394	394							
0.47 µF	474	474							
0.56 µF	564	564							
0.68 µF	684	684							
0.82 µF	824	824							
1.0 µF	105	105							
1.2 µF	125	125							
1.5 µF	155	155							
1.8 µF	185	185							
2.2 µF	225	225							
2.7 µF	275								
2.9 µF	295								
3.3 µF	335								
3.9 µF	395								
4.7 µF	475								
5.6 µF	565								

Table 2 – Chip Thickness/Packaging Quantities

Series	Style/Size	Tray Quantity Minimum[1]	Tray Quantity Maximum[1]
SM	SM20	1	50
	SM21		
	SM22		
	SM23		
	SM24		
	SM25		
	SM26		
	SM30		
	SM31		
	SM33		25
	SM34		10
	SM35		
	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_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.

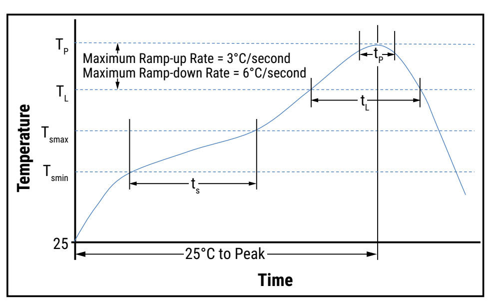


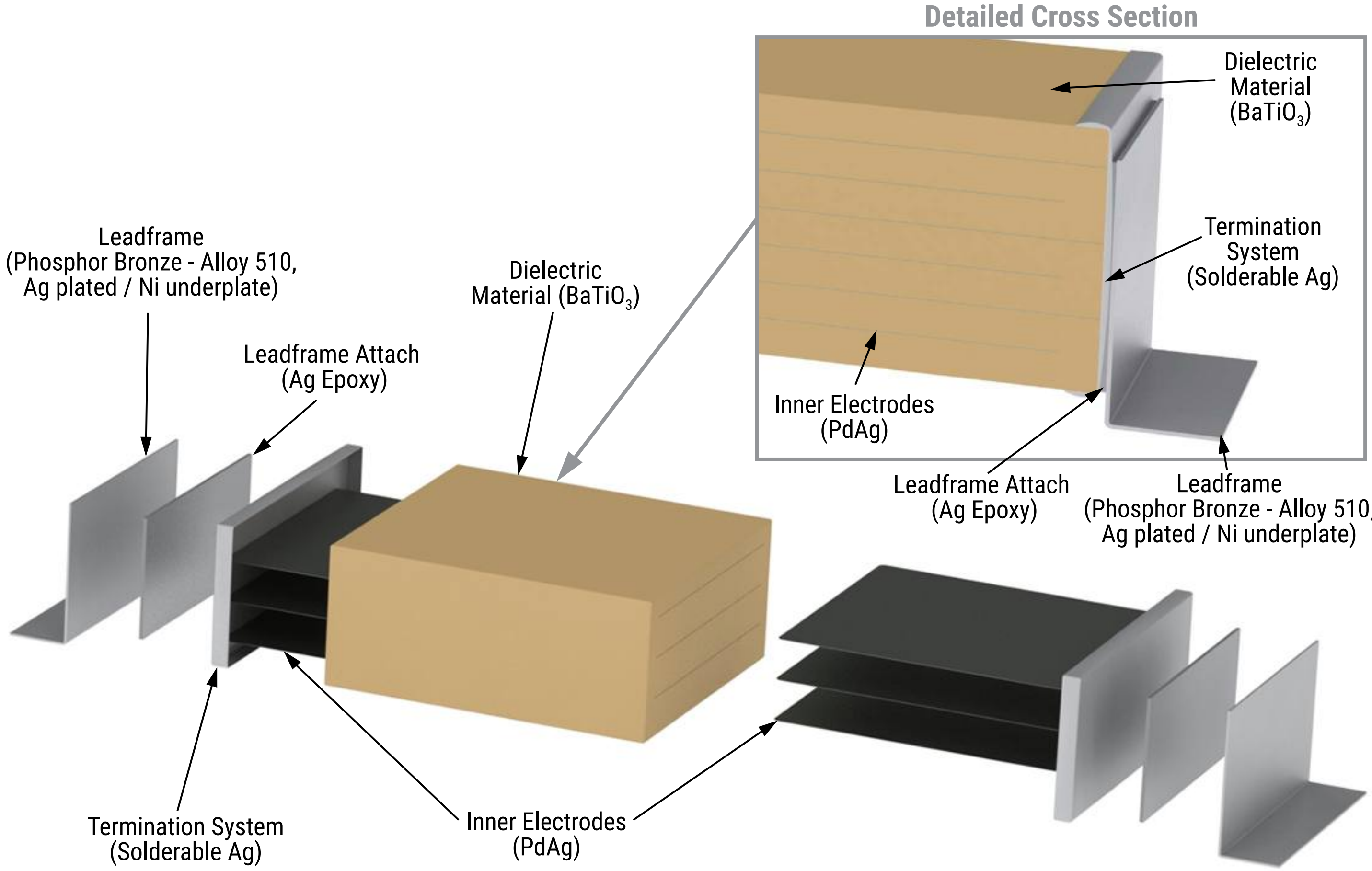
Table 3 – Performance & Reliability: Test Methods and Conditions

Stress	Reference	Test or Inspection Method
Board Flex	JIS–C–6429	Appendix 2, Note: 2 mm (minimum) for all except 3 mm for C0G.
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
		1,000 cycles (−55°C to +125°C). Measurement at 24 hours +/−2 hours after test conclusion.
Biased Humidity	MIL–STD–202 Method 103	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.
		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 40ºC 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.

ArcShield™ Technology, High Voltage, X7R Dielectric, 500 – 1,000 VDC (Commercial & Automotive Grade)

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 arc-over 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

C	0603	W	392	K	C	R	A	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.

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	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
Automotive 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

- 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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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			○		

[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

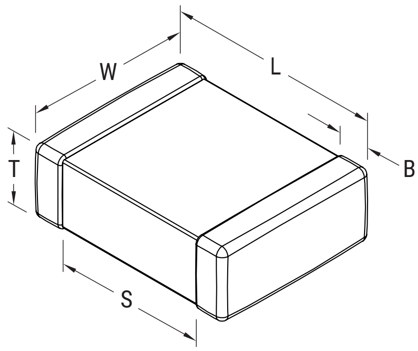
Applications

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)	See Table 2 for Thickness	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
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)		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)	See Table 2 for Thickness	0.45 (0.018) ±0.15 (0.006)	0.58 (0.023)	Solder Wave or Solder Reflow
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)	
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	
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)		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)		
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 ≤10µF

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

[4] *To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ 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	All	3.0	±20%	10% of Initial Limit
	16/25		5.0		
	< 16		7.5		

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

Cap	Cap Code	Case Size/ Series			C0603W/V			C0805W/V			C1206W/V			C1210W/V			C1808W/V			C1812W/V			C1825W/V		C2220W/V		C2225W/V	
		Voltage Code			C	B	D	C	B	D	C	B	D	C	B	D	C	B	D	C	B	D	C	B	C	B	C	B
		Rated Voltage (VDC)			500	630	1000	500	630	1000	500	630	1000	500	630	1000	500	630	1000	500	630	1000	500	630	500	630	500	630
		Capacitance Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																							
1,000 pF	102	J	K	M	CG	CG	CG																					
1,200 pF	122	J	K	M	CG	CG																						
1,500 pF	152	J	K	M	CG	CG																						
1,800 pF	182	J	K	M	CG																							
2,200 pF	222	J	K	M	CG			DG	DG	DG																		
2,700 pF	272	J	K	M	CG			DG	DG	DG																		
3,300 pF	332	J	K	M	CG			DG	DG	DG																		
3,900 pF	392	J	K	M	CG			DG	DG	DG																		
4,700 pF	472	J	K	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			FZ	FZ	FU	LA	LA	LA	GB	GB	GB						
47,000 pF	473	J	K	M							EJ			FZ	FU	FK	LA	LA	LB	GB	GB	GC						
56,000 pF	563	J	K	M							EJ			FZ	FU	FK	LA	LA	LB	GB	GB	GE						
62,000 pF	623	J	K	M							EJ			FZ	FK	FS	LA	LA	LC	GB	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		HE	HE				
0.15 µF	154	J	K	M										FK			LB			GE	GN		HE	HE	JE	JE		
0.18 µF	184	J	K	M																GF			HE	HG	JE	JE	KE	KE
0.22 µF	224	J	K	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	K	M																			HK		JN		KH	KJ
0.47 µF	474	J	K	M																					JN		KH	KJ
0.56 µF	564	J	K	M																							KJ	
Cap	Cap Code	Rated Voltage (VDC)			500	630	1000	500	630	1000	500	630	1000	500	630	1000	500	630	1000	500	630	1000	500	630	500	630	500	630
		Voltage Code			C	B	D	C	B	D	C	B	D	C	B	D	C	B	D	C	B	D	C	B	C	B	C	B
		Case Size/ Series			C0603W/V			C0805W/V			C1206W/V			C1210W/V			C1808W/V			C1812W/V			C1825W/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 Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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 Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[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

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		Packaging Quantities (pieces/unit packaging)	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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 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)				
		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.

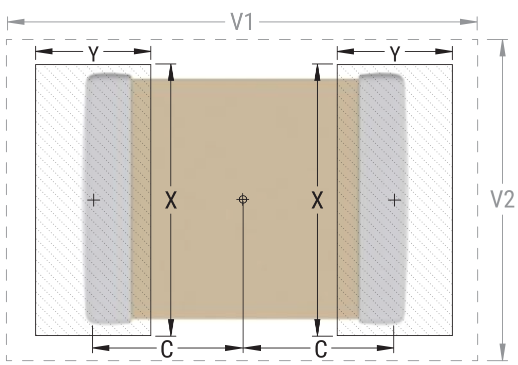
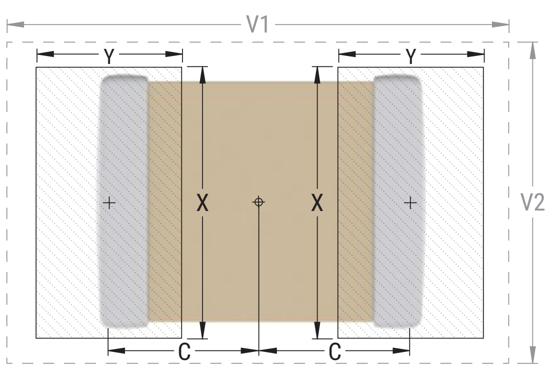


Table 3B – Land Pattern Design Recommendations per IPC–7351 – Flexible Termination

EIA Size 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)				
		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. 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	
	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.

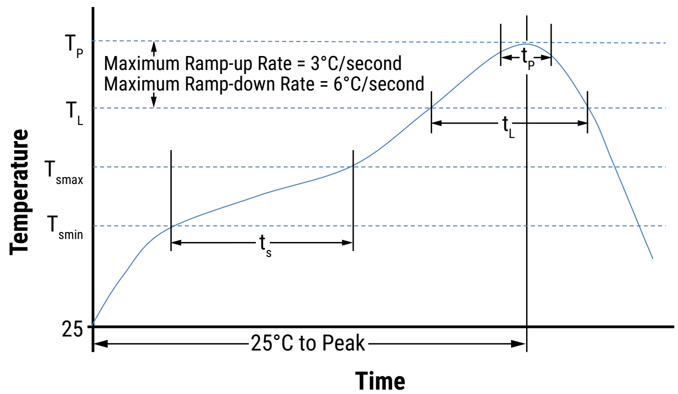


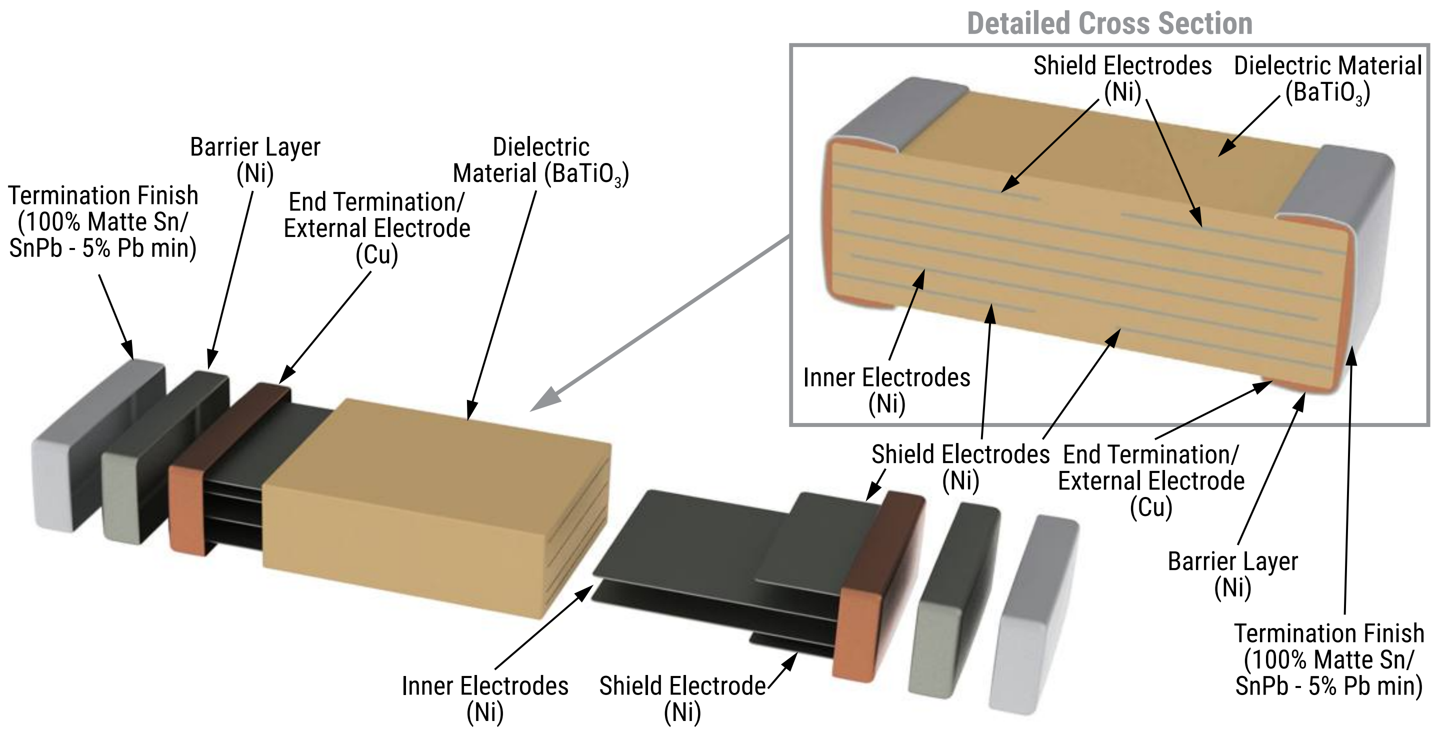
Table 4 – Performance & Reliability: Test Methods and Conditions

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 C0G. 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, 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.
Biased Humidity	MIL–STD–202 Method 103	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.
		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.

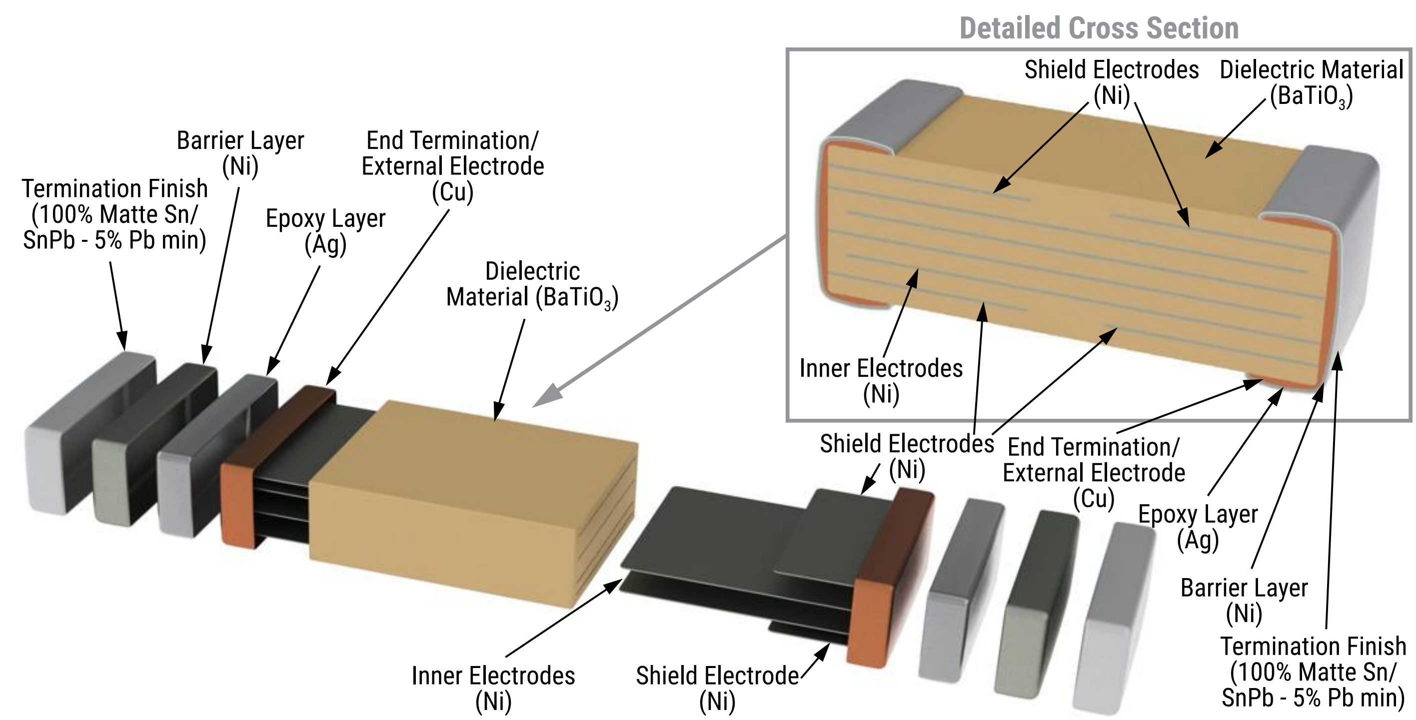
Storage & Handling

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)

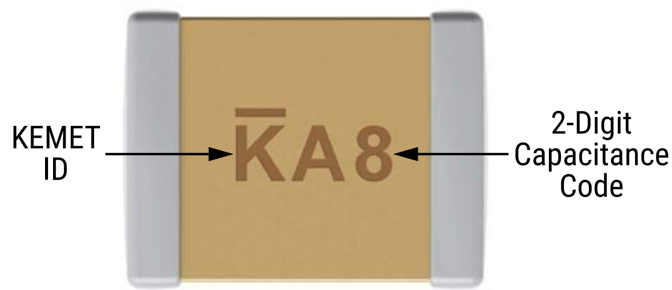
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic 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:

- C0G, 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 µF. Orientation of marking is vendor optional.

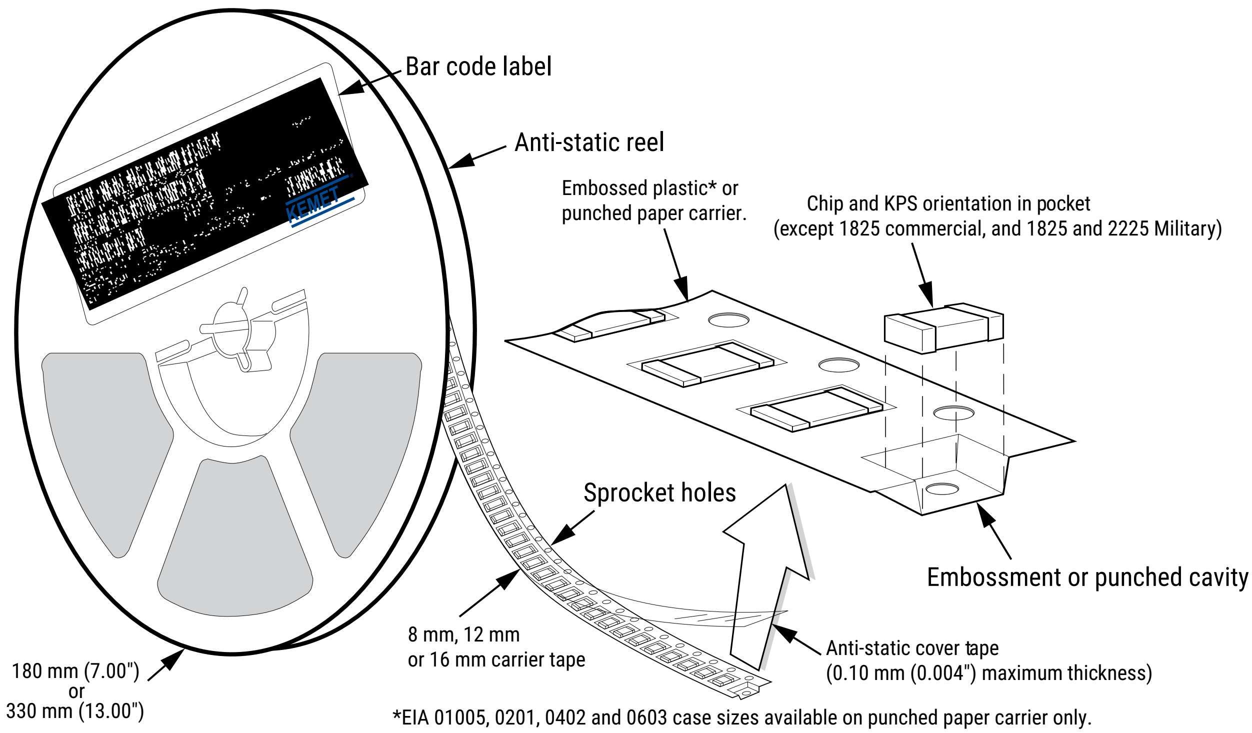


Capacitor Marking (Optional) cont.

Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.10	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

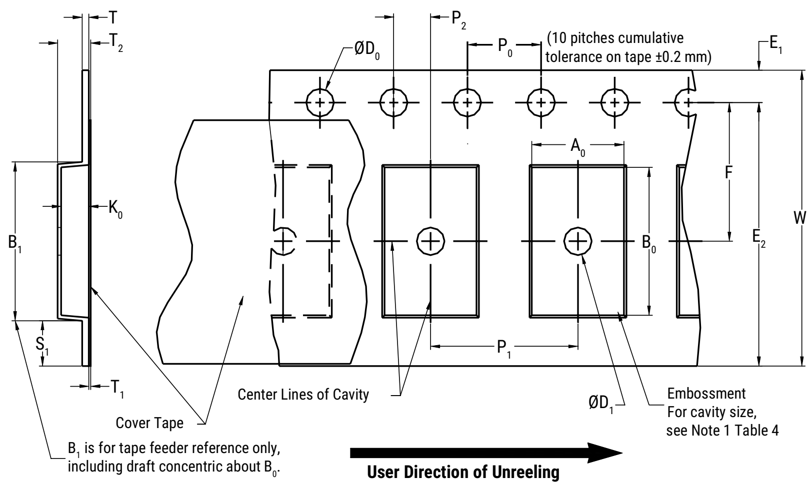


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +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)			
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)	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 S_1 < 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_0, B_0 and K_0 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

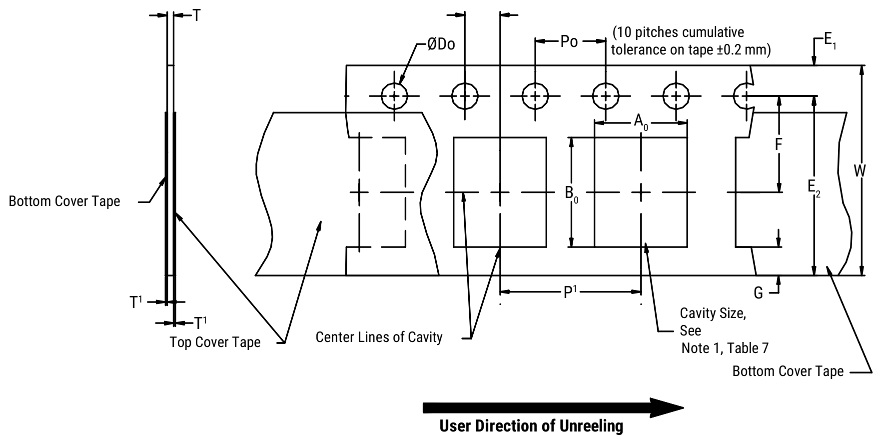


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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

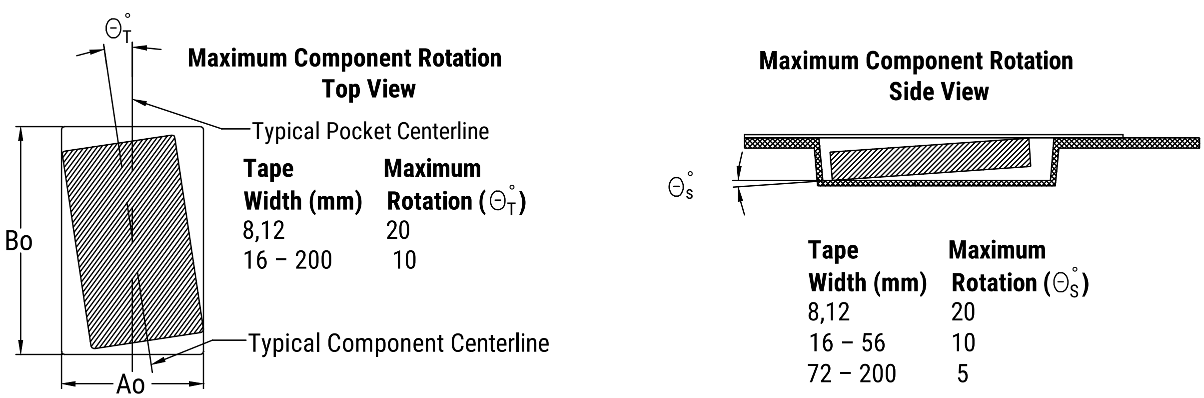


Figure 4 – Maximum Lateral Movement

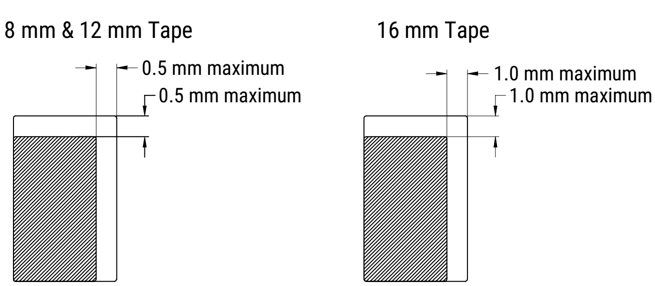


Figure 5 – Bending Radius

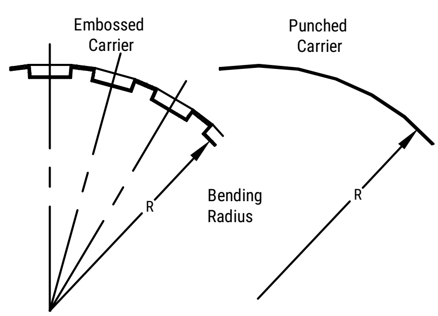
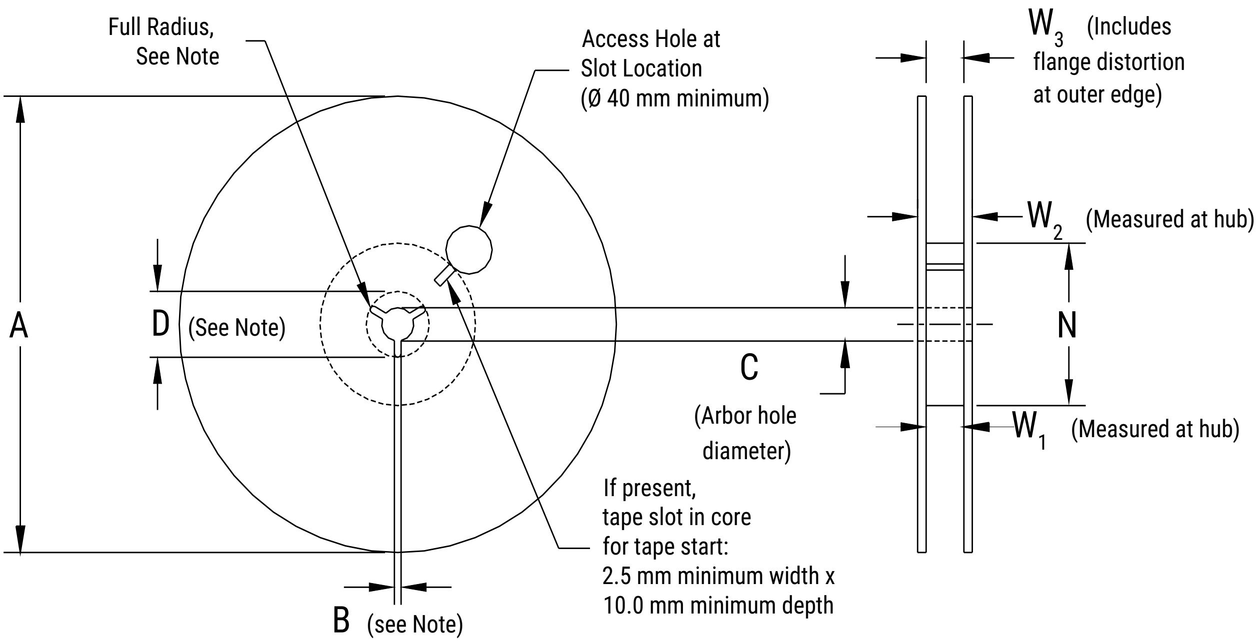


Figure 6 – Reel Dimensions



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

Table 8 – Reel Dimensions

Metric will govern

<table>
<tr><th colspan="5">Constant Dimensions — Millimeters (Inches)</th></tr>
<tr><th>Tape Size</th><th>A</th><th>B Minimum</th><th>C</th><th>D Minimum</th></tr>
<tr><td>8 mm</td><td rowspan="3">178 ±0.20
(7.008 ±0.008)
or
330 ±0.20
(13.000 ±0.008)</td><td rowspan="3">1.5
(0.059)</td><td rowspan="3">13.0 +0.5/−0.2
(0.521 +0.02/−0.008)</td><td rowspan="3">20.2
(0.795)</td></tr>
<tr><td>12 mm</td></tr>
<tr><td>16 mm</td></tr>
<tr><th colspan="5">Variable Dimensions — Millimeters (Inches)</th></tr>
<tr><th>Tape Size</th><th>N Minimum</th><th>W_1</th><th>W_2 Maximum</th><th>W_3</th></tr>
<tr><td>8 mm</td><td rowspan="3">50
(1.969)</td><td>8.4 +1.5/−0.0
(0.331 +0.059/−0.0)</td><td>14.4
(0.567)</td><td rowspan="3">Shall accommodate tape width without interference</td></tr>
<tr><td>12 mm</td><td>12.4 +2.0/−0.0
(0.488 +0.078/−0.0)</td><td>18.4
(0.724)</td></tr>
<tr><td>16 mm</td><td>16.4 +2.0/−0.0
(0.646 +0.078/−0.0)</td><td>22.4
(0.882)</td></tr>
</table>

Figure 7 – Tape Leader & Trailer Dimensions

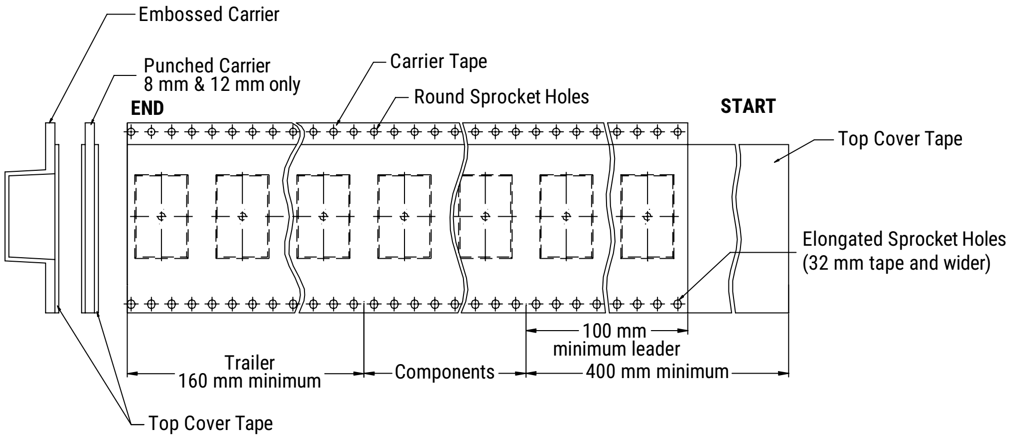
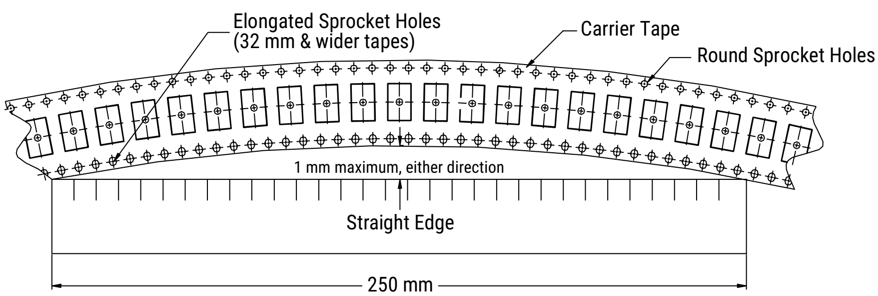


Figure 8 – Maximum Camber



Pulse Discharge, High Voltage, High Temperature 200°C C0G Dielectric, 1,000 VDC – 3,500 VDC (Industrial Grade)

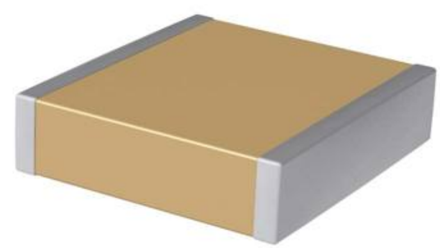
Overview

KEMET's Industrial Grade Pulse Discharge Series surface mount capacitors in C0G 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 C0G 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 C0G 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

C	2824	H	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 = C0G	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.

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	T050
Reel (Embossed Plastic Tape)/Unmarked – 100 pieces	T100
Reel (Embossed Plastic Tape)/Unmarked – 250 pieces	T250
Reel (Embossed Plastic Tape)/Unmarked – 500 pieces	T500
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.*

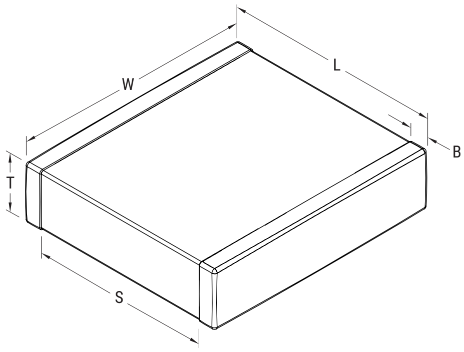
Benefits

- 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 Width	T Thickness 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)	See Table 2	1.27±0.40 (0.050±0.016)	N/A	Solder Reflow Only
3040	7.60±0.40 (0.300±0.016)	10.20±0.40 (0.402±0.016)				
3640	9.10±0.40 (0.358±0.016)	10.20±0.40 (0.402±0.016)				
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 MΩ-µF value by the capacitance and compare to GΩ limit. Select the lower of the two limits.

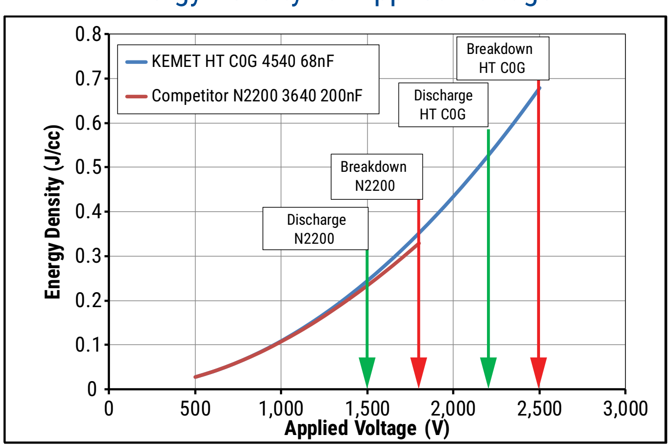
Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 and Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON."

Post Environmental Limits

High Temperature Life, Biased Humidity, Moisture Resistance					
Dielectric	Rated DC Voltage	Capacitance Value	Dissipation Factor (Maximum %)	Capacitance Shift	Insulation Resistance
C0G	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

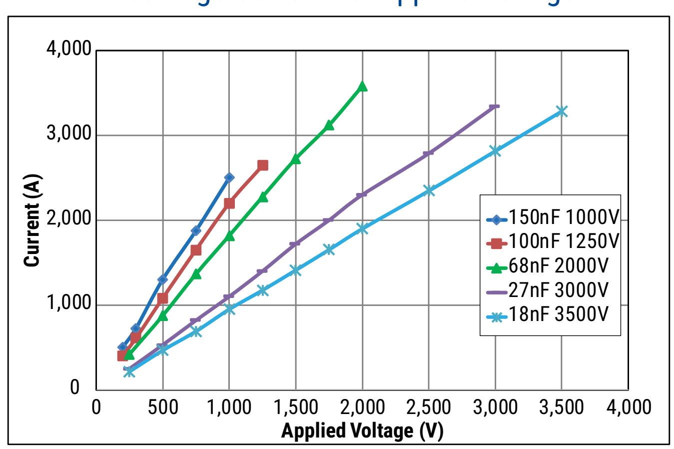


Table 1 – Pulse Discharge Series, Capacitance Range Waterfall

Capacitance	Cap Code	Case Size/Series			C2824H					C3040H					C3640H					C4540H				
		Voltage Code			D	U	G	H	V	D	U	G	H	V	D	U	G	H	V	D	U	G	H	V
		Dielectric Withstanding Voltage (DWV)			1000	1250	2000	3000	3500	1000	1250	2000	3000	3500	1000	1250	2000	3000	3500	1000	1250	2000	3000	3500
		Working Voltage			500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000
		Capacitance Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																			
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	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	M	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	K	M	TB	TB				QB	QC	QC			MA	MA	MB			SA	SA	SA		
39,000 pF	393	J	K	M	TB	TC				QB	QC	QD			MA	MA	MB			SA	SA	SB		
47,000 pF	473	J	K	M	TB					QB	QC				MA	MB	MC			SA	SA	SB		
56,000 pF	563	J	K	M	TC					QC	QD				MA	MB				SA	SA	SB		
68,000 pF	683	J	K	M						QC	QD				MB	MC				SA	SB	SC		
82,000 pF	823	J	K	M						QC					MB					SA	SB			
0.10 µF	104	J	K	M						QD					MC					SB	SC			
0.12 µF	124	J	K	M											MC					SB				
0.15 µF	154	J	K	M																SC				
Capacitance	Cap Code	Working Voltage			500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000
		Dielectric Withstanding Voltage (DWV)			1000	1250	2000	3000	3500	1000	1250	2000	3000	3500	1000	1250	2000	3000	3500	1000	1250	2000	3000	3500
		Voltage Code			D	U	G	H	V	D	U	G	H	V	D	U	G	H	V	D	U	G	H	V
		Case Size/Series			C2824H					C3040H					C3640H					C4540H				

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 Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			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 Code	Case Size	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity		Plastic Quantity	

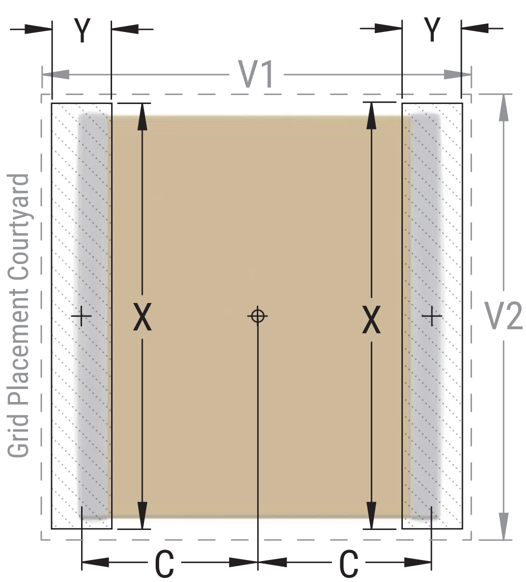
Package quantity based on finished chip thickness specifications.

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

Size Code (In.)	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)				
		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	Termination Finish	
	SnPb	100% Matte Sn
Preheat/Soak Temperature Minimum (T_{Smin}) Temperature Maximum (T_{Smax}) Time (t_S) from T_{Smin} to T_{Smax}	 100°C 150°C 60 – 120 seconds	 150°C 200°C 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.

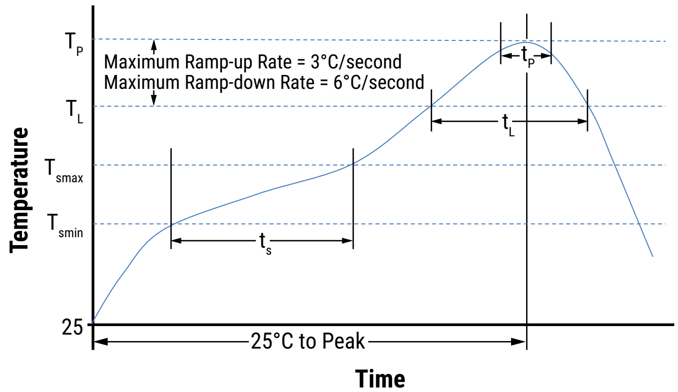


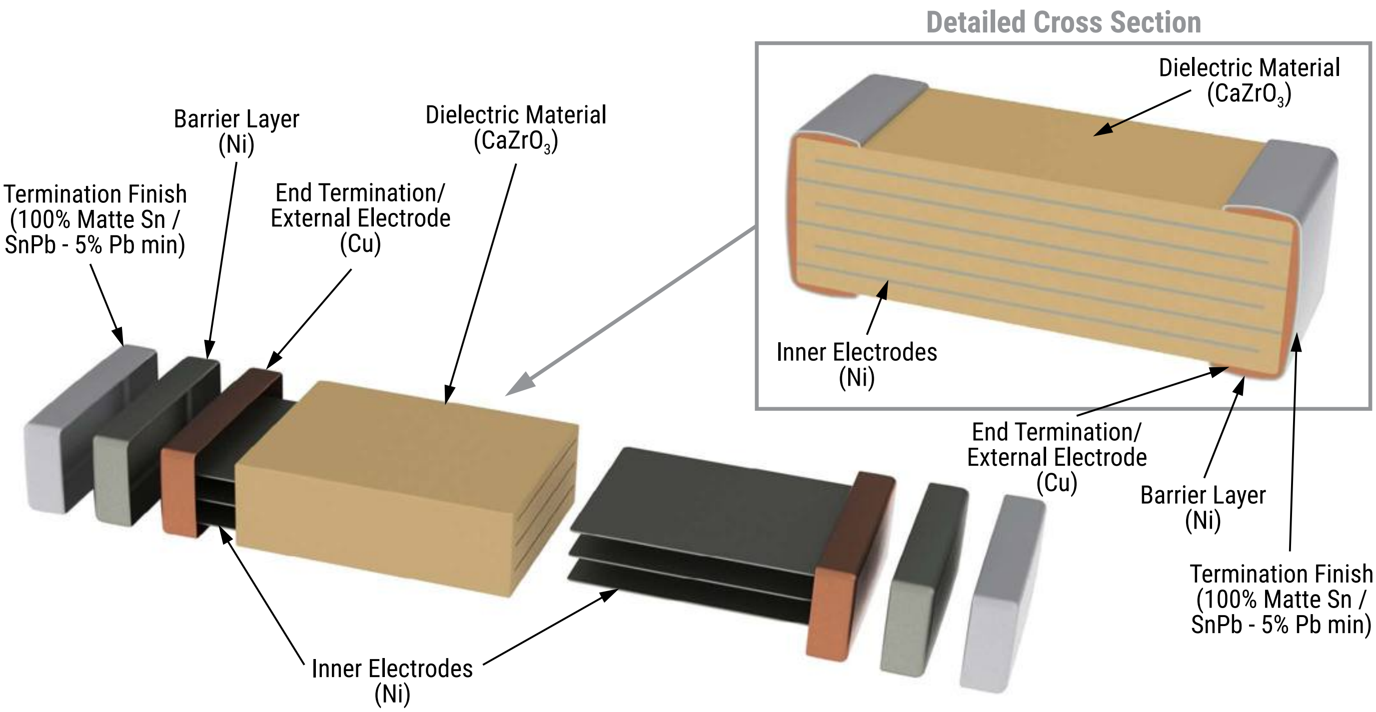
Table 4 – Performance & Reliability: Test Methods and Conditions

Product Qualification Test Plan	
Reliability/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, Mechanical & 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 40ºC 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:

- C0G, 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.

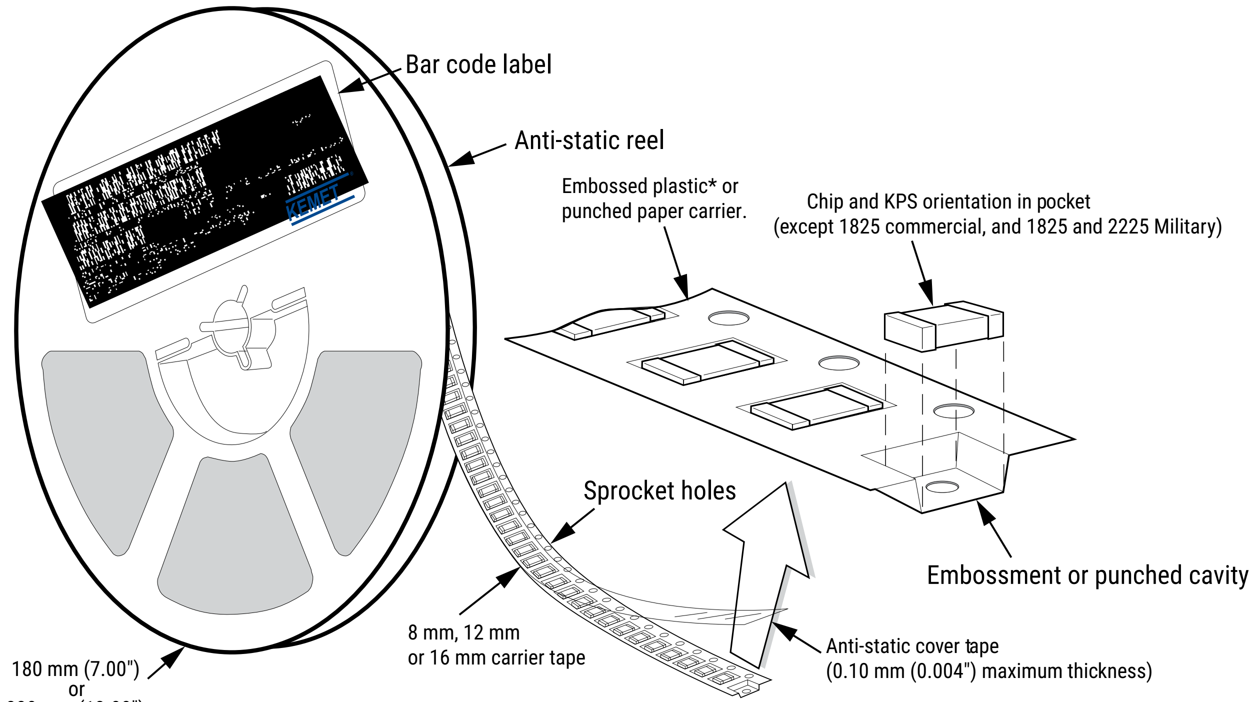
These capacitors are supplied unmarked only.

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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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		
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

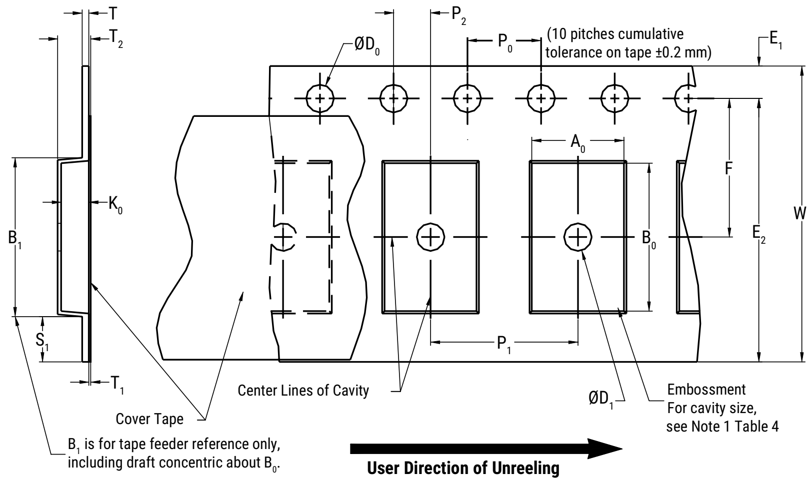


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	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)	25.0 (0.984)	0.600 (0.024)	0.600 (0.024)	0.100 (0.004)
12 mm					30 (1.181)			
16 mm								
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)	Note 5
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)	
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)	
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 S_1 < 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_1 dimension is a reference dimension for tape feeder clearance only.
5. The cavity defined by A_0, B_0 and K_0 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

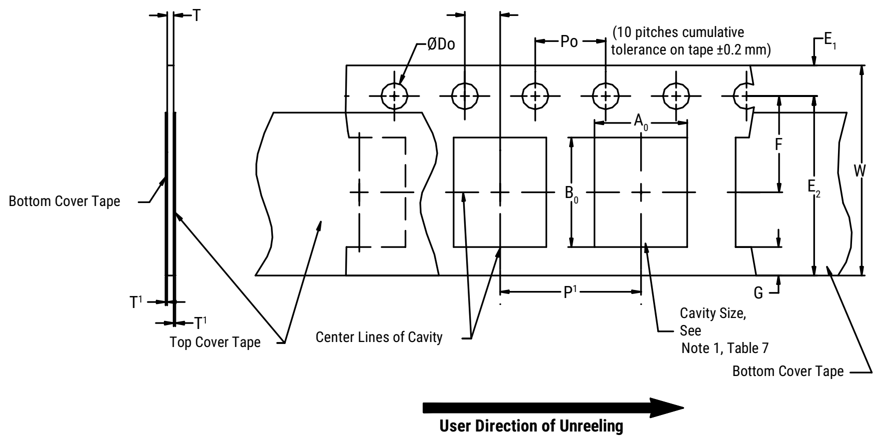


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 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_0, B_0 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

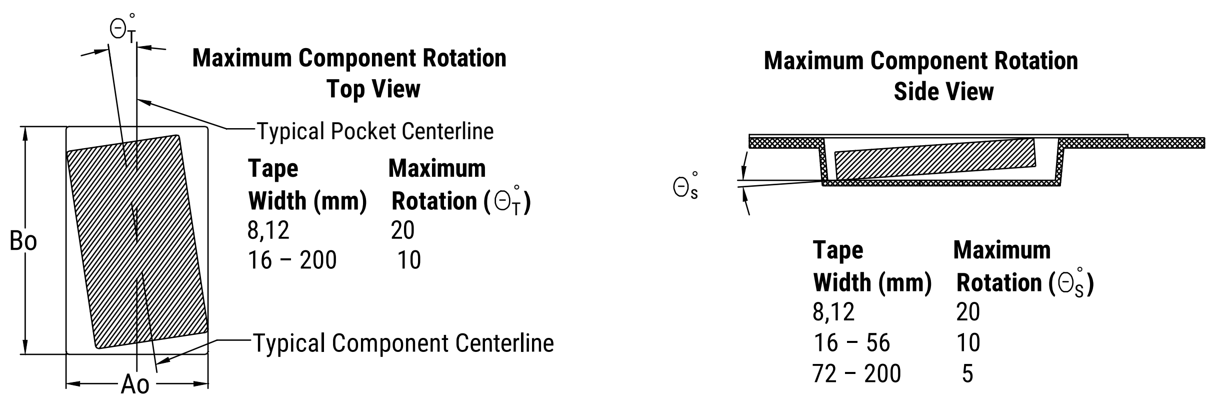


Figure 4 – Maximum Lateral Movement

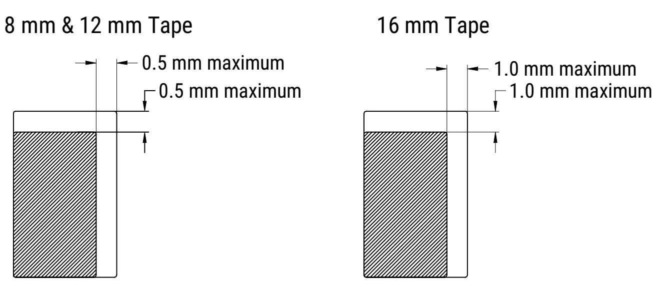


Figure 5 – Bending Radius

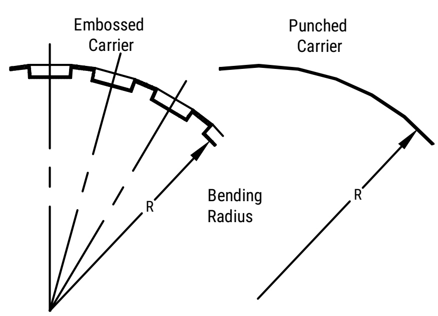
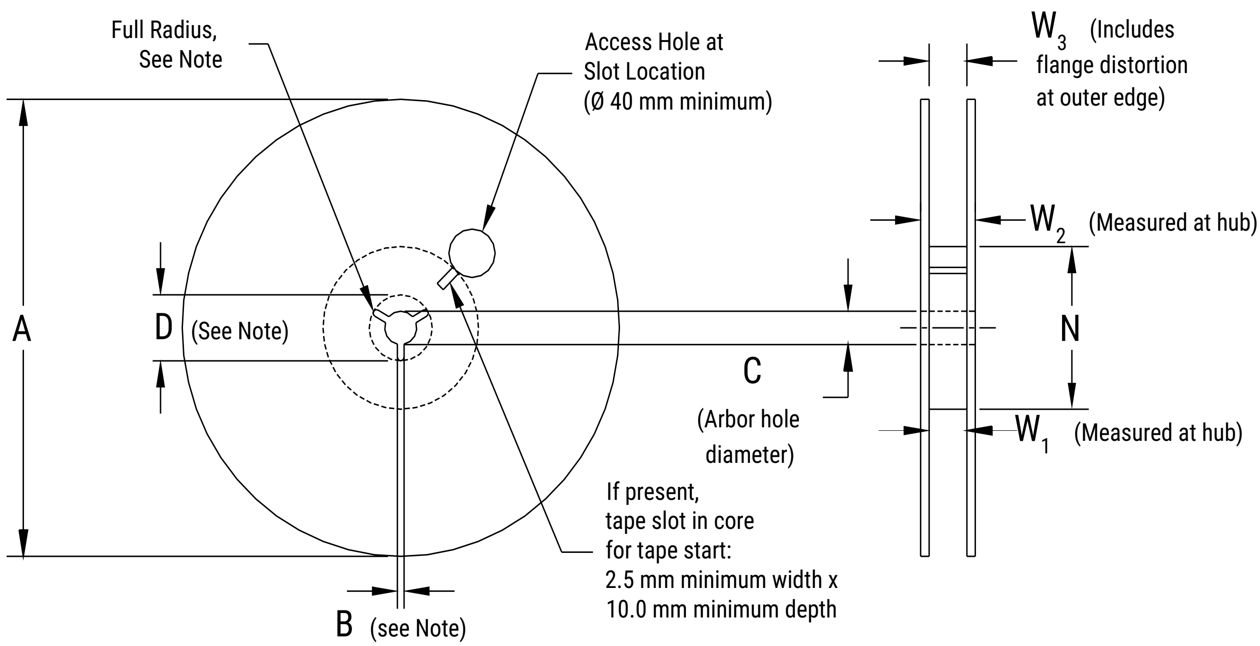


Figure 6 – Reel Dimensions



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	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				
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/−1.0 (1.078+0.039/−0.039)	

Figure 7 – Tape Leader & Trailer Dimensions

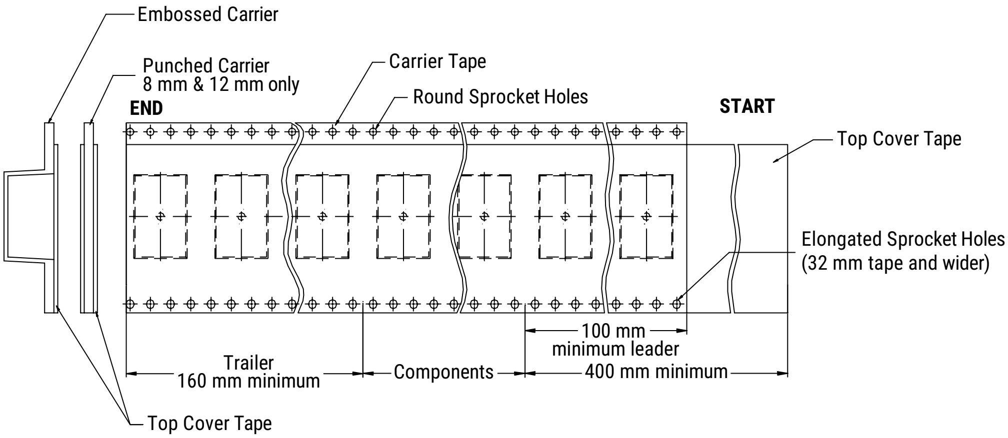
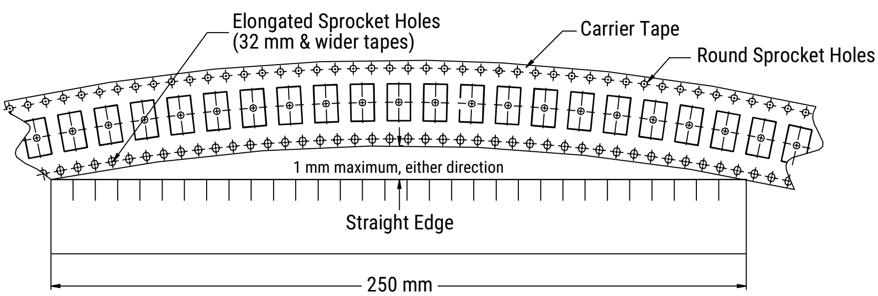


Figure 8 – Maximum Camber



KPS Series, High Voltage, X7R Dielectric, 500 – 630 VDC (Commercial Grade)

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 ±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.

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

C	2220	C	105	M	C	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)
	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 (±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
- 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.

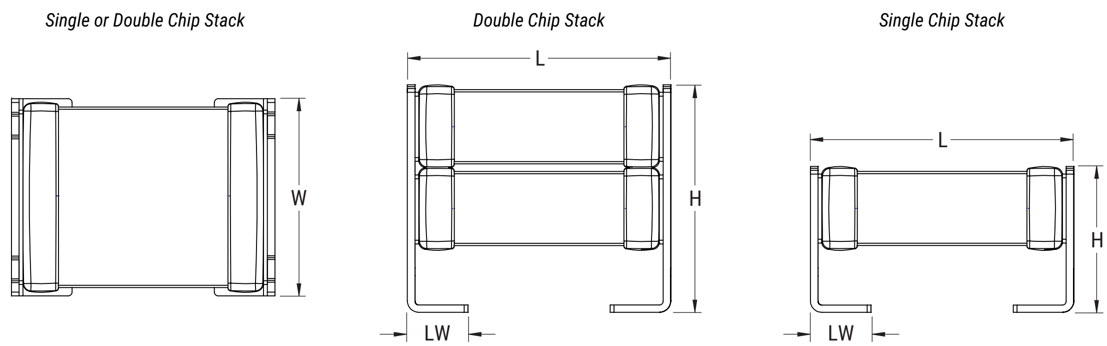
Qualification/Certification

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

[4] To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ 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
X7R	> 25	All	3.0	±20%	10% of Initial Limit
	16/25		5.0		
	< 16		7.5		

Table 1 – Capacitance Range/Selection Waterfall (2220 Case Sizes)

Capacitance	Capacitance Code	Case Size/Series		C2220C		
		Voltage Code		C	B	D
		Rated Voltage (VDC)		500	630	1000
		Capacitance Tolerance		Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions		
Single Chip Stack						
0.047 µF	473	K	M	JP	JP	
0.10 µF	104	K	M	JP	JP	
0.15 µF	154	K	M	JP	JP	
0.22 µF	224	K	M	JP	JP	
0.33 µF	334	K	M	JP		
0.47 µF	474	K	M	JP		
Double Chip Stack						
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		
Capacitance	Capacitance Code	Rated Voltage (VDC)		500	630	1000
		Voltage Code		C	B	D
		Case Size/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.

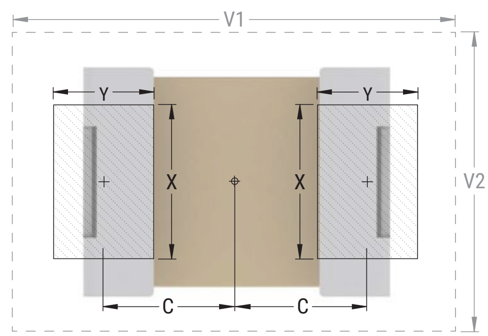
Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			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 CODE	METRIC SIZE CODE	Median (Nominal) Land Protrusion				
		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_{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_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.

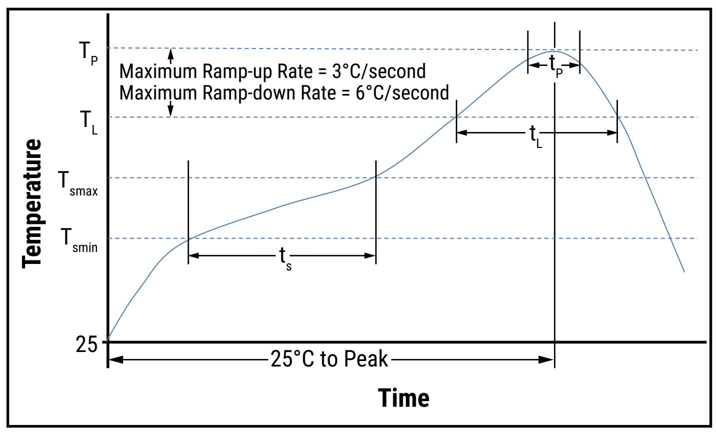


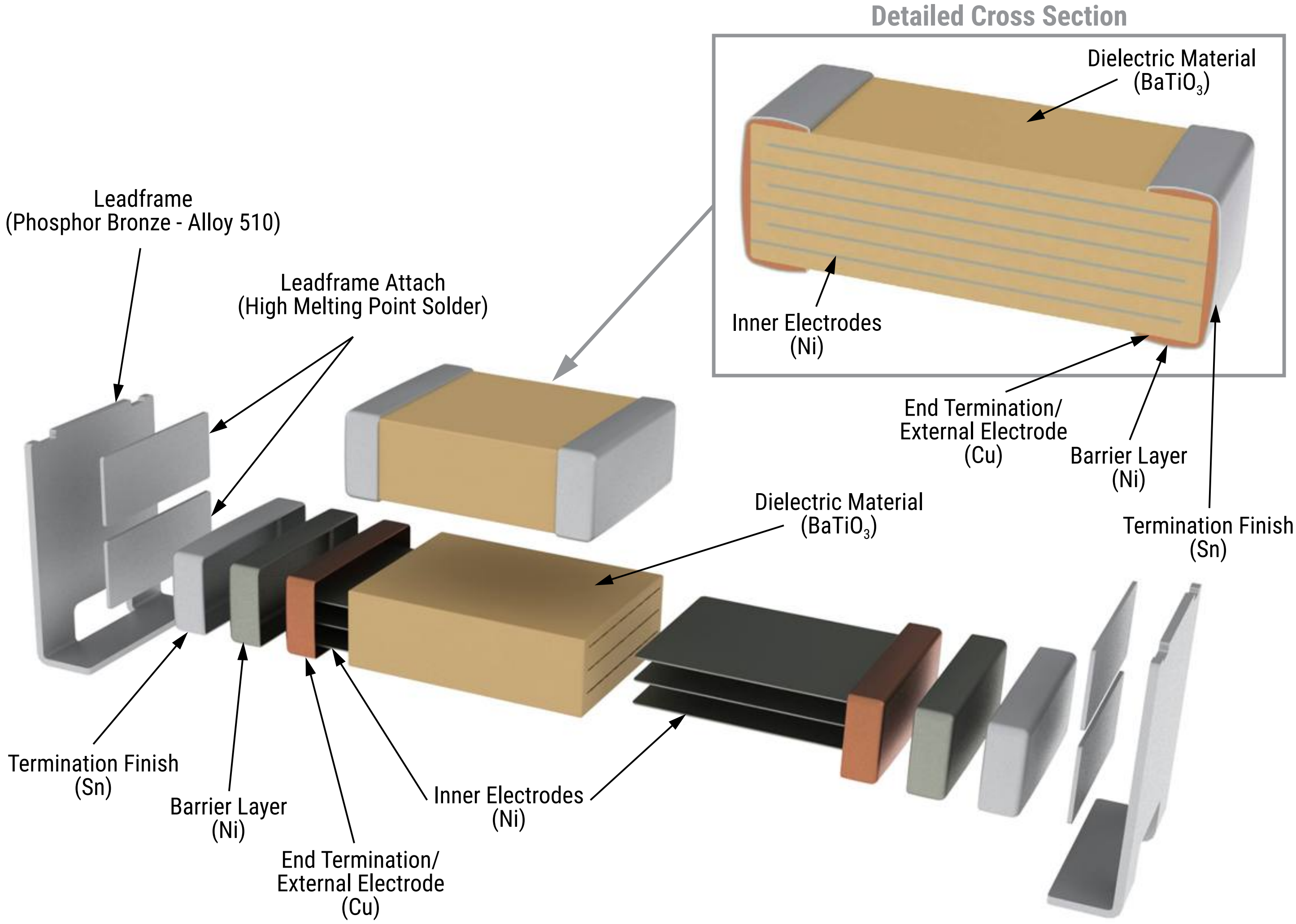
Table 4 – Performance & Reliability: Test Methods and Conditions

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
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 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 200 VDC maximum. 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 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 40ºC 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:

- C0G, 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.

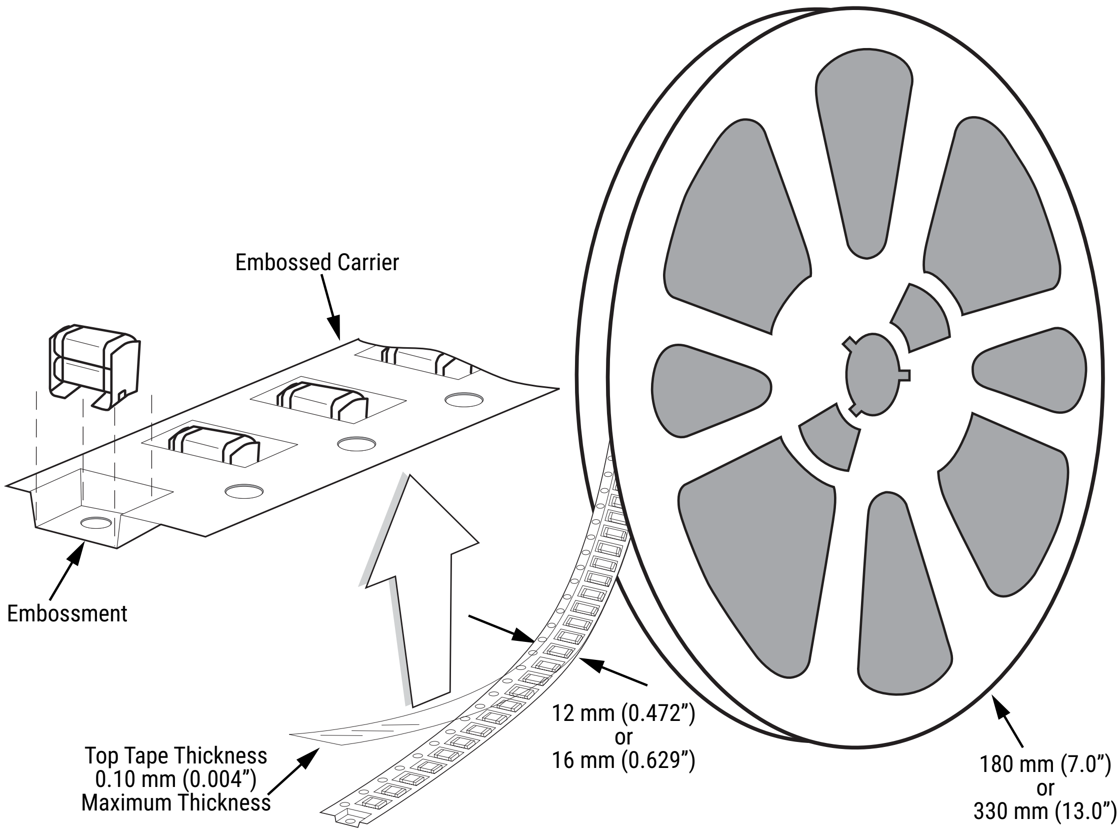


Table 5 – Carrier Tape Configuration – Embossed Plastic (mm)

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_1 carrier tape reference locations.*
**Refer to Table 5 for tolerance specifications.*

Figure 1 – Embossed (Plastic) Carrier Tape Dimensions

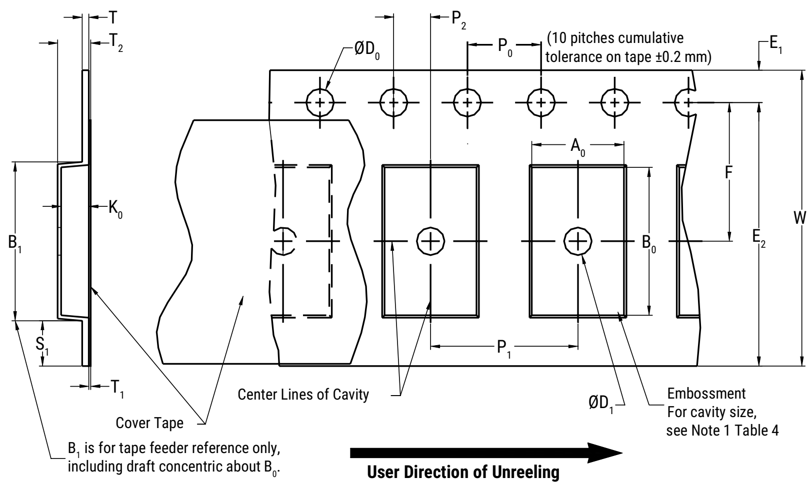


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +0.10/0.0−0.0 (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)			
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)	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 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 < 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_1 dimension is a reference dimension for tape feeder clearance only.*
5. *The cavity defined by A_0, B_0 and K_0 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.

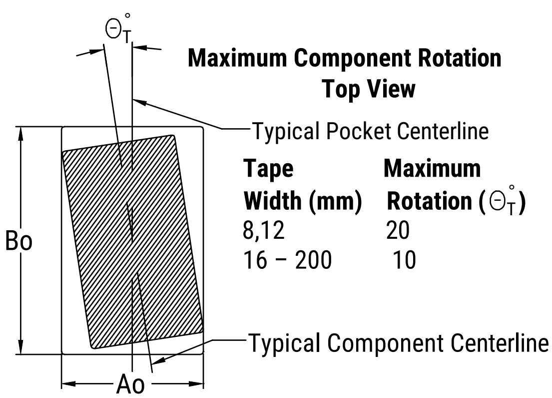
Packaging Information Performance Notes

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



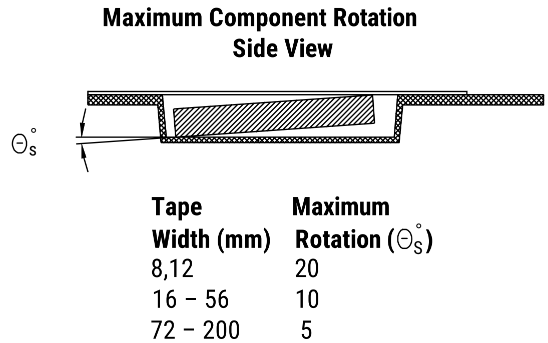


Figure 3 – Maximum Lateral Movement

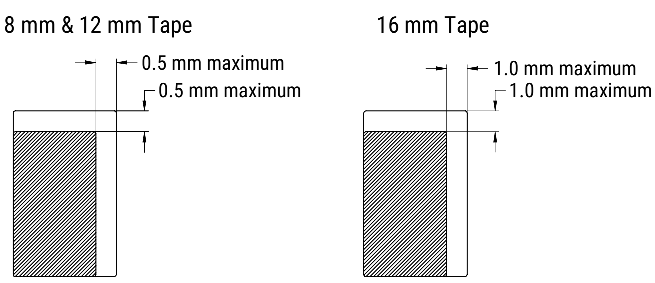


Figure 4 – Bending Radius

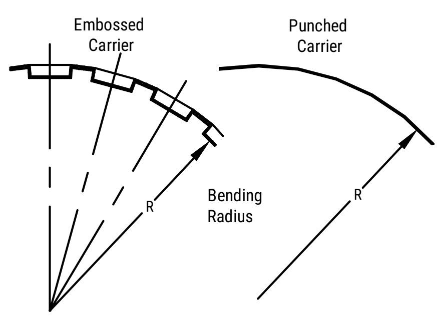
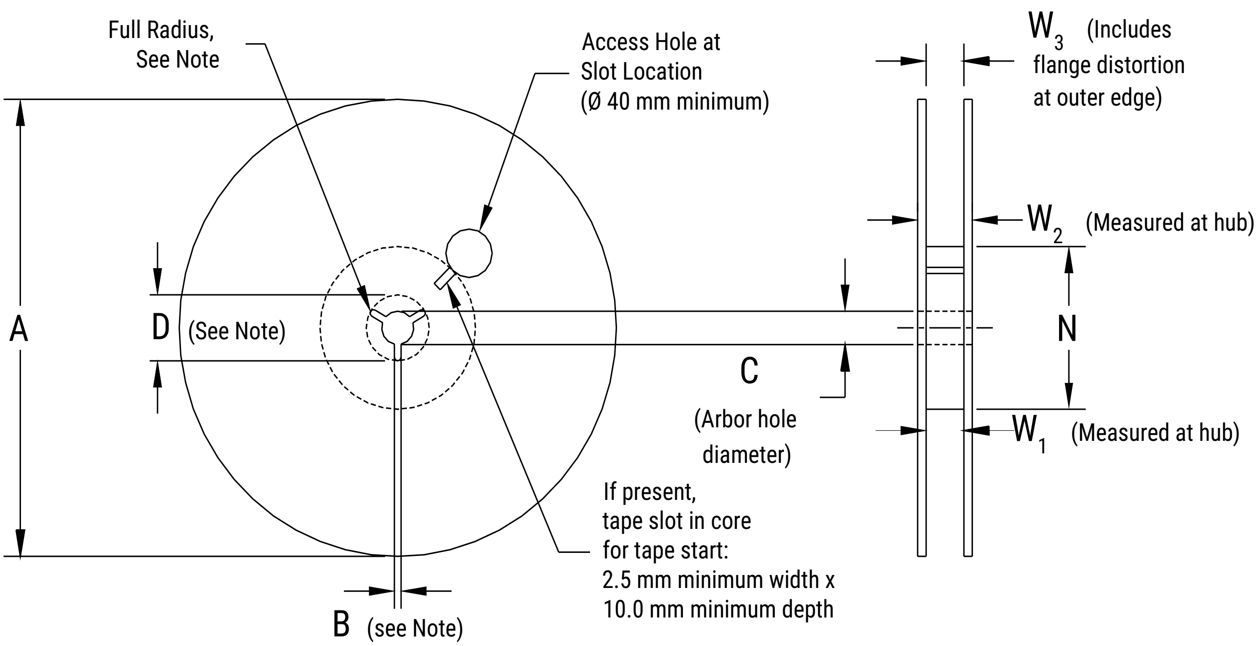


Figure 5 – Reel Dimensions



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

Table 7 – Reel Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)				
Tape Size	A	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 6 – Tape Leader & Trailer Dimensions

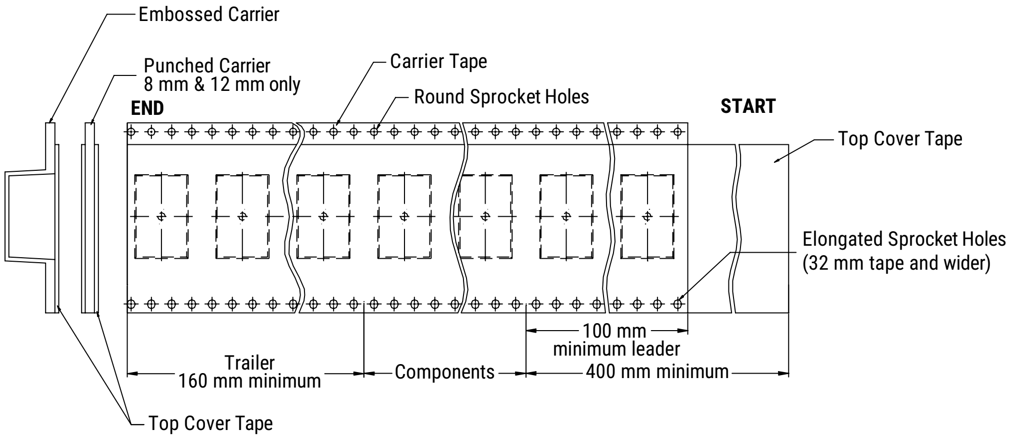
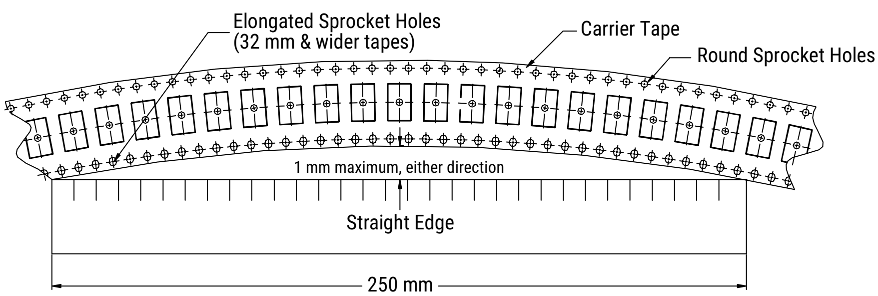


Figure 7 – Maximum Camber



KPS Series, High Voltage, X7R Dielectric, 500 – 630 VDC (Automotive Grade)

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 ±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

C	2220	C	474	M	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 (±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	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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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			○		

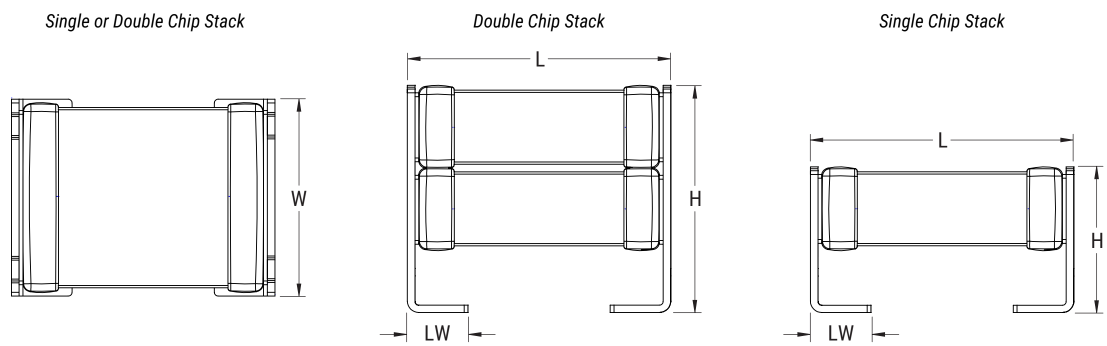
[1] *KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.*

● 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 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)	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 ≤ 10μF
120Hz ± 10Hz and 0.5 ± 0.1 Vrms if capacitance > 10μF
[4] To obtain IR limit, divide MΩ-μF value by the capacitance and compare to GΩ 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
X7R	> 25	All	3.0	±20%	10% of Initial Limit
	16/25		5.0		
	< 16		7.5		

Table 1 – Capacitance Range/Selection Waterfall (2220 Case Sizes)

Capacitance	Capacitance Code	Case Size/Series		C2220C		
		Voltage Code		C	B	D
		Rated Voltage (VDC)		500	630	1000
		Capacitance Tolerance		Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions		
Single Chip Stack						
0.047 µF	473	K	M	JP	JP	
0.10 µF	104	K	M	JP	JP	
0.15 µF	154	K	M	JP	JP	
0.22 µF	224	K	M	JP	JP	
Double Chip Stack						
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	
Capacitance	Capacitance Code	Rated Voltage (VDC)		500	630	1000
		Voltage Code		C	B	D
		Case Size/Series		C2220C		

These products are protected under US Patent 8,331,078 other patents pending, and any foreign counterparts.

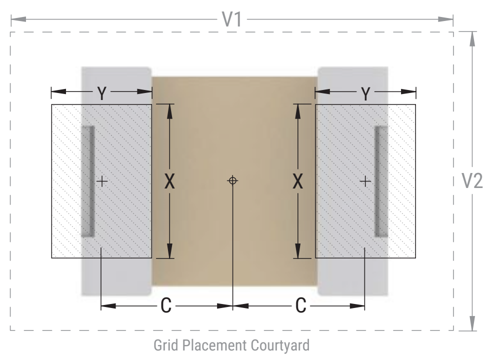
Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			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 CODE	METRIC SIZE CODE	Median (Nominal) Land Protrusion				
		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.

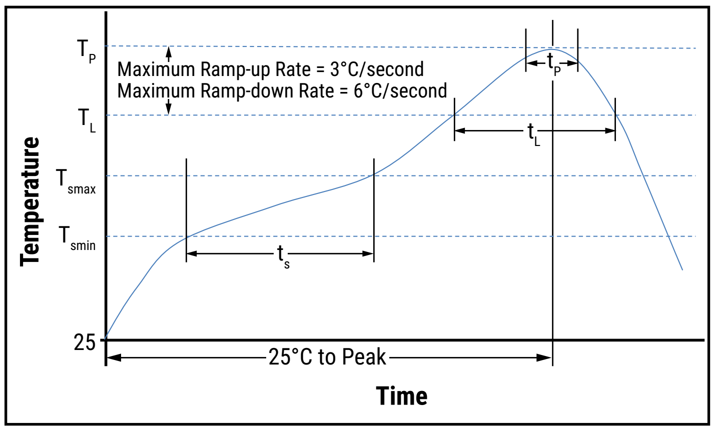
To prevent degradation of temperature cycling capability, care must be taken to prevent solder from flowing into the inner side of the lead frames (inner side of "J" lead in contact with the circuit board).

After soldering, the capacitors should be air cooled to room temperature before further processing. Forced air cooling is not recommended.

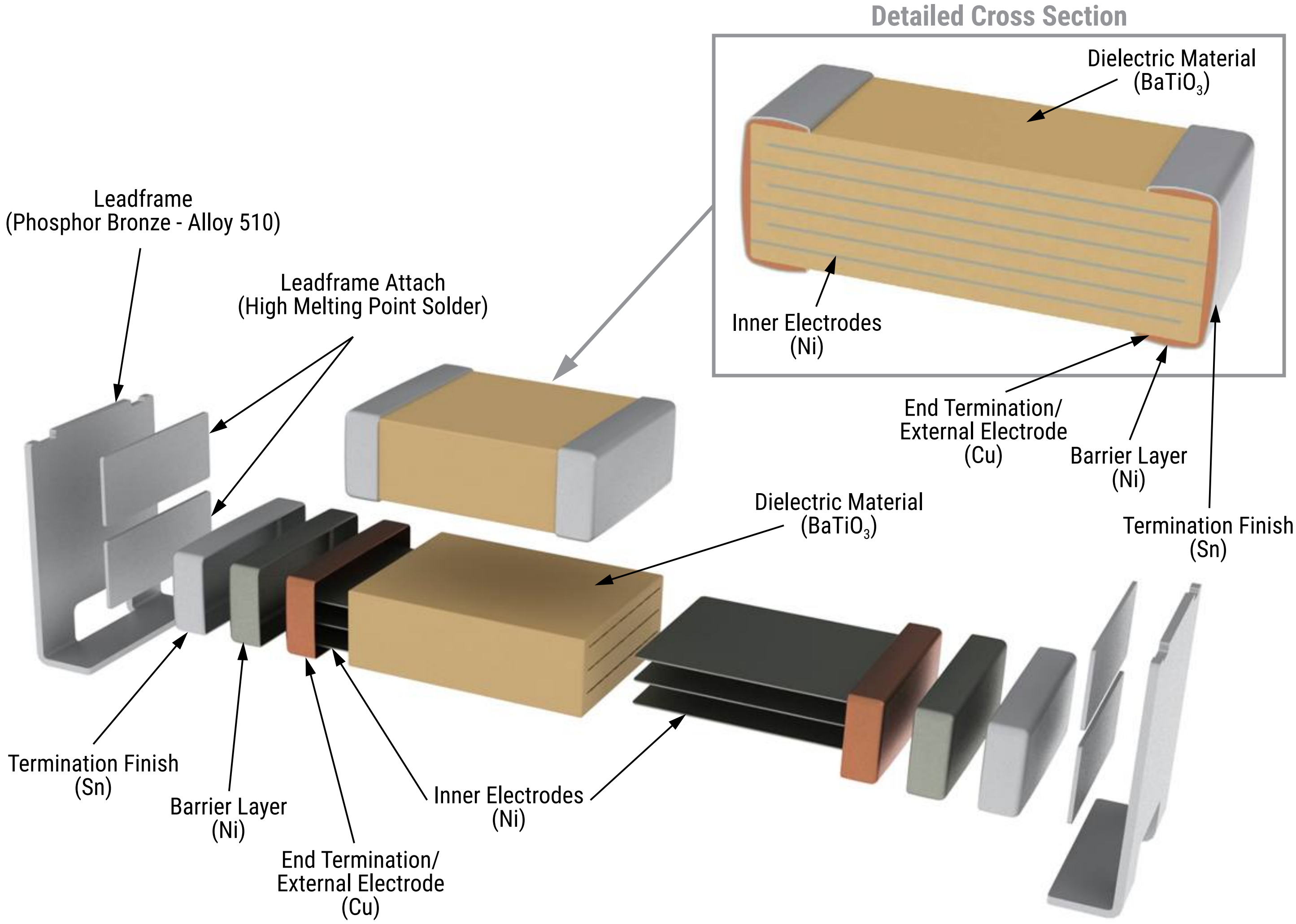
Hand soldering should be performed with care due to the difficulty in process control. If performed, care should be taken to avoid contact of the soldering iron to the capacitor body. The iron should be used to heat the solder pad, applying solder between the pad and the lead, until reflow occurs. Once 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_{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_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.



Construction



Product Marking

Laser marking option is not available on:

- C0G, 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.

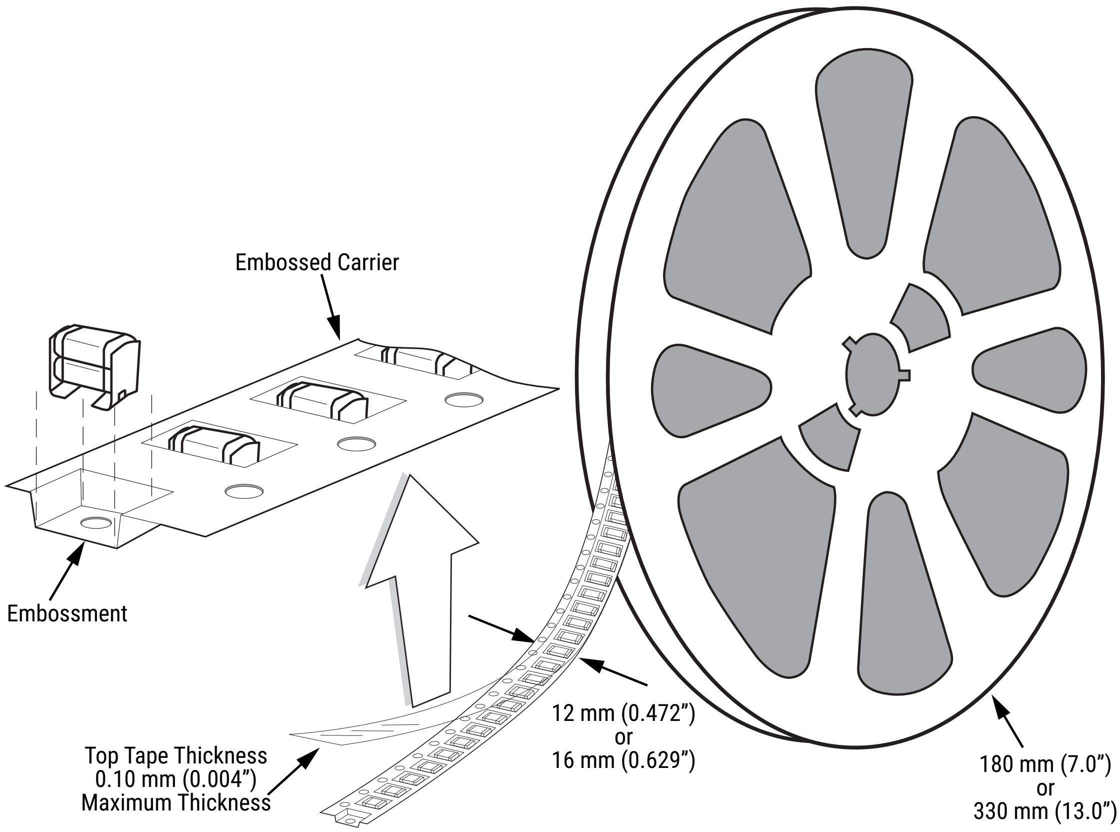


Table 4 – Carrier Tape Configuration – Embossed Plastic (mm)

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

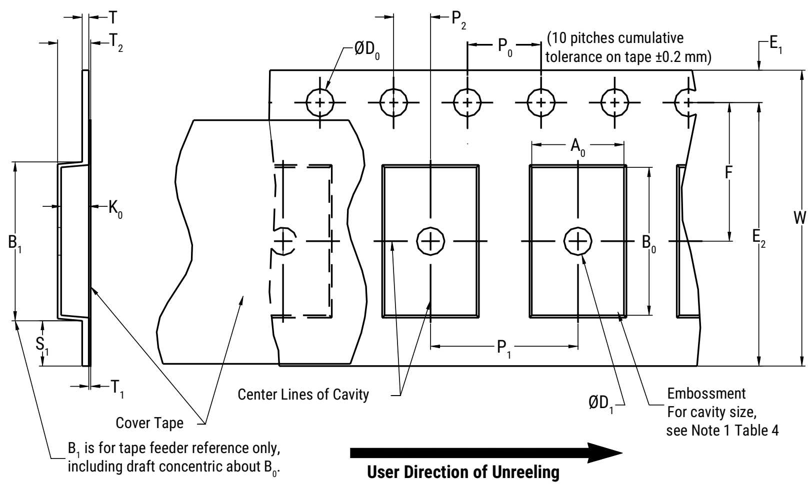


Table 5 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5+0.10/0.0-0.0 (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)			
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)	Note 5
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)	
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 < 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_1 dimension is a reference dimension for tape feeder clearance only.*
5. *The cavity defined by A_0, B_0 and K_0 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

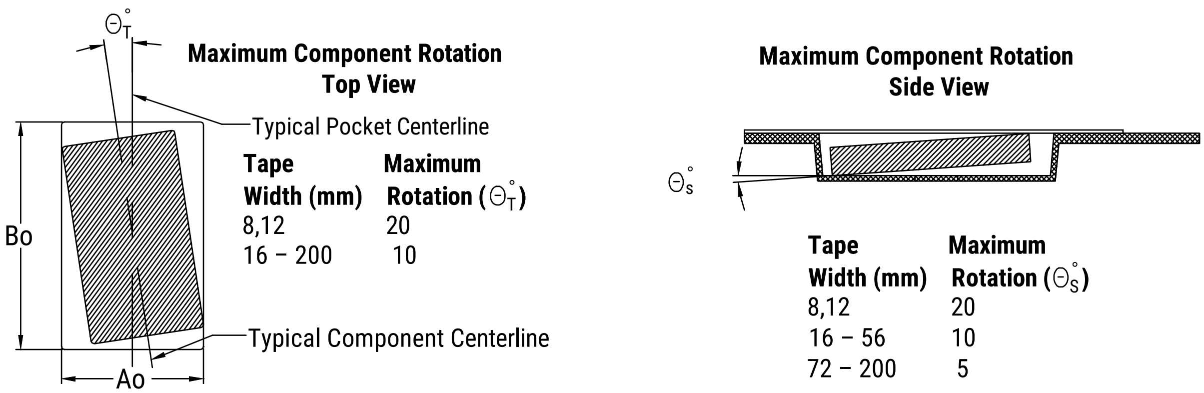


Figure 3 – Maximum Lateral Movement

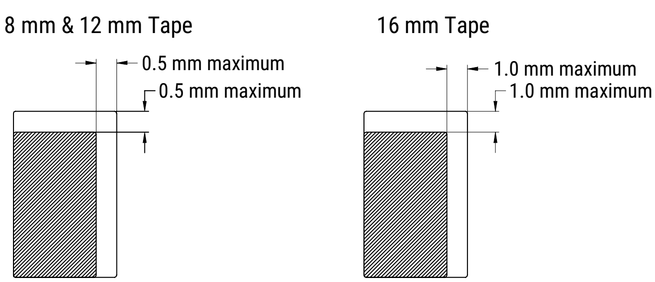


Figure 4 – Bending Radius

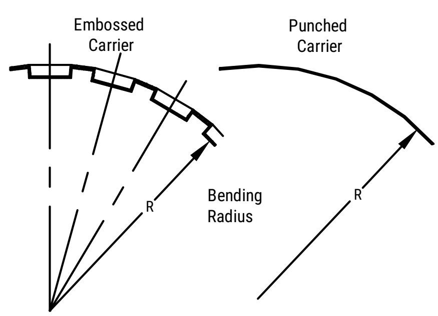
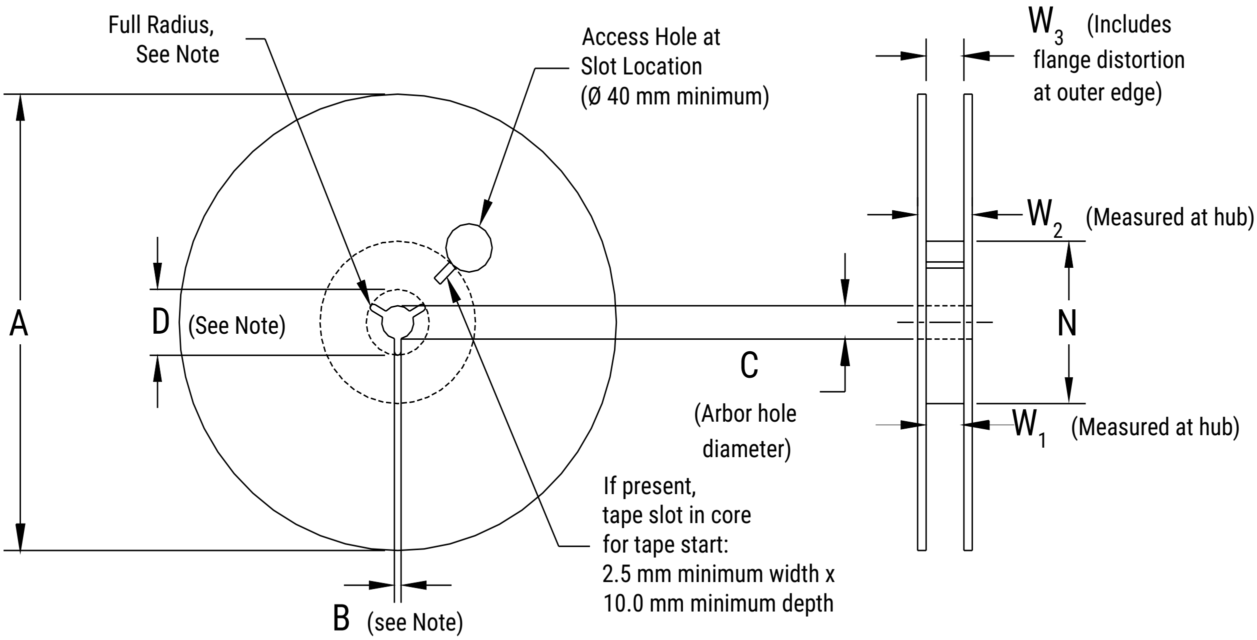


Figure 5 – Reel Dimensions



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	A	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 6 – Tape Leader & Trailer Dimensions

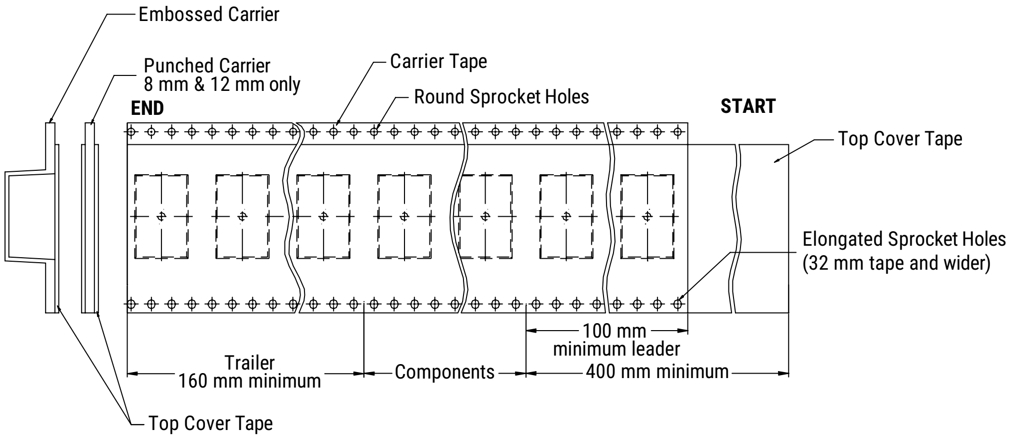
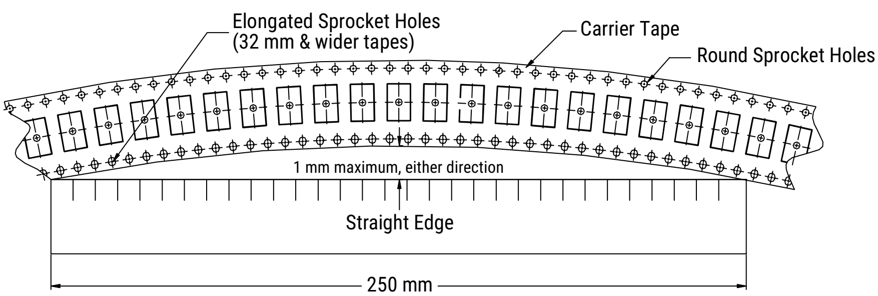


Figure 7 – Maximum Camber



KPS HT Series, High Temperature 150°C, X8L Dielectric, 10 – 50 VDC (Commercial & Automotive Grade)

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 ±15% from −55°C to +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 ±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

Ordering Information

C	2220	C	476	M	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.

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	AUTO7289

[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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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.

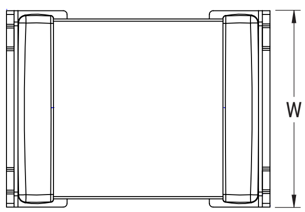
KEMET Automotive C-Spec	PPAP (Product Part Approval Process) Level				
	1	2	3	4	5
KEMET assigned[1]	●	●	●	●	●
AUTO			○		

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

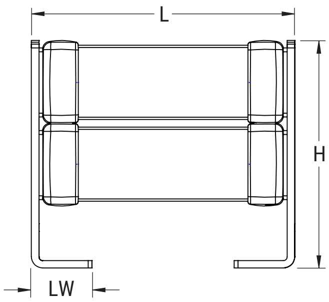
● Part number specific PPAP available
○ Product family PPAP only

Dimensions – Millimeters (Inches)

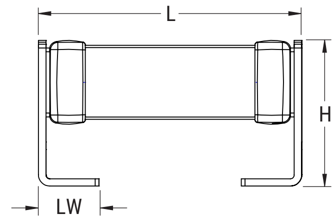
Single or Double Chip Stack



Double Chip Stack



Single Chip Stack



Number of Chips	EIA Size Code	Metric Size Code	L Length	W Width	H Height	LW Lead Width	Mounting Technique
Single	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)	Solder Reflow Only
	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)	
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)	
	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 +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.
[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 ≤ 10µF
120Hz ± 10Hz and 0.5 ± 0.1 Vrms if capacitance > 10µF
[4] To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ 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
X8L	≥ 25	All	3.0	±20%	10% of Initial Limit
	≤ 16		5.0		

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

Capacitance	Cap Code	Case Size/ Series			C1210C						C1812C					C2220C					
		Voltage Code			8	4	3	5	1	A	4	3	5	1	A	8	4	3	5	1	A
		Rated Voltage (VDC)			10	16	25	50	100	250	16	25	50	100	250	10	16	25	50	100	250
		Capacitance Tolerance			Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions																
Single Chip Stack																					
0.47 µF	474		K	M	FV	FV	FV	FV													
1.0 µF	105		K	M	FV	FV	FV	FV													
2.2 µF	225		K	M	FV	FV	FV									JP	JP	JP			
3.3 µF	335		K	M	FV	FV	FV									JP	JP	JP			
4.7 µF	475		K	M	FV	FV	FV									JP	JP	JP			
10 µF	106		K	M												JP	JP	JP			
15 µF	156		K	M												JP					
22 µF	226		K	M												JP					
Double Chip Stack																					
1.0 µF	105			M	FW	FW	FW	FW													
2.2 µF	225			M	FW	FW	FW	FW													
3.3 µF	335			M	FW	FW	FW														
4.7 µF	475			M	FW	FW	FW				GR	GR	GR			JR	JR	JR			
10 µF	106			M	FW	FW	FW									JR	JR	JR			
22 µF	226			M												JR	JR	JR			
33 µF	336			M												JR					
47 µF	476			M												JR					
Capacitance	Cap Code	Rated Voltage (VDC)			10	16	25	50	100	250	16	25	50	100	250	10	16	25	50	100	250
		Voltage Code			8	4	3	5	1	A	4	3	5	1	A	8	4	3	5	1	A
		Case Size/ Series			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

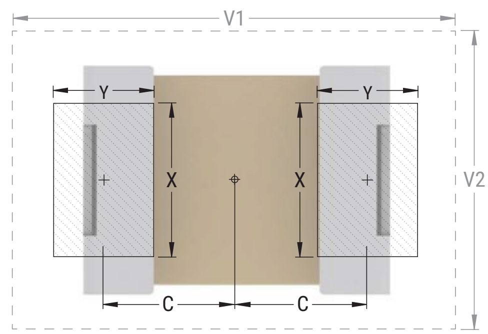
Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
FV	1210	3.35 ± 0.10	0	0	600	2,000
FW	1210	6.15 ± 0.15	0	0	300	1,000
GR	1812	5.00 ± 0.50	0	0	400	1,700
JP	2220	3.50 ± 0.30	0	0	300	1,300
JR	2220	5.00 ± 0.50	0	0	200	800

Package quantity based on finished chip thickness specifications.

Table 3 – KPS Land Pattern Design Recommendations (mm)

EIA SIZE 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.



Grid Placement Courtyard

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_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.

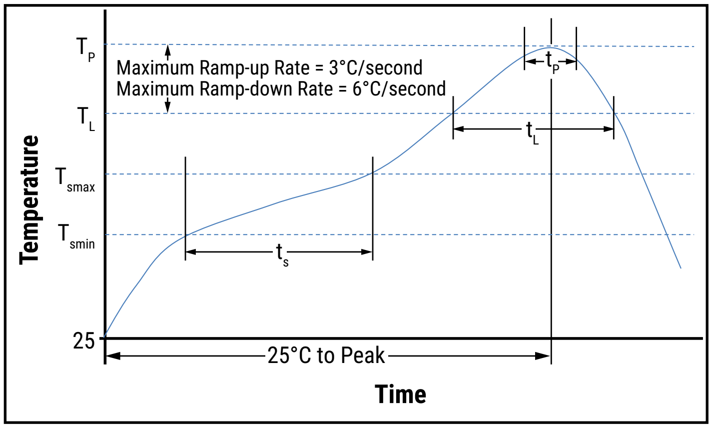


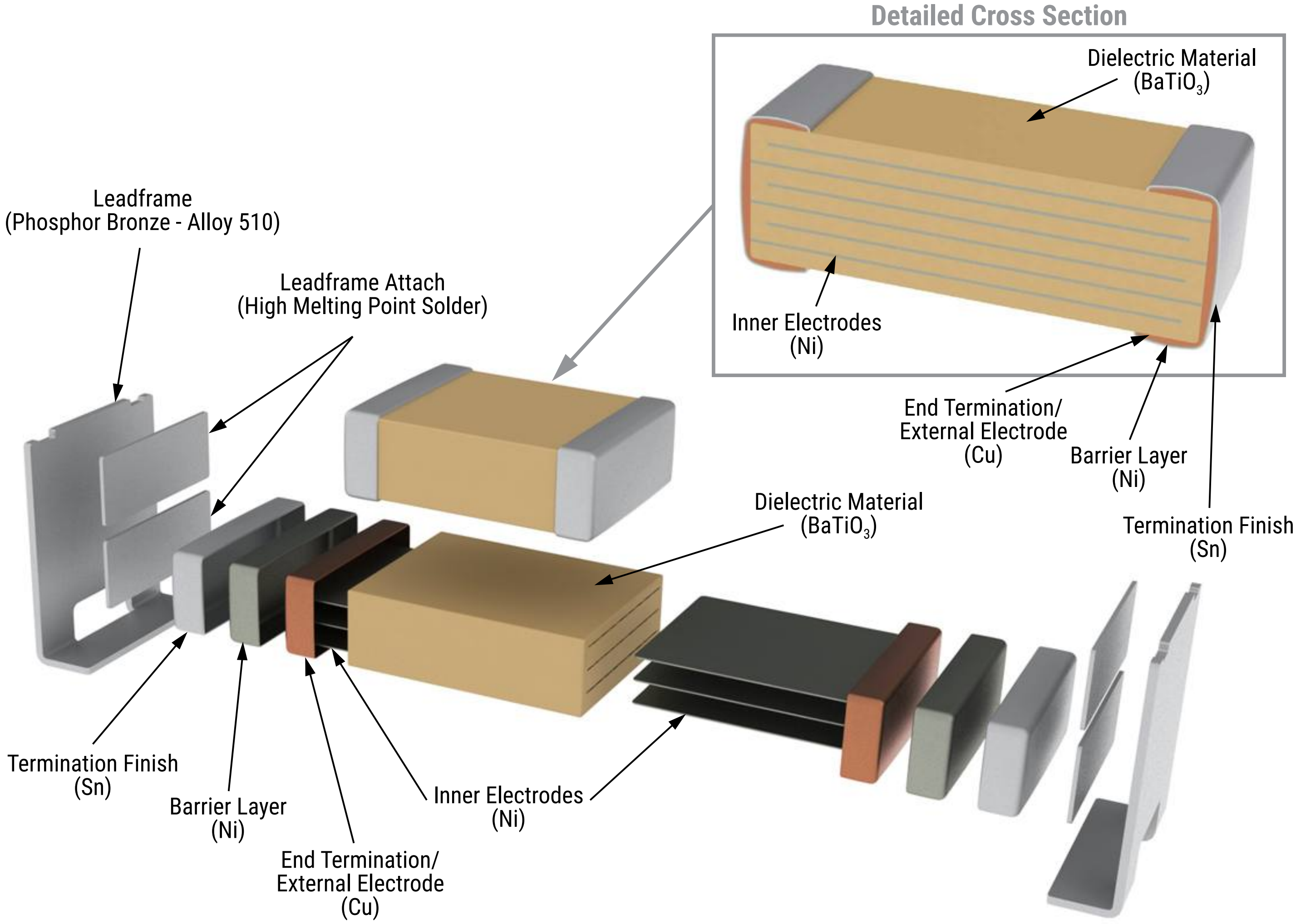
Table 4 – Performance & Reliability: Test Methods and Conditions

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
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 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.
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/+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 40ºC 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:

- C0G, 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.

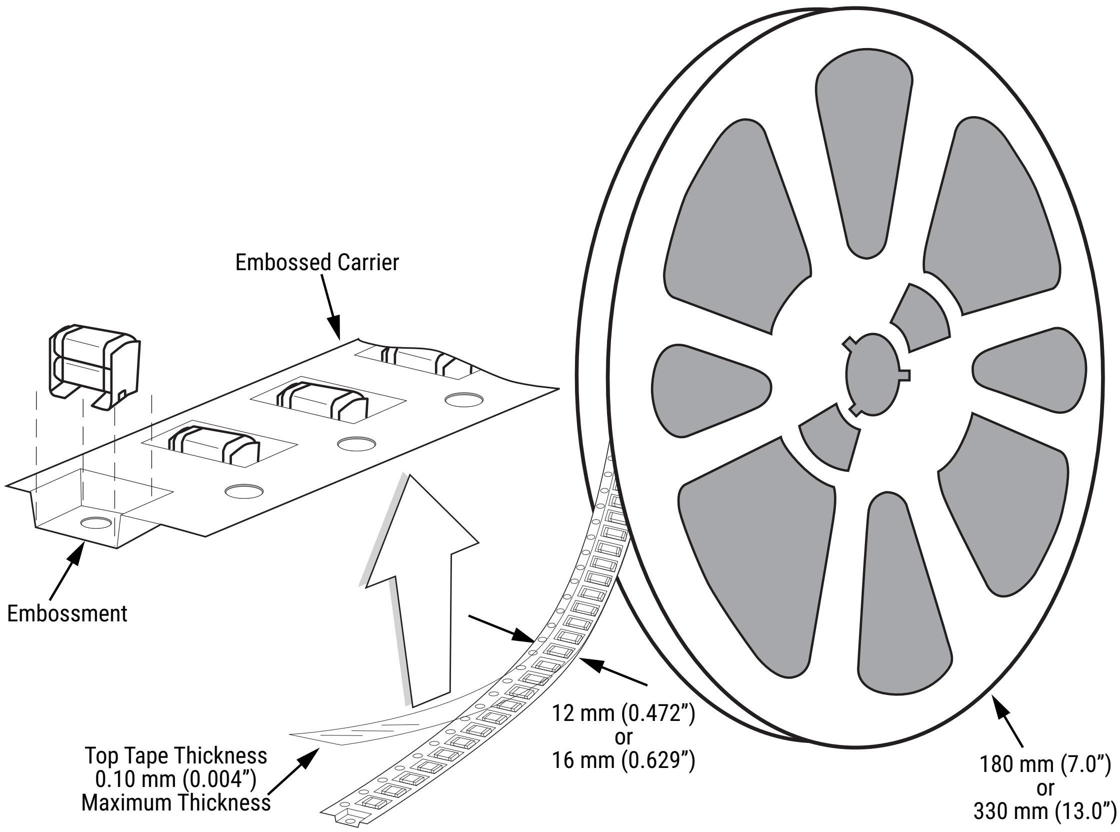


Table 4 – Carrier Tape Configuration – Embossed Plastic (mm)

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

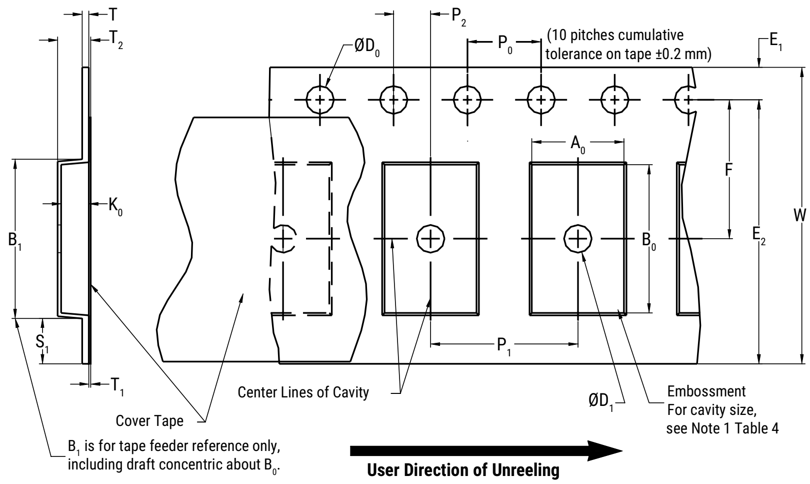


Table 5 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5+0.10/0.0-0.0 (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)			
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)	Note 5
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)	
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 < 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_1 dimension is a reference dimension for tape feeder clearance only.*
5. *The cavity defined by A_0, B_0 and K_0 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

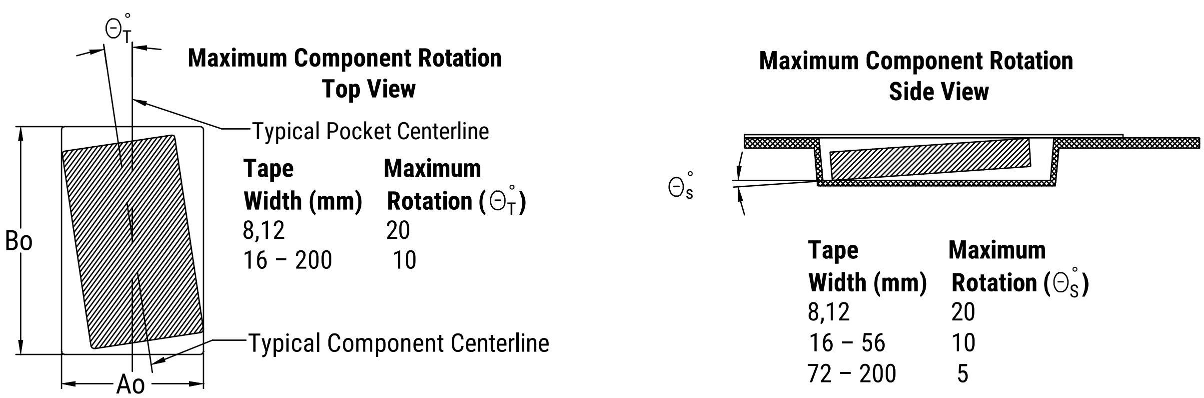


Figure 3 – Maximum Lateral Movement

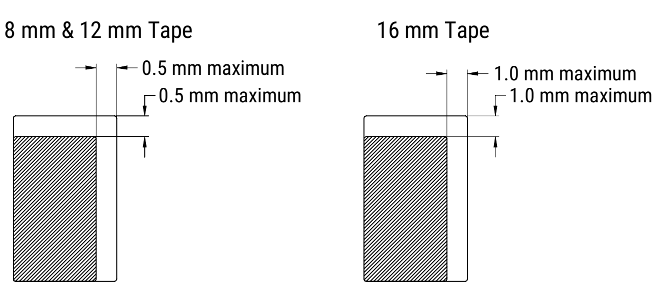


Figure 4 – Bending Radius

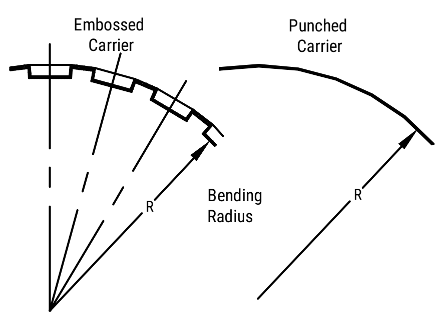
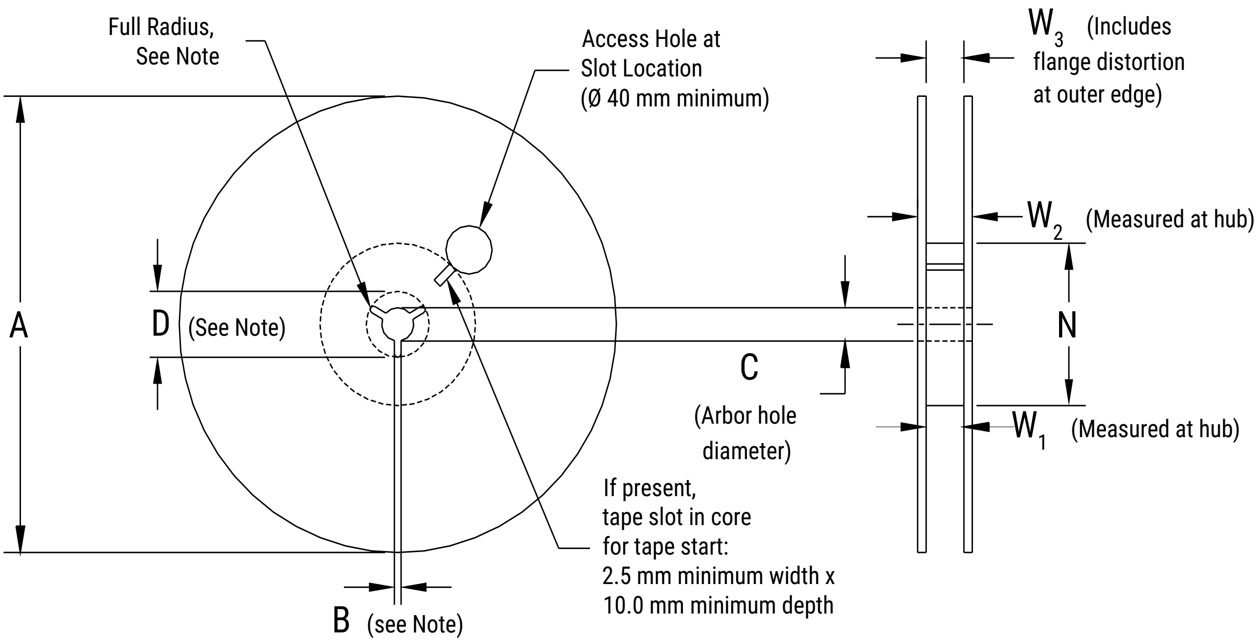


Figure 5 – Reel Dimensions



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	A	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 6 – Tape Leader & Trailer Dimensions

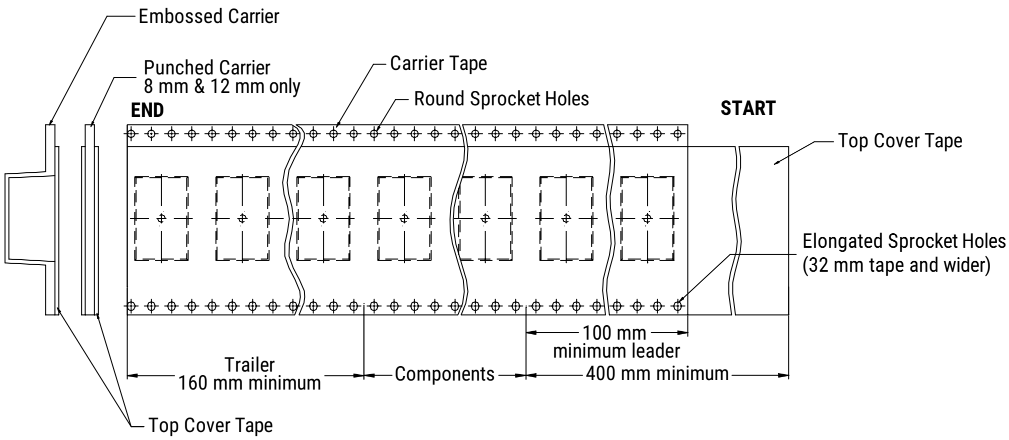
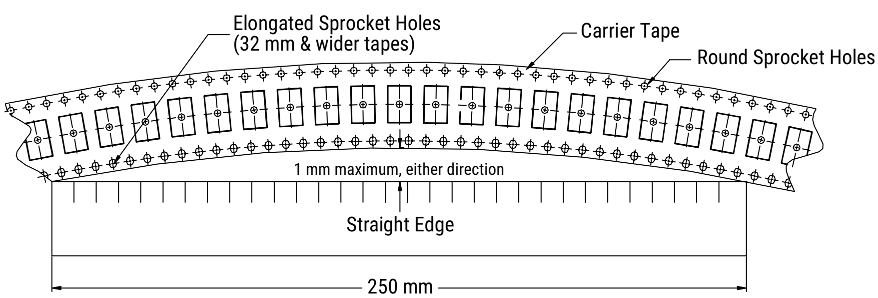


Figure 7 – Maximum Camber



Flexible Termination System (FT-CAP), C0G Dielectric, 10 – 250 VDC (Commercial & Automotive Grade)

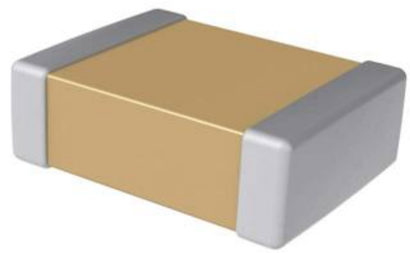
Overview

KEMET's Flexible Termination (FT-CAP) Multilayer Ceramic Capacitor in C0G 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 C0G 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/ºC 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

C	1206	X	563	J	3	G	A	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 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 = ±0.10 pF C = ±0.25 pF D = ±0.5 pF F = ±1% G = ±2% J = ±5% K = ±10% M = ±20%	8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 2 = 200 A = 250	G = C0G	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)
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/2mm pitch[2]	7081
13" Reel/Unmarked/2mm pitch[2]	7082
Automotive 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 μF
- 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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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:

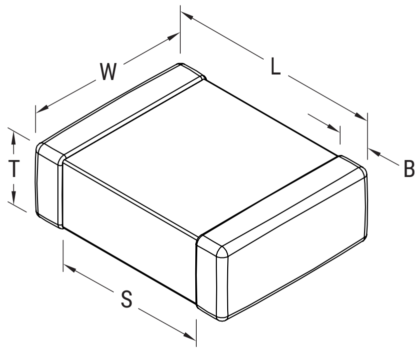
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

[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)	See Table 2 for Thickness	0.45 (0.018) ±0.15 (0.006)	0.58 (0.023)	Solder Wave or Solder Reflow
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)	
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	
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
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)		
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)		

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 ≤ 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 MΩ-µF value by the capacitance and compare to GΩ 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
C0G	All	All	0.5	0.3% or ±0.25 pF	10% of Initial Limit

Table 1A – Capacitance Range/Selection Waterfall (0603 – 1206 Case Sizes)

Capacitance	Cap Code	Case Size/Series								C0603X							C0805X							C1206X						
		Voltage Code								8	4	3	5	1	2	A	8	4	3	5	1	2	A	8	4	3	5	1	2	A
		Rated Voltage (VDC)								10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																				
0.50 & 0.75 pF	508 & 758	B	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
10 - 91 pF*	100 - 910*				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
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*				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
200 - 300 pF*	201 - 301*				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
330 pF	331				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
360 pF	361				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
390 pF	391				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
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	471				F	G	J	K	M	CJ	CJ	CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	DD	DD	EQ	EQ	EQ	EQ	EQ	EQ	EQ
510 pF	511				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
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				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
680 pF	681				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
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	821				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
910 pF	911				F	G	J	K	M	CJ	CJ	CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DD	DD	DD	EQ	EQ	EQ	EQ	EQ	EQ	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	EQ	EQ	EQ	EQ	EQ	EQ
1,100 pF	112				F	G	J	K	M	CJ	CJ	CJ	CJ	CJ	CH	CH	DR	DR	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ
1,200 pF	122				F	G	J	K	M	CJ	CJ	CJ	CJ	CJ	CH	CH	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	152				F	G	J	K	M	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	CJ	CJ	CJ	CJ	CH	CH	DD	DD	DD	DD	DD	DR	DR	EQ	EQ	EQ	EQ	ES	ES	ES
1,800 pF	182				F	G	J	K	M	CJ	CJ	CJ	CJ	CJ	CH	CH	DD	DD	DD	DD	DD	DR	DR	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	CH	CH	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	DR	EQ	EQ	EQ	EQ	ER	ER	ER
2,700 pF	272				F	G	J	K	M	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	ER	ER	ER
3,000 pF	302				F	G	J	K	M	CJ	CJ	CJ	CJ	CJ			DD	DD	DD	DD	DR	DR	DR	ER	ER	ER	ER	ER	EQ	EQ
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	K	M	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	DS	DR	DD	DD	ER	ER	ER	ER	ER	EQ	EQ
4,700 pF	472				F	G	J	K	M	CJ	CJ	CJ	CJ	CJ			DS	DS	DS	DS	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	DS	DS	DR	DD	DD	ES	ES	ES	ES	ES	EQ	EQ
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	K	M	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	752				F	G	J	K	M	CJ	CJ	CJ					DR	DR	DR	DR	DR	DG	DG	EQ	EQ	EQ	EQ	EQ	EQ	EQ
8,200 pF	822				F	G	J	K	M	CJ	CJ	CJ					DR	DR	DR	DR	DR	DG	DG	ER	ER	ER	ER	EQ	ER	ER
9,100 pF	912				F	G	J	K	M	CJ	CJ	CJ					DR	DR	DR	DR	DR			ER	ER	ER	ER	EQ	ER	ER
10,000 pF	103				F	G	J	K	M	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
18,000 pF	183				F	G	J	K	M								DR	DR	DR	DD				EQ	EQ	EQ	EQ	EQ	EH	EH
22,000 pF	223				F	G	J	K	M								DD	DD	DD	DF				EQ	EQ	EQ	EQ	ER	EH	EH
27,000 pF	273				F	G	J	K	M								DF	DF	DF					EQ	EQ	EQ	EQ	ET		
33,000 pF	333				F	G	J	K	M								DG	DG	DG					EQ	EQ	EQ	EQ	ET		
39,000 pF	393				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				F	G	J	K	M															ES	ES	ES	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				
Capacitance	Cap Code	Rated Voltage (VDC)								10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250
		Voltage Code								8	4	3	5	1	2	A	8	4	3	5	1	2	A	8	4	3	5	1	2	A
		Case Size/Series								C0603X							C0805X							C1206X						

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)

Capacitance	Cap Code	Case Size/Series								C1210X							C1812X				C1825X				C2220X				C2225X			
		Voltage Code								8	4	3	5	1	2	A	5	1	2	A	5	1	2	A	5	1	2	A	5	1	2	A
		Rated Voltage (VDC)								10	16	25	50	100	200	250	50	100	200	250	50	100	200	250	50	100	200	250	50	100	200	250
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																						
1.0 - 9.1 pF*	109 - 919*	B	C	D						FN	FN	FN	FN	FN	FN	FN																
10 - 91 pF*	100 - 910*				F	G	J	K	M	FN	FN	FN	FN	FN	FN	FN																
100 - 430 pF*	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	M	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				F	G	J	K	M	FN	FN	FN	FN	FN	FE	FE	GB	GB	GB	GB												
2,000 pF	202				F	G	J	K	M	FN	FN	FN	FN	FQ	FE	FE	GB	GB	GB	GB												
2,200 pF	222				F	G	J	K	M	FN	FN	FN	FN	FQ	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	M	FN	FN	FN	FN	FQ	FQ	FQ	GB	GB	GB	GB												
3,000 pF	302				F	G	J	K	M	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												
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	HB	HB	HB	HB					KE	KE	KE	KE
5,100 pF	512				F	G	J	K	M	FN	FN	FN	FN	FZ	FZ	FZ													KE	KE	KE	KE
5,600 pF	562				F	G	J	K	M	FN	FN	FN	FN	FZ	FZ	FZ	GB	GB	GH	GH	HB	HB	HB	HB					KE	KE	KE	KE
6,200 pF	622				F	G	J	K	M	FN	FN	FN	FN	FZ	FN	FN													KE	KE	KE	KE
6,800 pF	682				F	G	J	K	M	FN	FN	FN	FN	FZ	FN	FN	GB	GB	GJ	GJ	HB	HB	HB	HB	JE	JE	JB		KE	KE	KE	KE
7,500 pF	752				F	G	J	K	M	FQ	FQ	FQ	FQ	FQ	FN	FN													KE	KE	KE	KE
8,200 pF	822				F	G	J	K	M	FQ	FQ	FQ	FQ	FQ	FN	FN	GB	GH	GB	GB	HB	HB	HB	HB	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	HB	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	M	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	273				F	G	J	K	M	FN	FN	FN	FN	FN	FZ	FZ	GB	GB	GB	GB	HB	HG			JE	JB	JB		KE	KE		
33,000 pF	333				F	G	J	K	M	FN	FN	FN	FN	FN	FU	FU	GB	GB	GB	GB					JB	JB	JB		KE			
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	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					JB	JB	JB					
0.10 µF	104				F	G	J	K	M	FE	FE	FE	FZ	FM			GB	GD	GM	GM					JB	JB	JD					
0.12 µF	124				F	G	J	K	M	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	G	J	K	M	FK	FK	FK					GK								JB	JD						
0.27 µF	274				F	G	J	K	M																JB	JF						
0.33 µF	334				F	G	J	K	M																JD	JG						
0.39 µF	394				F	G	J	K	M																JG							
0.47 µF	474				F	G	J	K	M																JG							
Capacitance	Cap Code	Rated Voltage (VDC)								10	16	25	50	100	200	250	50	100	200	250	50	100	200	250	50	100		200	50	100	200	250
		Voltage Code								8	4	3	5	1	2	A	5	1	2	A	5	1	2	A	5	1		2	5	1	2	A
		Case Size/Series								C1210X							C1812X				C1825X				C2220X				C2225X			

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 Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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
FK	1210	2.10 ± 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
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 Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[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

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		Packaging Quantities (pieces/unit packaging)	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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.*

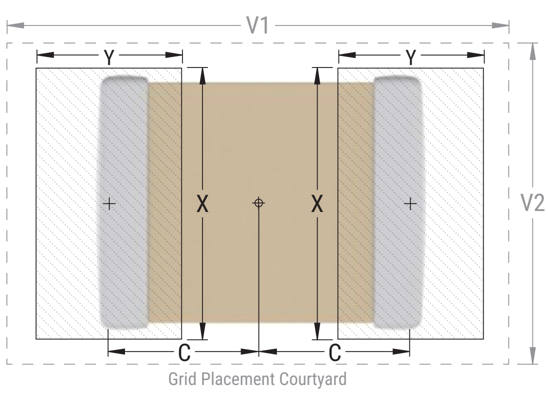
[2] *A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard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

Table 3 – 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)				
		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	
	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.

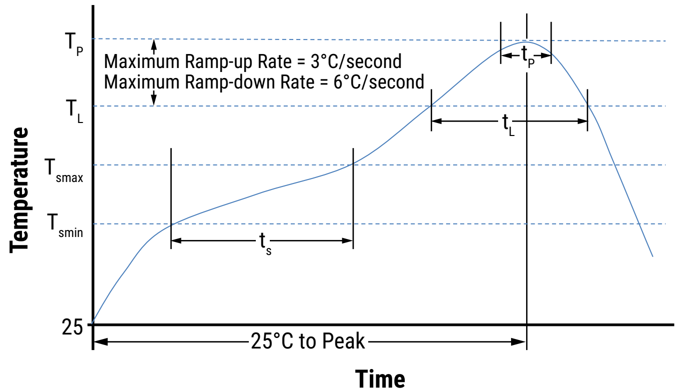


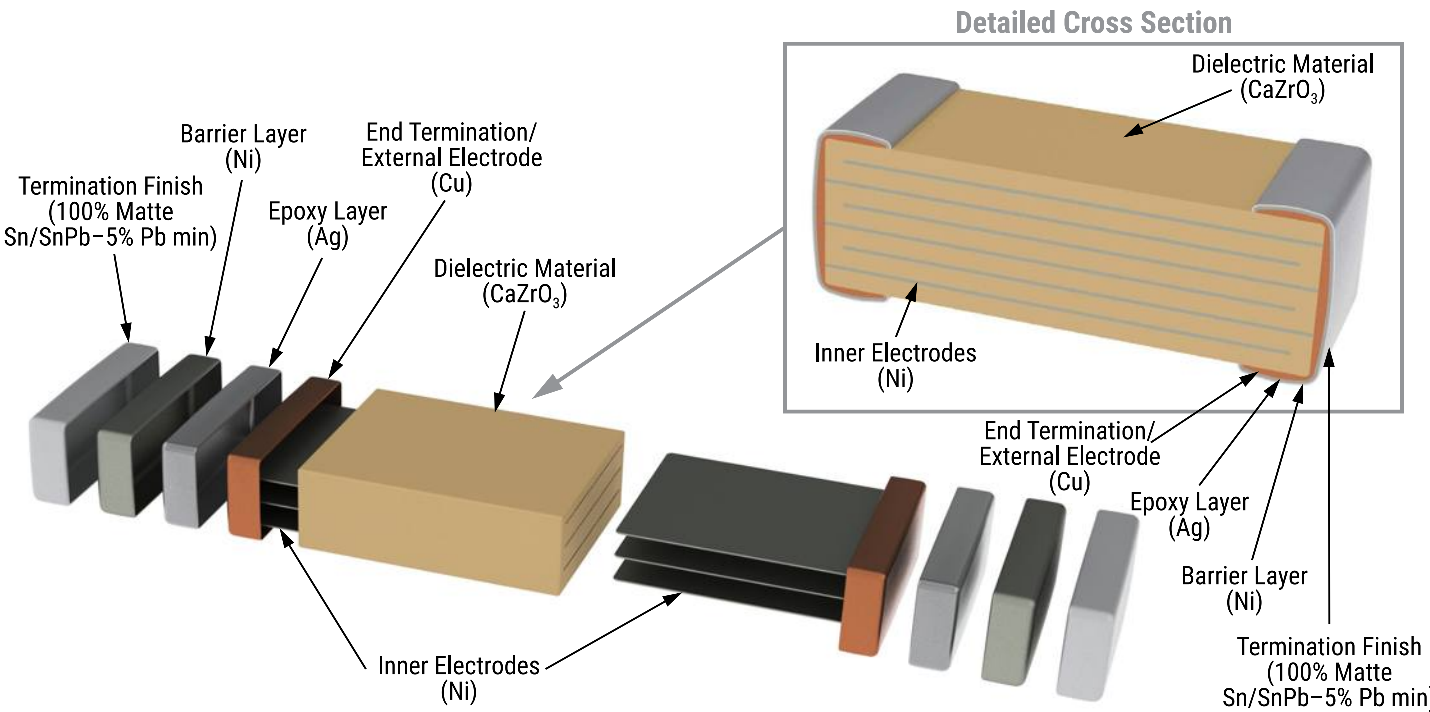
Table 4 – Performance & Reliability: Test Methods and Conditions

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 C0G. 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. 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 40ºC 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)

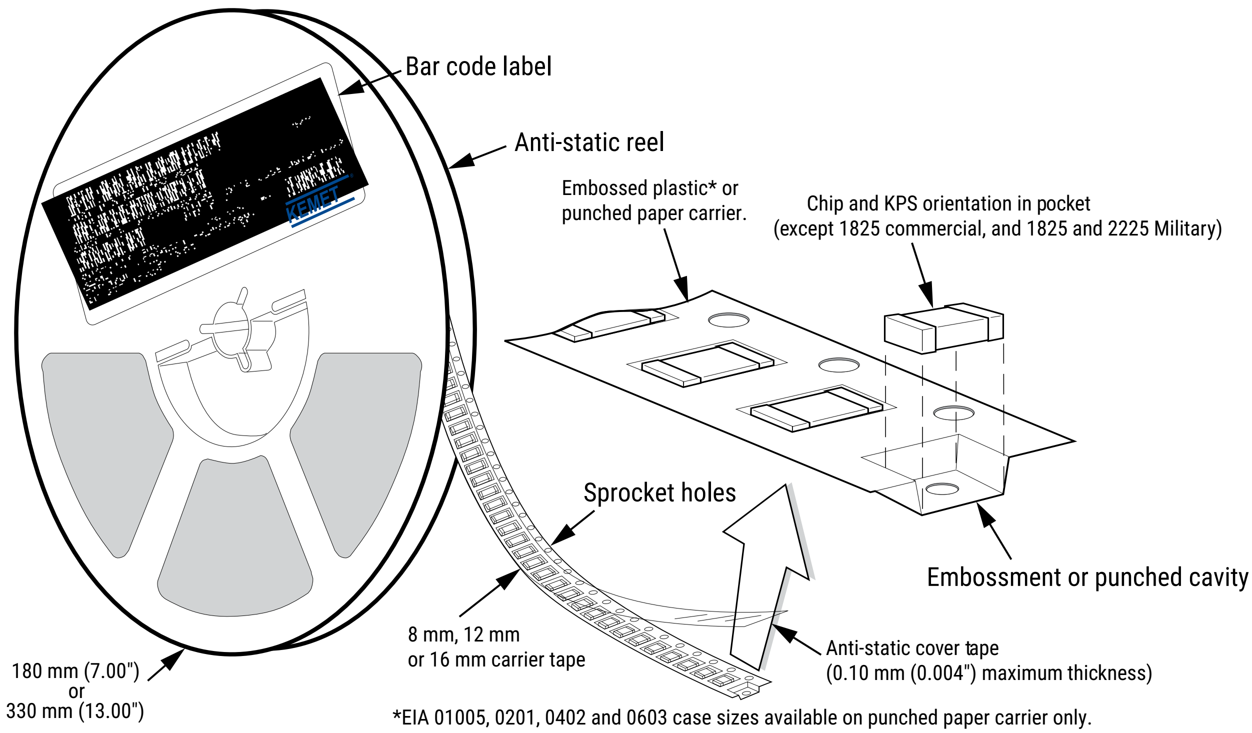
Laser marking option is not available on:

- C0G, 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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

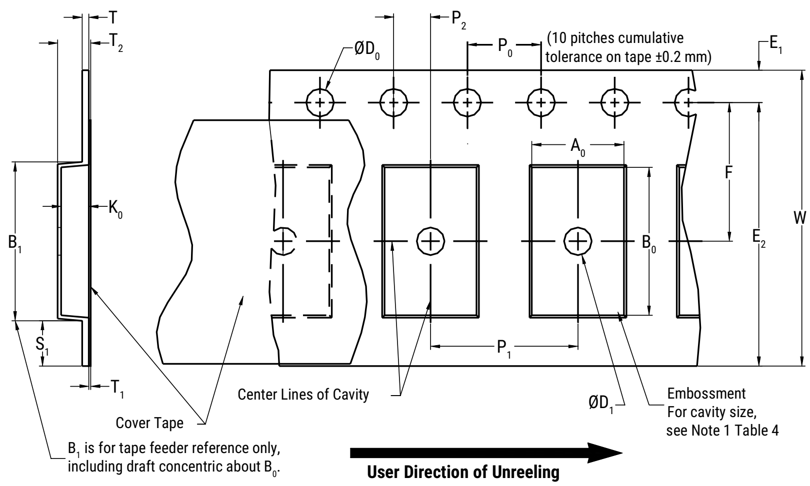


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +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)			
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)	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 S_1 < 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_0, B_0 and K_0 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

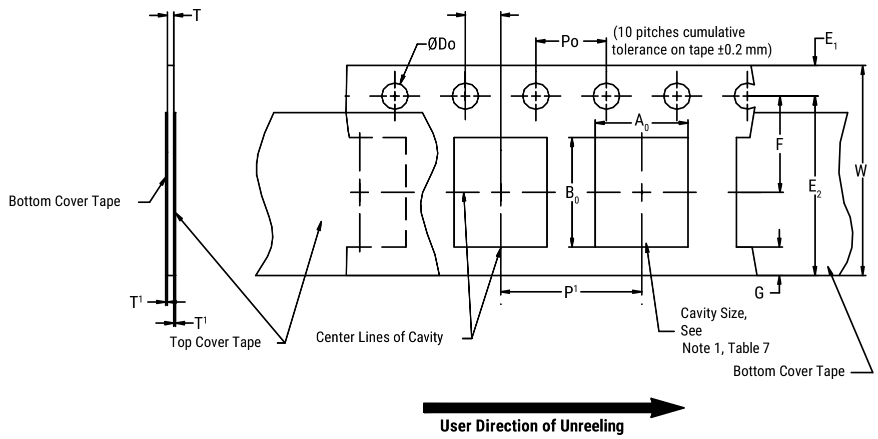


Table 7 – Punched (Paper) Carrier Tape Dimensions

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_0B_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_0, B_0 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.)

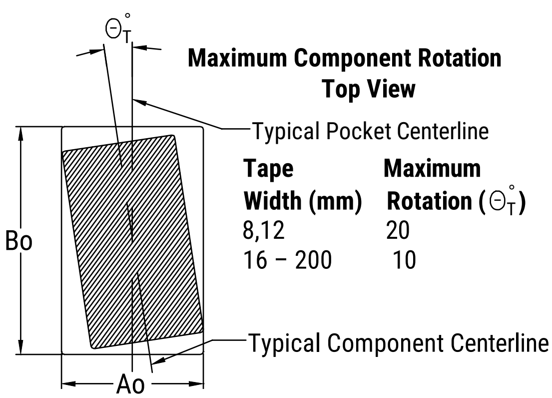
Packaging Information Performance Notes

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



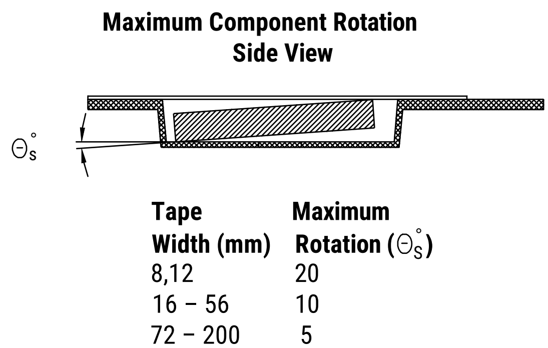


Figure 4 – Maximum Lateral Movement

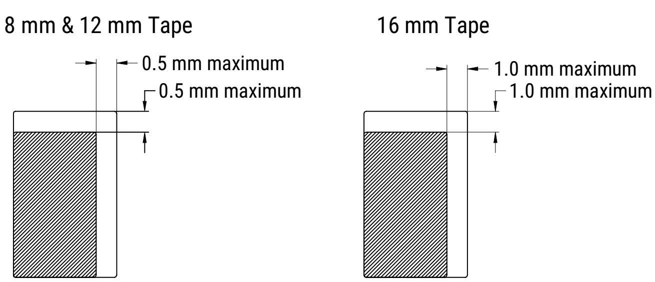


Figure 5 – Bending Radius

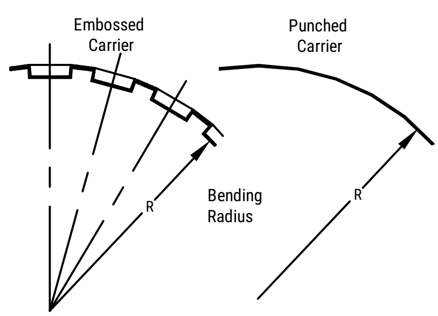
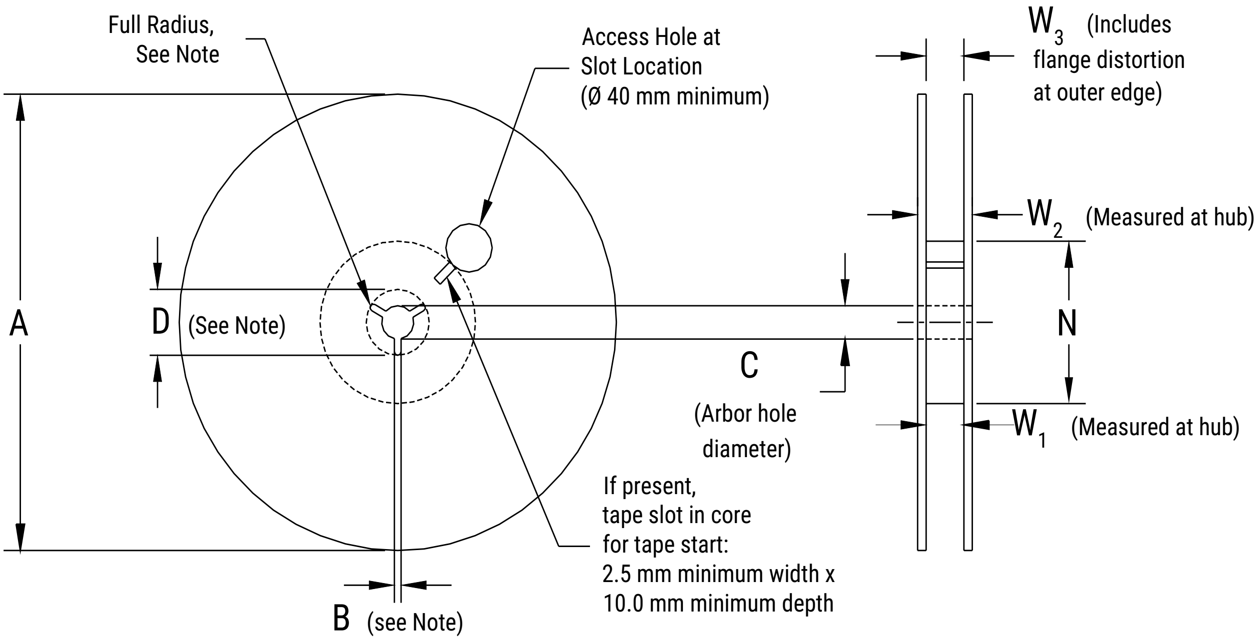


Figure 6 – Reel Dimensions



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	A	B Minimum	C	D Minimum
8 mm 12 mm 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	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

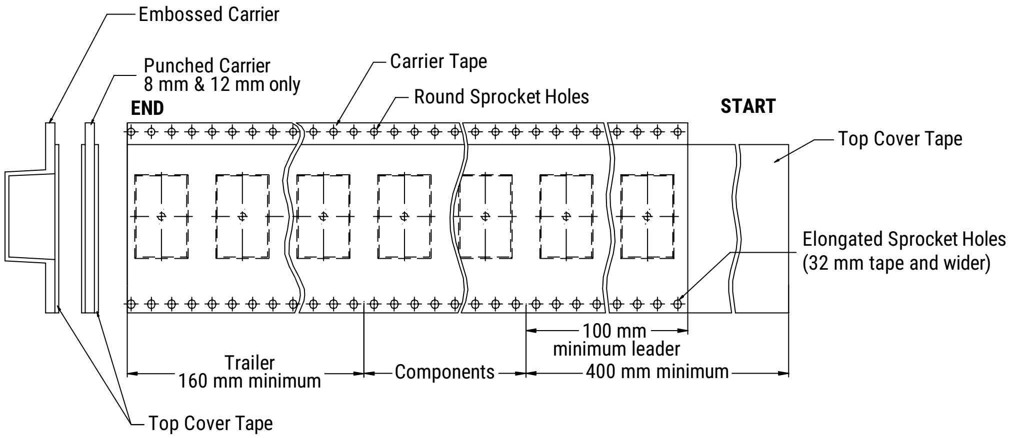
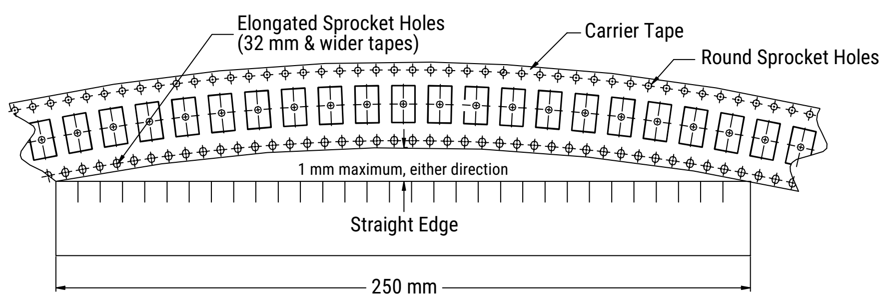


Figure 8 – Maximum Camber



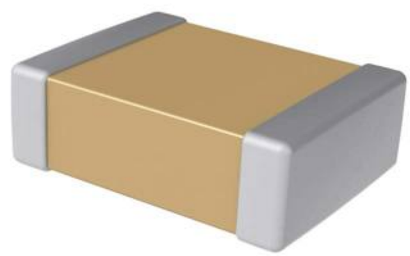
Flexible Termination System (FT-CAP), Ultra-Stable X8R Dielectric, 10 – 100 VDC (Commercial & Automotive Grade)

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.
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 ±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

C	1206	X	104	J	3	H	A	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 = ±0.10 pF C = ±0.25 pF D = ±0.5 pF F = ±1% G = ±2% J = ±5% K = ±10% M = ±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)
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	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 +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, ±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
- 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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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:

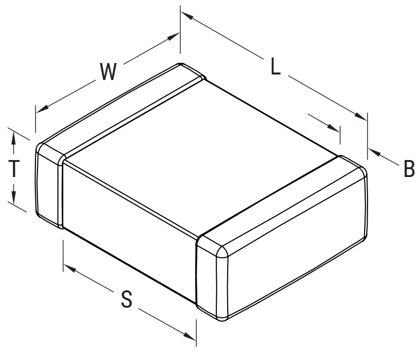
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

[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)	See Table 2 for Thickness	0.45 (0.018) ±0.15 (0.006)	0.58 (0.023)	Solder Wave or Solder Reflow
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)	
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	
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
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)		

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.*

[2] *Capacitance and dissipation factor (DF) measured under the following conditions:*
1 MHz ±100 kHz and 1.0 ±0.2 V_{rms} if capacitance ≤ 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 MΩ-µF value by the capacitance and compare to GΩ 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)

Capacitance	Cap Code	Case Size/Series								C0603C					C0805C					C1206C					C1210C					C1812C	
		Voltage Code								8	4	3	5	1	8	4	3	5	1	8	4	3	5	1	8	4	3	5	1	5	1
		RatedVoltage (VDC)								10	16	25	50	100	10	16	25	50	100	10	16	25	50	100	10	16	25	50	100	50	100
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Packaging Specs for Chip Thickness Dimensions																					
0.50 & 0.75 pF	508 & 758	B	C	D						CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR												
0.75 pF	758	B	C	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	119	B	C	D						CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN		
1.2 pF	129	B	C	D						CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	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	B	C	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	B	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						CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN		
2.2 pF	229	B	C	D						CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN		
2.4 pF	249	B	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	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	309	B	C	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		
3.6 pF	369	B	C	D						CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN		
3.9 pF	399	B	C	D						CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN		
4.3 pF	439	B	C	D						CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN		
4.7 pF	479	B	C	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	B	C	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	B	C	D						CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN		
6.8 pF	689	B	C	D						CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN		
7.5 pF	759	B	C	D						CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN		
8.2 pF	829	B	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	B	C	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	110				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		
12 pF	120				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		
13 pF	130				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		
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	M	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	220				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		
24 pF	240				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		
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	M	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		
39 pF	390				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 pF	430				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		
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	M	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	M	CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN		
62 pF	620				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		
68 pF	680				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		
75 pF	750				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		
82 pF	820				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		
91 pF	910				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		
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	CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN		
130 pF	131				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		
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	M	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				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		
Capacitance	Cap Code	Rated Voltage (VDC)								10	16	25	50	100	10	16	25	50	100	10	16	25	50	100	10	16	25	50	100	50	100
		Voltage Code								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								C0603C					C0805C					C1206C					C1210C					C1812C	

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

Capacitance	Cap Code	Case Size/Series	C0603C					C0805C					C1206C					C1210C					C1812C	
		Voltage Code	8	4	3	5	1	8	4	3	5	1	8	4	3	5	1	8	4	3	5	1	5	1
		RatedVoltage (VDC)	10	16	25	50	100	10	16	25	50	100	10	16	25	50	100	10	16	25	50	100	50	100
		Capacitance Tolerance	Product Availability and Chip Thickness Codes See Packaging Specs for Chip Thickness Dimensions																					
220 pF	221	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		
240 pF	241	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		
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	331	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		
360 pF	361	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		
390 pF	391	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		
430 pF	431	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		
470 pF	471	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
510 pF	511	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
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 K M	CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN	GB	GB
680 pF	681	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
750 pF	751	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
820 pF	821	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
910 pF	911	F G J K M	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 M	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	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
1,300 pF	132	F G J K M	CJ	CJ	CJ	CJ	CJ	DD	DD	DD	DD	DD	EQ	EQ	EQ	EQ	ER	FN	FN	FN	FN	FN	GB	GB
1,500 pF	152	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
1,600 pF	162	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
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 K M	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 M	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		
2,700 pF	272	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	GB	GB
3,000 pF	302	F G J K M	CJ	CJ	CJ	CJ	CJ	DD	DD	DR	DR	DR	ER	ER	ER	ER	ER	FN	FN	FN	FN	FQ		
3,300 pF	332	F G J K 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 K M	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 K M	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	512	F G J K M	CJ	CJ	CJ	CJ		DS	DS	DR	DR	DR	ES	ES	ES	ES	ES	FN	FN	FN	FN	FZ		
5,600 pF	562	F G J K M	CJ	CJ	CJ	CJ		DR	DR	DR	DR	DR	ES	ES	ES	ES	ES	FN	FN	FN	FN	FZ	GB	GB
6,200 pF	622	F G J K M	CJ	CJ	CJ	CJ		DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FZ		
6,800 pF	682	F G J K M	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 K M	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 M	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		
10,000 pF	103	F G J K M	CJ	CJ	CJ			DR	DR	DR	DR	DD	EQ	EQ	EQ	EQ	EQ	FA	FA	FA	FA	FA	GB	GH
12,000 pF	123	F G J K M						DR	DR	DR	DR	DS	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN	GB	GG
15,000 pF	153	F G J K M						DR	DR	DR	DD	DG	EQ	EQ	EQ	EQ	EQ	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 K M						DD	DD	DD	DF		EQ	EQ	EQ	EQ	ER	FN	FN	FN	FN	FN	GB	GB
27,000 pF	273	F G J K M						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	F G J K M											ER	ER	ER	ET	EH	FN	FN	FN	FN	FE	GB	GB
56,000 pF	563	F G J K M											ES	ES	ES	EF		FN	FN	FN	FN	FA	GB	GB
68,000 pF	683	F G J K M											EF	EF	EF	EH		FN	FN	FN	FQ	FZ	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 K M											EH	EH	EH			FE	FE	FE	FZ	FM	GB	GD
120,000 pF	124	F G J K M																FZ	FZ	FZ	FU		GB	GH
150,000 pF	154	F G J K M																FU	FU	FU	FM		GD	GN
180,000 pF	184	F G J K M																FJ	FJ	FJ			GH	
220,000 pF	224	F G J K M																					GK	
Capacitance	Cap Code	Rated Voltage (VDC)	10	16	25	50	100	10	16	25	50	100	10	16	25	50	100	10	16	25	50	100	50	100
		Voltage Code	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	C0603C					C0805C					C1206C					C1210C					C1812C	

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

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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 Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[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

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		Packaging Quantities (pieces/unit packaging)	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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.

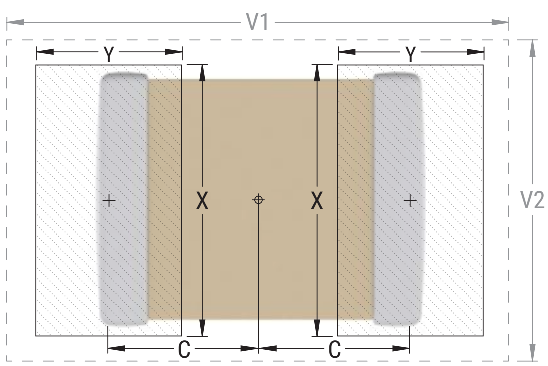
[2] A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and automotive grade products). The 15th through 22nd character positions of the ordering code should be left blank. All products ordered without a packaging C-Spec will default to our standard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

Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC–7351 (mm)

EIA Size 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)				
		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	
	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.

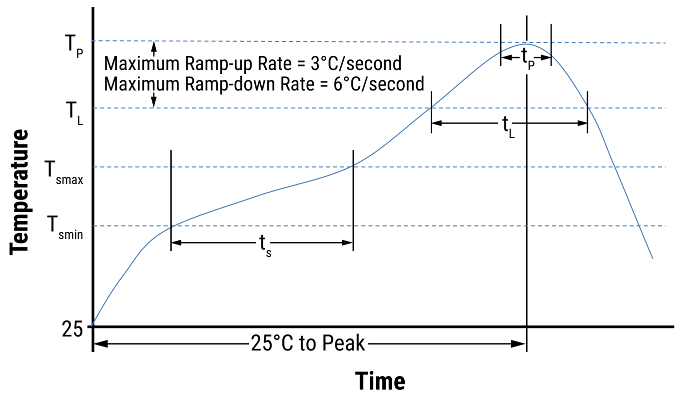


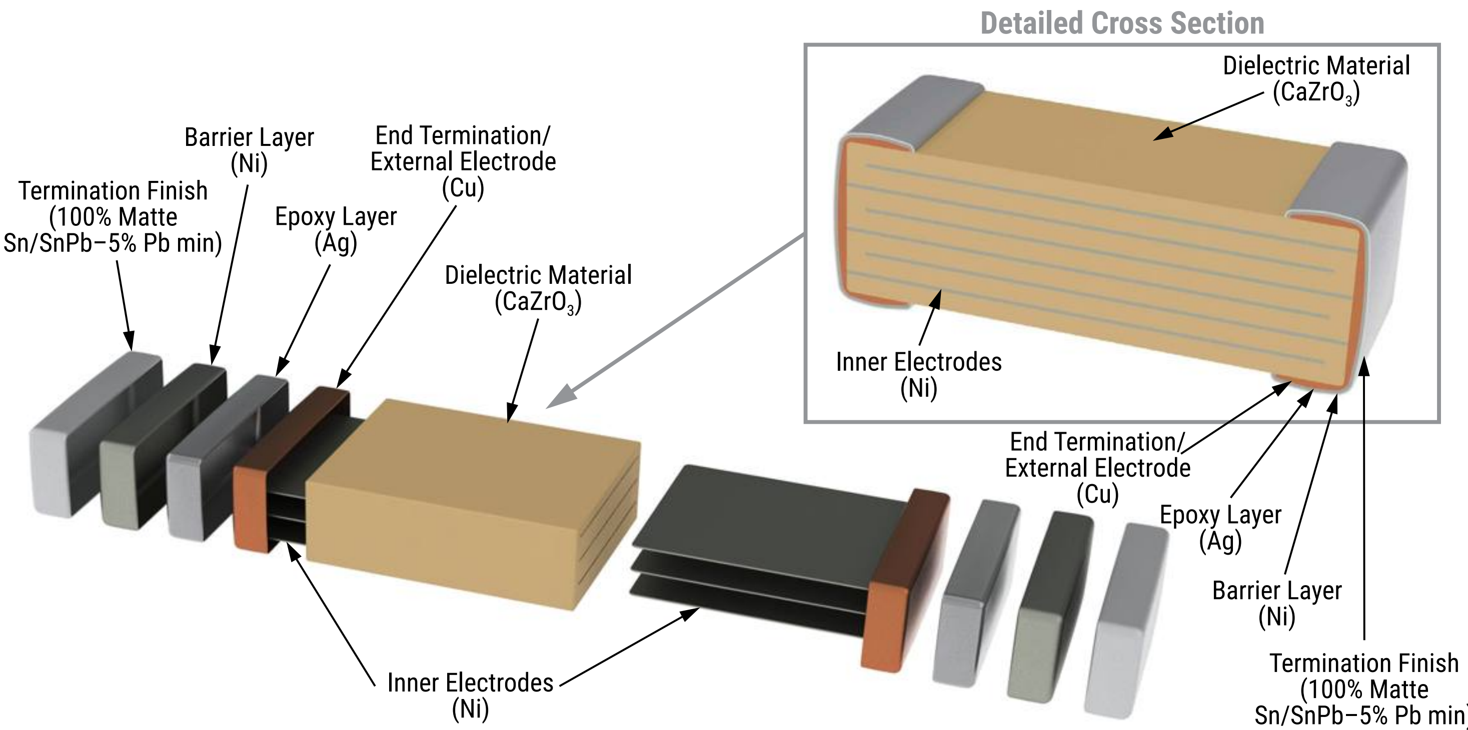
Table 4 – Performance & Reliability: Test Methods & Conditions

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 C0G. 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 +150°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 100K 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/+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 40ºC 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)

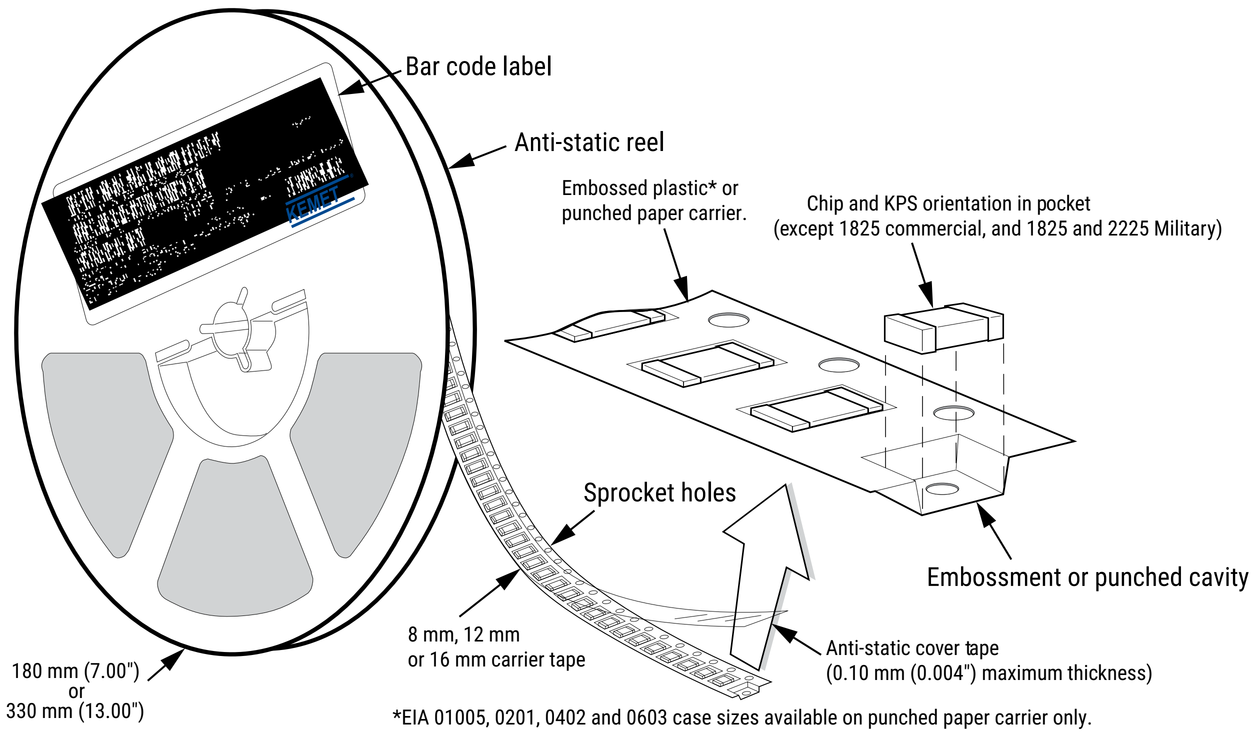
Laser marking option is not available on:

- C0G, 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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

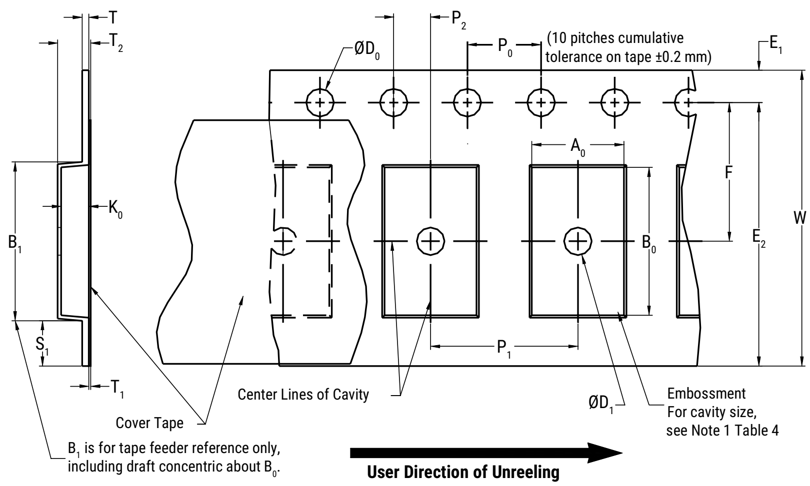


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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 (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)	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 S_1 < 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_0, B_0 and K_0 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

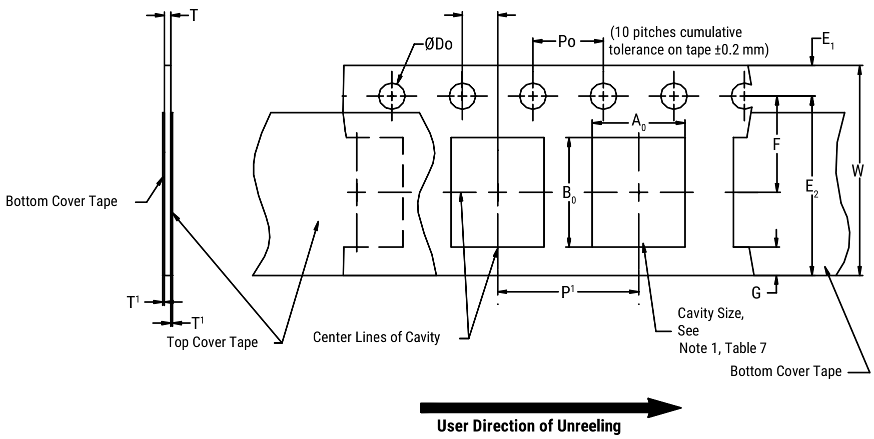


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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.)

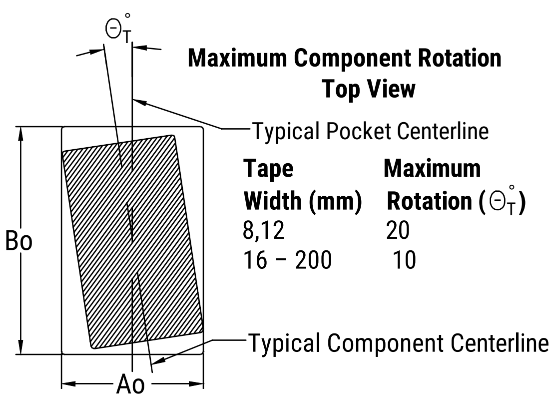
Packaging Information Performance Notes

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



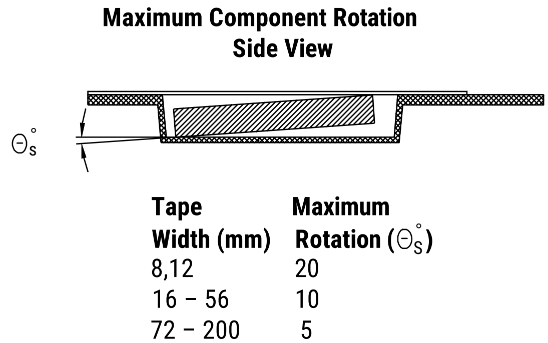


Figure 4 – Maximum Lateral Movement

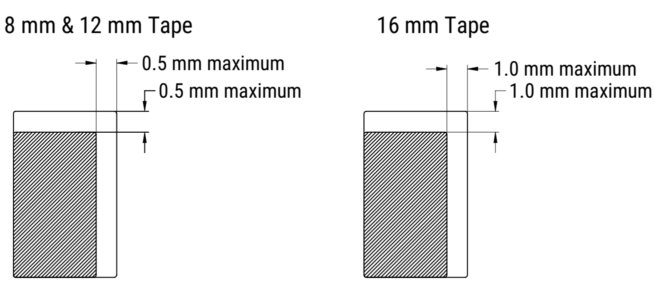


Figure 5 – Bending Radius

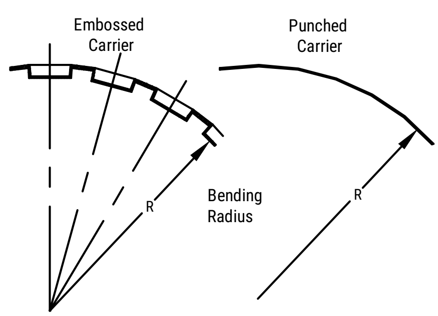
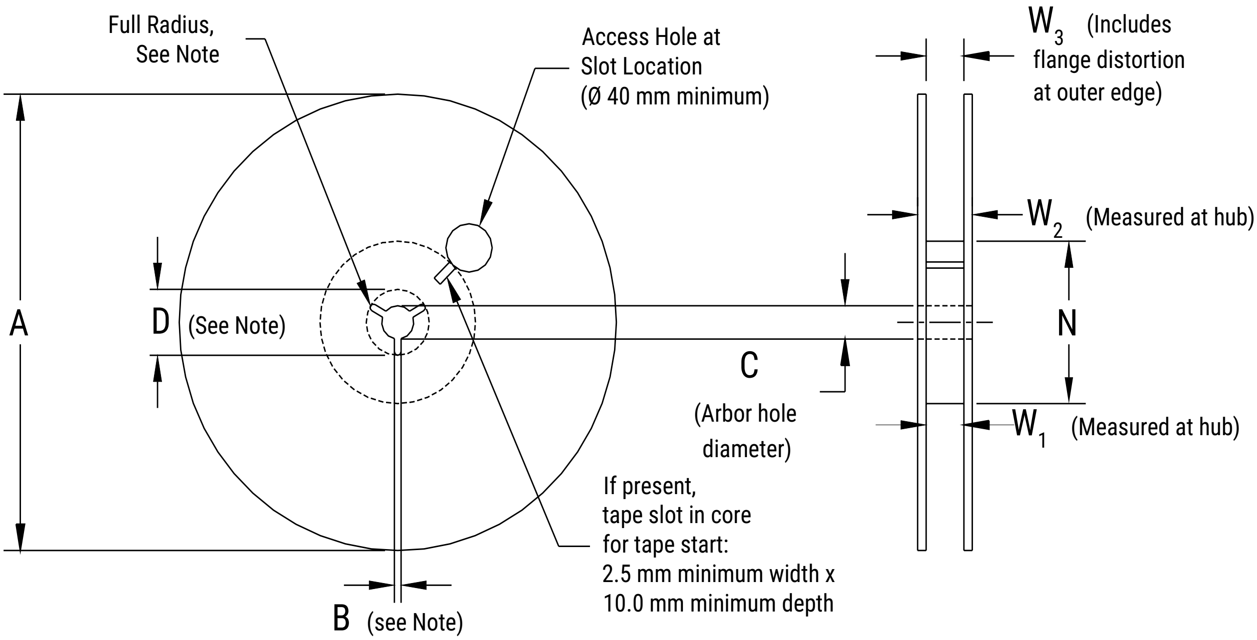


Figure 6 – Reel Dimensions



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	A	B Minimum	C	D Minimum
8 mm 12 mm 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	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

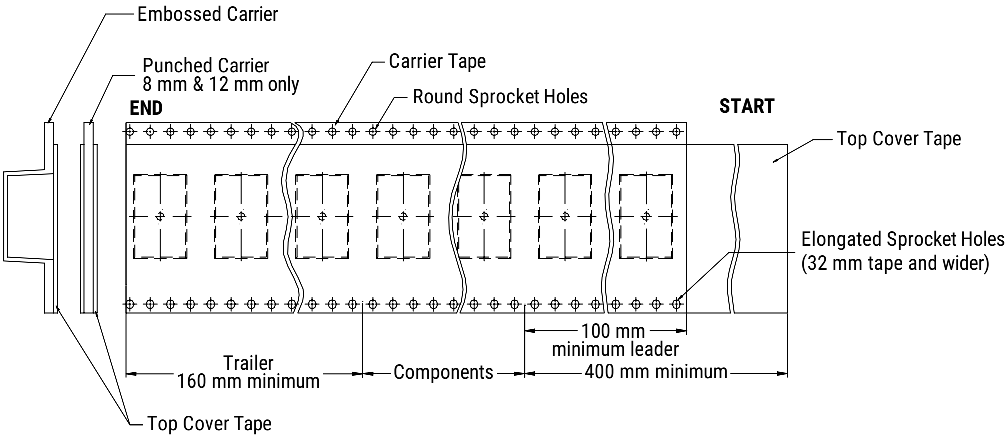
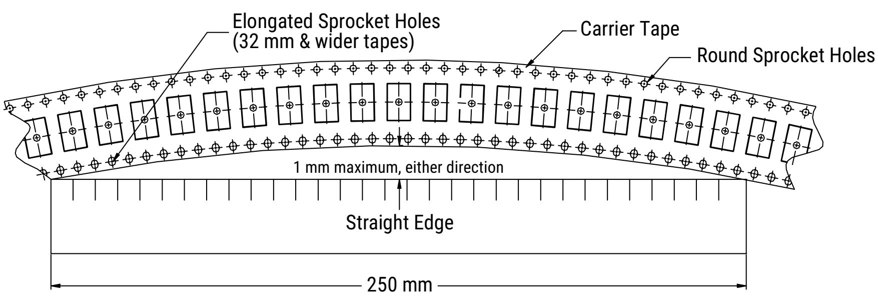


Figure 8 – Maximum Camber



HV-HT Series, High Voltage, High Temperature 200°C, C0G Dielectric, 500 – 2,000 VDC (Industrial Grade)

Overview

KEMET's High Voltage-High Temperature (HV-HT) series surface mount C0G Multilayer Ceramic Capacitors (MLCCs) are constructed of a robust and proprietary base metal electrode (BME) dielectric system that offers industry-leading performance at extreme temperatures. These surface mountable devices feature a 200ºC 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/ºC 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.

Ordering Information

C	2225	H	393	J	C	G	A	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 = ±0.10 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 = C0G	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"

[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.*

Packaging C-Spec Ordering Options Table

Termination Finish Options	Packaging Type/Options	Packaging Ordering Code (C-Spec)
Standard Packaging – Unmarked[3]		
C = 100% Matte Sn L = SnPb (5% Pb min.) F = Gold (Au) 30 – 70 µin G = Gold (Au) 100 µin minimum	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)
	7" Tape & Reel/2 mm pitch[4]	7081
	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	T1K0
Moisture Sensitive Packaging[5] – Unmarked[3]		
E = Gold (Au) 1.97 – 11.8 µin F = Gold (Au) 30 – 70 µin G = Gold (Au) 100 µin minimum	Waffle Tray[2]	7282
	7" Tape & Reel	7130
	7" Tape & Reel – 50 pcs	Contact KEMET[6]
	7" Tape & Reel – 100 pcs	
	7" Tape & Reel – 250 pcs	
	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.*

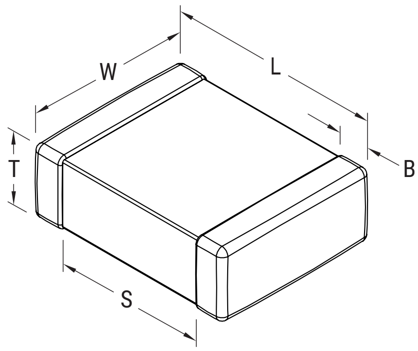
Benefits

- 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)	See Table 2 for Thickness	0.50 (0.02) ±0.25 (0.010)	0.75 (.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	
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)		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)		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)		
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)		

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Table 1A – Capacitance Range/Selection Waterfall (0805 – 1808 Case Sizes)

Capacitance	Cap Code	Case Size/Series								C0805H			C1206H					C1210H					C1808H				
		Voltage Code								C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Rated Voltage (VDC)								500	630	1000	500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																	
1.0 - 9.1 pF*	109 - 919*	B	C	D						DG	DG	DG											LB	LB	LB	LB	LB
10 pF - 47pF*	100 - 470*				F	G	J	K	M	DG	DG	DG	ED	ED	ED	ED	ED	FM	FM	FM	FM	FM	LB	LB	LB	LB	LB
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
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
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
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	LB
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
82 pF	820				F	G	J	K	M	DG	DG	DG	ED	ED	ED	ED	EF	FM	FM	FM	FM	FM	LB	LB	LB	LB	LB
91 pF	910				F	G	J	K	M	DG	DG	DG	ED	ED	ED	ED	EF	FM	FM	FM	FM	FM	LB	LB	LB	LB	LB
100 pF	101				F	G	J	K	M	DG	DG	DG	ED	ED	ED	ED	EF	FM	FM	FM	FM	FM	LB	LB	LB	LB	LB
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
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
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
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
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
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
200 pF	201				F	G	J	K	M	DG	DG	DG	ED	ED	ED	EF	EG	FG	FG	FG	FM	FM	LA	LA	LA	LA	LC
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
240 pF	241				F	G	J	K	M	DG	DG	DG	ED	ED	ED	EG	EG	FG	FG	FG	FM	FM	LA	LA	LA	LB	LC
270 pF	271				F	G	J	K	M	DG	DG	DG	ED	ED	ED	EG	EG	FG	FG	FG	FK	FK	LA	LA	LA	LB	LC
300 pF	301				F	G	J	K	M	DG	DG		ED	ED	EF	EG		FG	FG	FG	FK	FK	LA	LA	LA	LB	LC
330 pF	331				F	G	J	K	M	DG	DG		ED	ED	EF	EG		FG	FG	FG	FK	FK	LA	LA	LA	LB	LC
360 pF	361				F	G	J	K	M	DG	DG		ED	ED	EF	EG		FG	FG	FG	FK	FS	LA	LA	LA	LB	LA
390 pF	391				F	G	J	K	M	DG	DG		ED	ED	EF	EG		FG	FG	FG	FK	FS	LA	LA	LA	LB	LA
430 pF	431				F	G	J	K	M	DG	DG		ED	ED	EF	EG		FG	FM	FM	FS	FS	LA	LB	LB	LC	LA
470 pF	471				F	G	J	K	M	DG	DG		ED	ED	EG	EG		FG	FM	FM	FS	FS	LA	LB	LB	LC	LA
510 pF	511				F	G	J	K	M	DG	DG		ED	ED	EG	EG		FG	FM	FM	FS	FS	LA	LB	LB	LC	LB
560 pF	561				F	G	J	K	M	DG	DG		ED	ED	EG	EG		FG	FM	FM	FS	FS	LA	LB	LB	LC	LB
620 pF	621				F	G	J	K	M	DG			ED	ED	EG			FG	FM	FM	FS	FS	LA	LB	LB	LA	LC
680 pF	681				F	G	J	K	M	DG			ED	ED	EG			FG	FM	FM	FS	FS	LB	LB	LB	LA	LC
750 pF	751				F	G	J	K	M	DG			ED	EF	EG			FG	FM	FM	FM		LB	LB	LB	LA	
820 pF	821				F	G	J	K	M	DG			ED	EF	EG			FG	FM	FM	FM		LB	LB	LB	LA	
910 pF	911				F	G	J	K	M				ED	EF	EG			FM	FM	FM	FY		LB	LB	LB	LA	
1,000 pF	102				F	G	J	K	M				ED	EF	EG			FM	FM	FM	FY		LB	LB	LB	LB	
1,100 pF	112				F	G	J	K	M				EF	EG				FM	FK	FK	FS		LC	LC	LC	LB	
1,200 pF	122				F	G	J	K	M				EF	EG				FM	FK	FK	FS		LC	LC	LC	LC	
1,300 pF	132				F	G	J	K	M				EF	EG				FM	FS	FS			LC	LC	LC	LC	
1,500 pF	152				F	G	J	K	M				EF	EG				FK	FS	FS			LC	LC	LC	LC	
1,600 pF	162				F	G	J	K	M				EF	EG				FK	FS	FS			LC	LC	LC		
1,800 pF	182				F	G	J	K	M				EF	EG				FK	FS	FS			LC	LC	LC		
2,000 pF	202				F	G	J	K	M				EG					FK	FL	FS			LC	LA	LB		
2,200 pF	222				F	G	J	K	M				EG					FK	FL	FS			LC	LA	LB		
2,400 pF	242				F	G	J	K	M				EG					FS	FL	FS			LC	LA	LB		
2,700 pF	272				F	G	J	K	M				EG					FS	FL	FS			LC	LA	LC		
3,000 pF	302				F	G	J	K	M									FS	FL				LA	LA			
3,300 pF	332				F	G	J	K	M									FS	FM				LA	LA			
3,600 pF	362				F	G	J	K	M									FL	FM				LA	LB			
3,900 pF	392				F	G	J	K	M									FL	FY				LA	LB			
4,300 pF	432				F	G	J	K	M									FM	FY				LA	LC			
4,700 pF	472				F	G	J	K	M									FM	FY				LA	LC			
Capacitance	Cap Code	Rated Voltage (VDC)								500	630	1000	500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000
		Voltage Code								C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Case Size/Series								C0805H			C1206H					C1210H					C1808H				

**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 (0805 – 1808 Case Sizes) cont.

Capacitance	Cap Code	Case Size/Series	C0805H			C1206H					C1210H					C1808H				
		Voltage Code	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Rated Voltage (VDC)	500	630	1000	500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000
		Capacitance Tolerance	Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																	
5,100 pF	512	F G J K M									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									
Capacitance	Cap Code	Rated Voltage (VDC)	500	630	1000	500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000
		Voltage Code	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Case Size/Series	C0805H			C1206H					C1210H					C1808H				

**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)

Capacitance	Cap Code	Case Size/Series					C1812H					C1825H					C2220H					C2225H				
		Voltage Code					C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Rated Voltage (VDC)					500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000
		Capacitance Tolerance					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																			
10 pF - 47pF*	100 - 470*	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
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	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
62 pF	620	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
68 pF	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	K	M	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	M	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	111	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
120 pF	121	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
130 pF	131	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
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	K	M	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	M	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	221	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
240 pF	241	F	G	J	K	M	GH	GH	GH	GH	GH	HE	HE	HE	HE	HE	JK	JK	JK	JK	JK	KE	KE	KE	KE	KE
270 pF	271	F	G	J	K	M	GH	GH	GH	GH	GH	HE	HE	HE	HE	HE	JK	JK	JK	JK	JK	KE	KE	KE	KE	KE
300 pF	301	F	G	J	K	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	M	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	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
470 pF	471	F	G	J	K	M	GK	GK	GK	GK	GK	HE	HE	HE	HE	HE	JE	JE	JE	JE	JE	KF	KF	KF	KF	KE
510 pF	511	F	G	J	K	M	GH	GH	GH	GK	GH	HE	HE	HE	HE	HE	JK	JK	JK	JK	JK	KF	KF	KF	KF	KE
560 pF	561	F	G	J	K	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	K	M	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	K	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	911	F	G	J	K	M	GH	GH	GH	GH	GM	HE	HE	HE	HG	HG	JE	JK	JK	JK	JK	KE	KE	KE	KF	KE
1,000 pF	102	F	G	J	K	M	GH	GH	GH	GH	GM	HE	HE	HE	HG	HG	JE	JK	JK	JK	JK	KE	KE	KE	KF	KE
1,100 pF	112	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
1,200 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	K	M	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	M	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	182	F	G	J	K	M	GK	GK	GK	GM		HE	HG	HG	HG	HG	JE	JK	JK	JK	JE	KE	KE	KE	KF	KE
2,000 pF	202	F	G	J	K	M	GK	GK	GK	GM		HE	HG	HG	HE	HJ	JE	JK	JK	JE	JK	KE	KE	KE	KF	KE
2,200 pF	222	F	G	J	K	M	GK	GK	GK	GO		HE	HG	HG	HE	HJ	JE	JK	JK	JE	JK	KE	KE	KE	KF	KF
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	K	M	GK	GH	GK	GO		HE	HG	HG	HE	HK	JK	JK	JK	JE	JL	KE	KE	KE	KE	KH
3,000 pF	302	F	G	J	K	M	GK	GH	GK			HG	HG	HG	HE	HK	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
3,600 pF	362	F	G	J	K	M	GK	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	GK	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	KH	
Capacitance	Cap Code	Rated Voltage (VDC)					500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000
		Voltage Code					C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Case Size/Series					C1812H					C1825H					C2220H					C2225H				

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.

Capacitance	Cap Code	Case Size/Series					C1812H					C1825H					C2220H					C2225H				
		Voltage Code					C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Rated Voltage (VDC)					500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000
		Capacitance Tolerance					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																			
5,100 pF	512	F	G	J	K	M	GH	GK	GO			HG	HE	HG	HK		JK	JK	JK	JL		KE	KF	KF	KH	
5,600 pF	562	F	G	J	K	M	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	HK				JE	JL				KE	KH			
22,000 pF	223											HJ					JK	JN				KF	KJ			
27,000 pF	273											HJ					JL	JN				KF	KJ			
33,000 pF	333											HK					JN					KH				
39,000 pF	393																					KJ				
Capacitance	Cap Code	Rated Voltage (VDC)					500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000
		Voltage Code					C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Case Size/Series					C1812H					C1825H					C2220H					C2225H				

**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)

Capacitance	Cap Code	Case Size/Series			C2824H					C3040H					C3640H					C4540H				
		Voltage Code			C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Rated Voltage (VDC)			500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000
		Capacitance Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																			
10 - 2,000 pF	100 - 202	J	K	M																				
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	M																				
3,900 pF	392	J	K	M	TA	TA	TA	TA	TB	QB	QB	QB	QB	QB	MA	MA	MA	MA	MA					
4,300 pF	432	J	K	M																				
4,700 pF	472	J	K	M	TA	TA	TA	TB	TB	QB	QB	QB	QB	QB	MA	MA	MA	MA	MA	SA	SA	SA	SA	SA
5,100 pF	512	J	K	M																				
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
6,200 pF	622	J	K	M																				
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																				
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																				
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	K	M	TB	TB				QB	QC	QC			MA	MA	MB			SA	SA	SA		
39,000 pF	393	J	K	M	TB	TC				QB	QC	QD			MA	MA	MB			SA	SA	SB		
47,000 pF	473	J	K	M	TB					QB	QC				MA	MB	MC			SA	SA	SB		
56,000 pF	563	J	K	M	TC					QC	QD				MA	MB				SA	SA	SB		
68,000 pF	683	J	K	M						QC	QD				MB	MC				SA	SB	SC		
82,000 pF	823	J	K	M						QC					MB					SA	SB			
0.1 µF	104	J	K	M						QD					MC					SB	SC			
0.12 µF	124	J	K	M											MC					SB				
0.15 µF	154	J	K	M																SC				
Capacitance	Cap Code	Rated Voltage (VDC)			500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000
		Voltage Code			C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Case Size/Series			C2824H					C3040H					C3640H					C4540H				

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

Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			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	1206	1.20±0.15	0	0	2,500	10,000
EG	1206	1.60±0.15	0	0	2,000	8,000
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
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	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 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 – Bulk Packaging Quantities

Packaging Type			Loose Packaging		Secure Packaging	
			Bulk Bag (default)		2" x 2" Waffle Pack/Tray[3]	
Packaging C-Spec[1]			N/A[2]		7282/7292	
Case Size		Chip Thickness (mm)	Packaging Quantities (pieces/unit packaging)			
EIA (in)	Metric (mm)		Minimum	Maximum	Minimum	Maximum
0402	1005	All	1	50,000	1	368
0603	1608					368
0805	2012					100
1206	3216	≤ 1.25 (nominal)				126
1206	3216	> 1.25 (nominal)				50
1210	3225	All				80
1808	4520			20,000		50
1812	4532					42
1825	4564					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.*

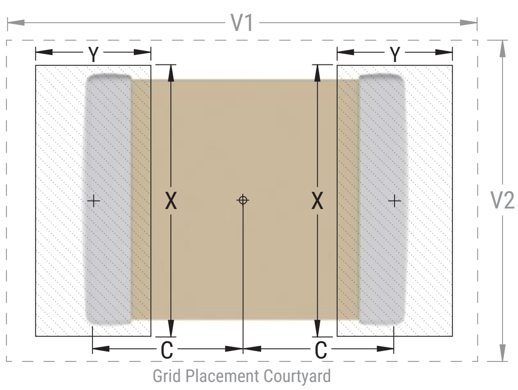
[3] *Also commonly referred to as "Chip Carrier" or "Molded Tray". All tray packaging options offer static protection.*

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

EIA Size Code	Metric Size Code	Density Level A: Maximum (Most) Land 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
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	
	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.

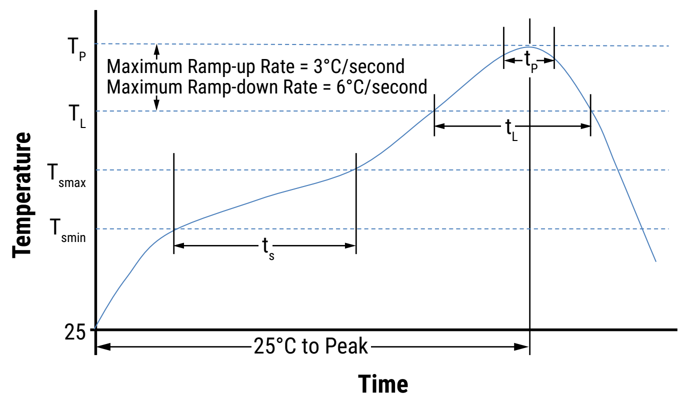


Table 4 – Performance & Reliability: Test Methods and Conditions

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.

<table>
<tr><th>Stress</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Dielectric Withstanding Voltage (DWV)</td><td>KEMET Internal</td><td>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)</td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit

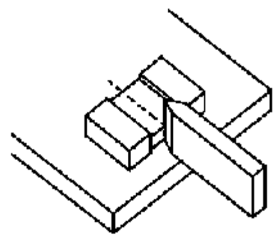
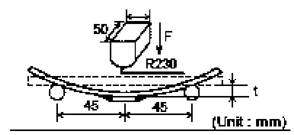
Withstand test voltage without insulation breakdown or damage.</td></tr>
<tr><td>Aging Rate (Maximum % Capacitance Loss/Decade Hour)</td><td>KEMET Internal</td><td>Maximum % capacitance loss/decade hour</td><td>0% Loss/Decade Hour</td></tr>
<tr><td>Terminal Strength</td><td>KEMET Internal</td><td>Shear stress test per specific case size,
Time: 60 ±1 second.
<table><tr><th>Case Size</th><th>Force</th></tr><tr><td>0805</td><td>9N</td></tr><tr><td>≥ 1206</td><td>18N</td></tr></table></td><td>No evidence of mechanical damage</td></tr>
<tr><td>Board Flex</td><td>AEC-Q200-005</td><td>Standard Termination
System 2.0 mm
Flexible Termination
System 3.0 mm
Test Time: 60± 5 seconds
Ramp Time: 1 mm/second

</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Resistance to Soldering Heat</td><td>MIL-STD-202 Method 210</td><td>Condition B, no per-heat of samples, Single Wave Solder</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Thermal Shock</td><td>MIL-STD-202 Method 107</td><td>300 cycles (−55°C to +150°C),
20 seconds transfer, 15 minute dwell</td><td>Measurement at 24 hours ±4 hours after test conclusion.
Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit</td></tr>
<tr><td>Temperature Cycling</td><td>JESD22 Method JA-104</td><td>50 cycles (−55°C to +200°C)</td><td>Measurement at 24 hours ±4 hours after test conclusion.
Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit</td></tr>
</table>

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

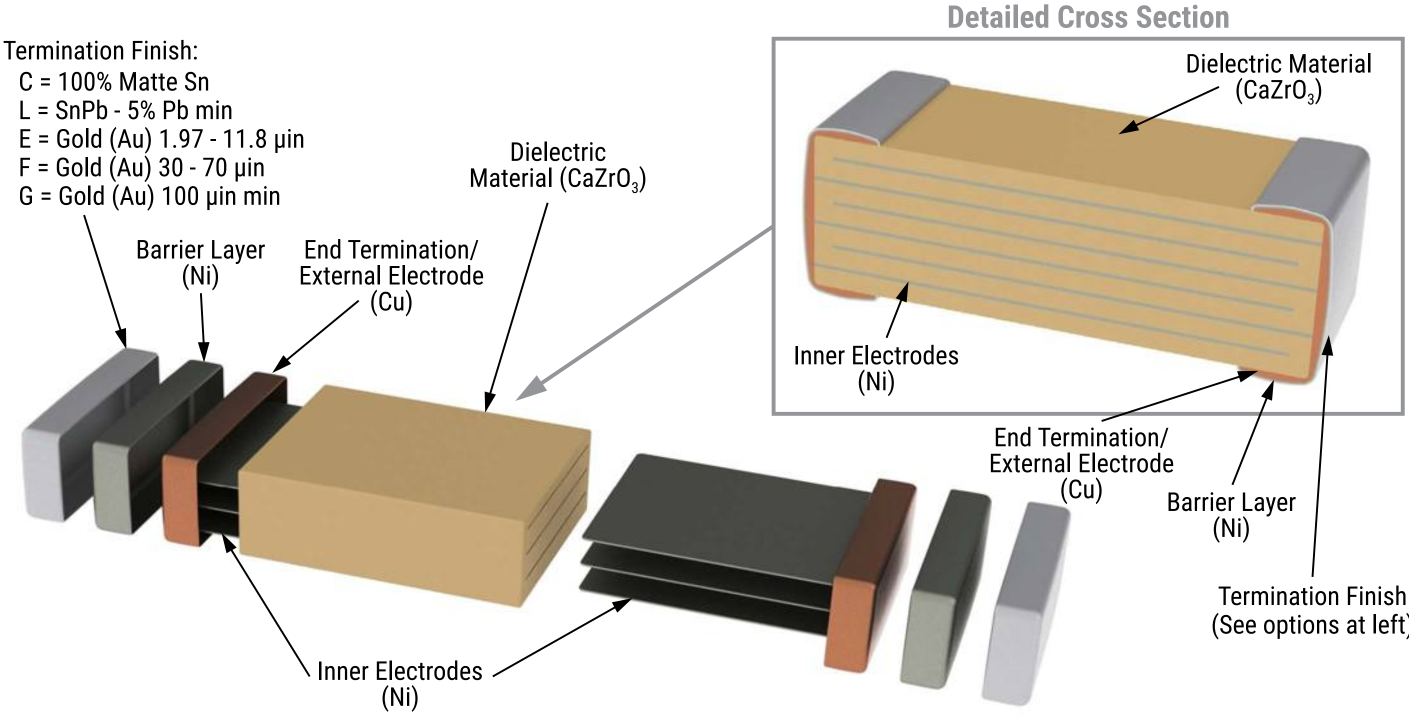
Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will 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)	C	1.5 years upon receipt
SnPb (5% Pb min.)	L	1.5 years upon receipt
Gold (Au) 1.97 – 11.8 µin[2]	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 (Typical)



Capacitor Marking (Optional):

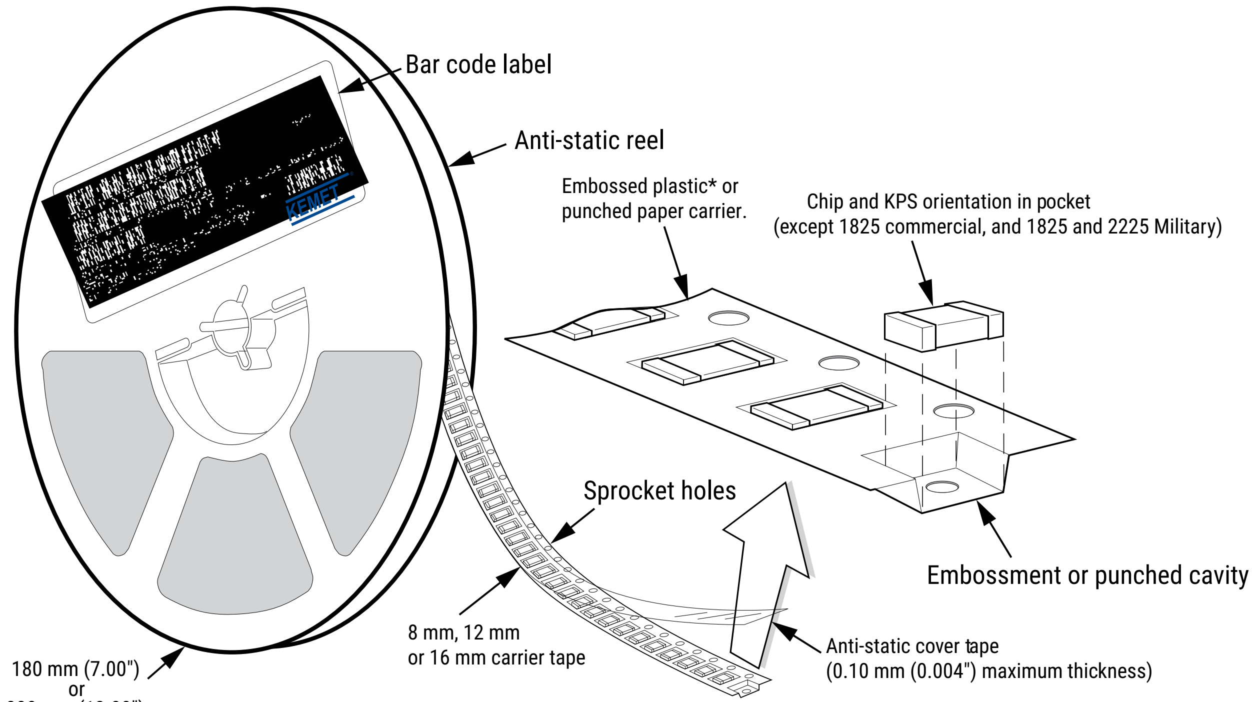
Laser marking option is not available on:

- C0G, 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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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		
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

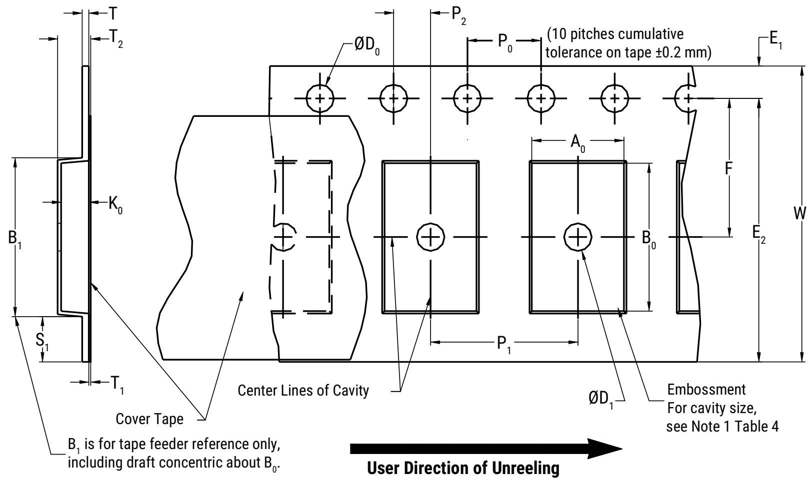


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

<table>
<tr><th colspan="9">Constant Dimensions — Millimeters (Inches)</th></tr>
<tr><th>Tape Size</th><th>D_0</th><th>E_1</th><th>P_0</th><th>P_2</th><th>R Reference Note 2</th><th>S_1 Minimum Note 3</th><th>T Maximum</th><th>T1 Maximum</th></tr>
<tr><td>8 mm</td><td rowspan="3">1.5+0.10/−0.0 (0.059+0.004/−0.0)</td><td rowspan="3">1.75±0.10 (0.069±0.004)</td><td rowspan="3">4.0±0.10 (0.157±0.004)</td><td rowspan="3">2.0±0.05 (0.079±0.002)</td><td>25.0 (0.984)</td><td rowspan="3">0.600 (0.024)</td><td rowspan="3">0.600 (0.024)</td><td rowspan="3">0.100 (0.004)</td></tr>
<tr><td>12 mm</td><td rowspan="2">30 (1.181)</td></tr>
<tr><td>16 mm</td></tr>
<tr><td>24 mm</td><td>1.5+0.10/−0.0 (0.059+0.004/−0.0)</td><td>1.75±0.10 (0.069±0.004)</td><td>4.0±0.10 (0.157±0.004)</td><td>2.0±0.10 (0.078±0.003)</td><td>30 (1.181)</td><td>5 (0.196)</td><td>0.250 (0.009)</td><td>0.350 (0.013)</td></tr>
<tr><th colspan="9">Variable Dimensions — Millimeters (Inches)</th></tr>
<tr><th>Tape Size</th><th>Pitch</th><th>E_2 Minimum</th><th>F</th><th>P_1</th><th>T_2 Maximum</th><th>W Maximum</th><th colspan="2">A_0,B_0 & K_0</th></tr>
<tr><td>8 mm</td><td>Single (4 mm)</td><td>6.25 (0.246)</td><td>3.5±0.05 (0.138±0.002)</td><td>4.0±0.10 (0.157±0.004)</td><td>2.5 (0.098)</td><td>8.3 (0.327)</td><td colspan="2" rowspan="4">Note 5</td></tr>
<tr><td>12 mm</td><td>Single (4 mm) & Double (8 mm)</td><td>10.25 (0.404)</td><td>5.5±0.05 (0.217±0.002)</td><td>8.0±0.10 (0.315±0.004)</td><td>4.6 (0.181)</td><td>12.3 (0.484)</td></tr>
<tr><td>16 mm</td><td>Triple (12 mm)</td><td>14.25 (0.561)</td><td>7.5±0.05 (0.138±0.002)</td><td>12.0±0.10 (0.157±0.004)</td><td>4.6 (0.181)</td><td>16.3 (0.642)</td></tr>
<tr><td>24 mm</td><td>16 mm</td><td>22.25 (0.875)</td><td>11.5±0.10 (0.452±0.003)</td><td>16.0±0.10 (0.629±0.004)</td><td>3 (0.118)</td><td>24.3 (0.956)</td></tr>
</table>

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 S_1 < 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_1 dimension is a reference dimension for tape feeder clearance only.*
5. *The cavity defined by A_0, B_0 and K_0 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

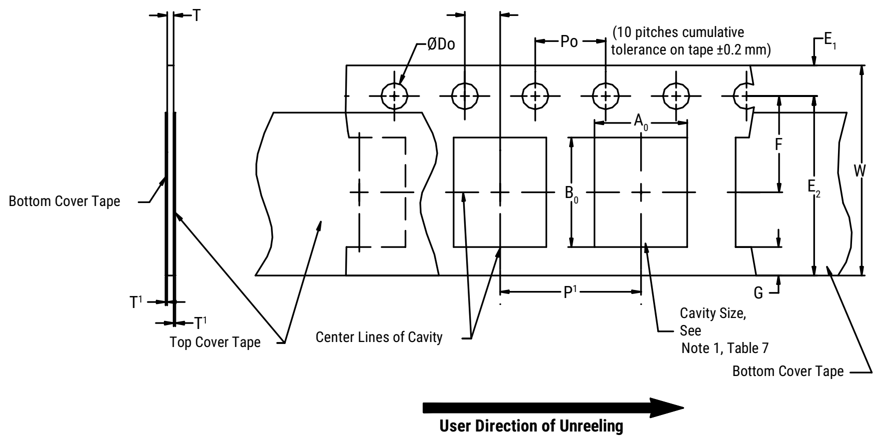


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 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_0, B_0 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

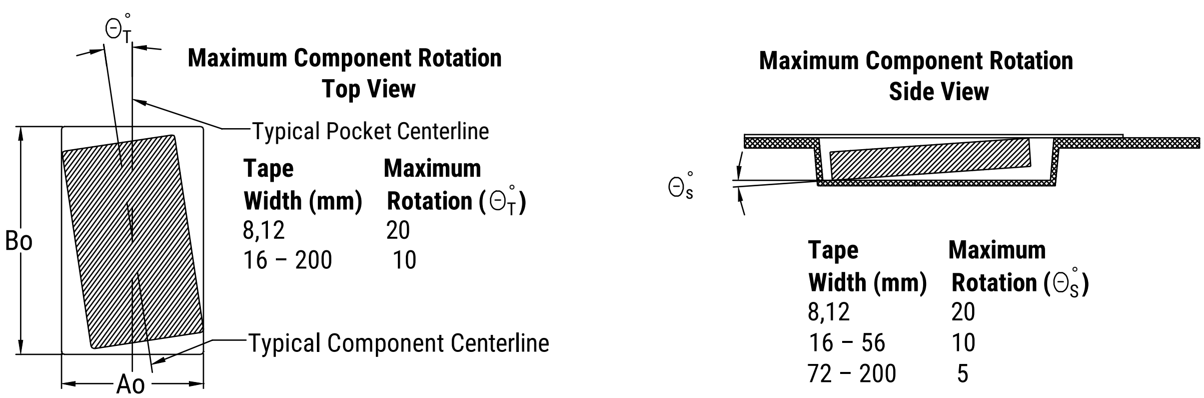


Figure 4 – Maximum Lateral Movement

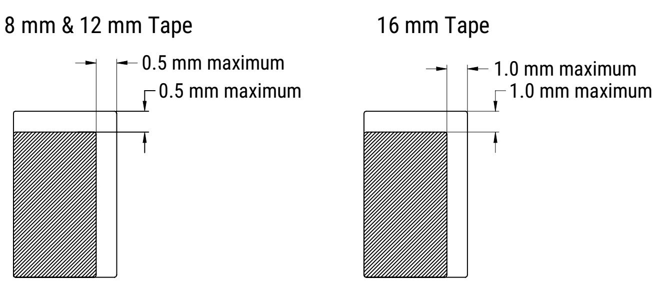


Figure 5 – Bending Radius

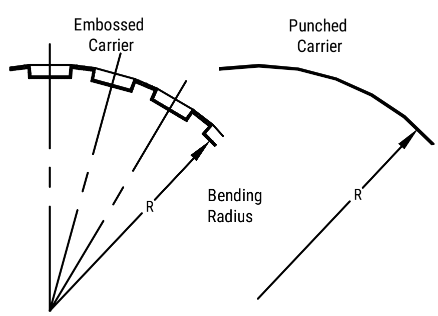
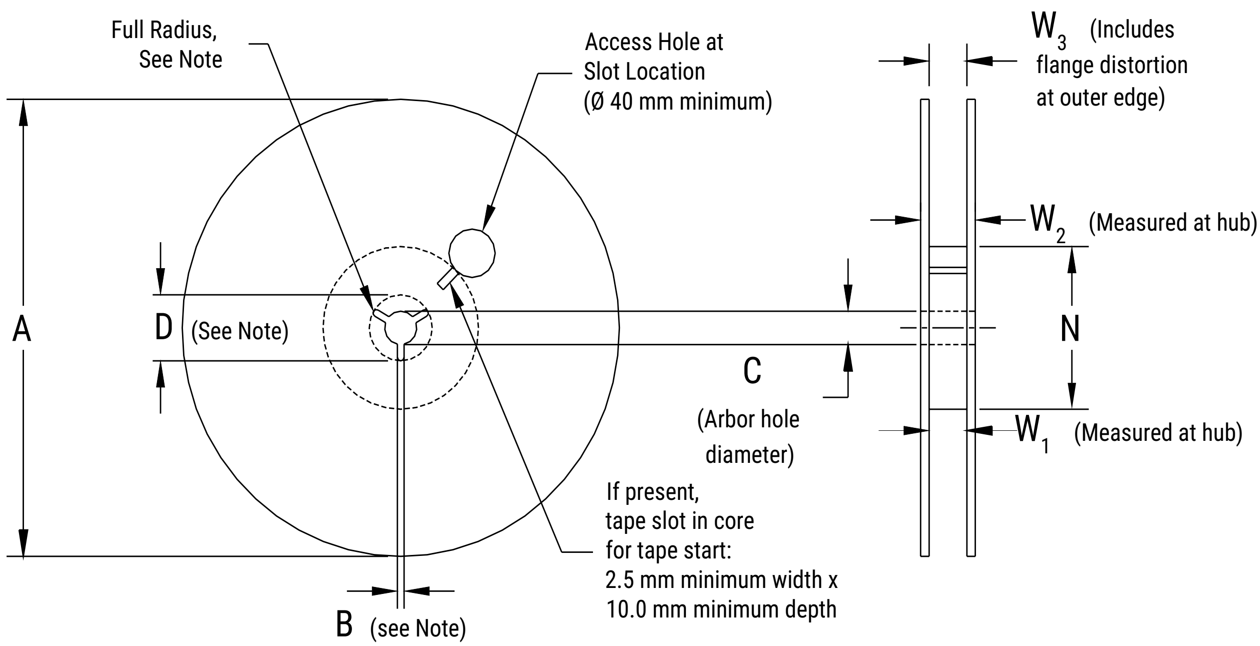


Figure 6 – Reel Dimensions



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	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				
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/−1.0 (1.078+0.039/−0.039)	

Figure 7 – Tape Leader & Trailer Dimensions

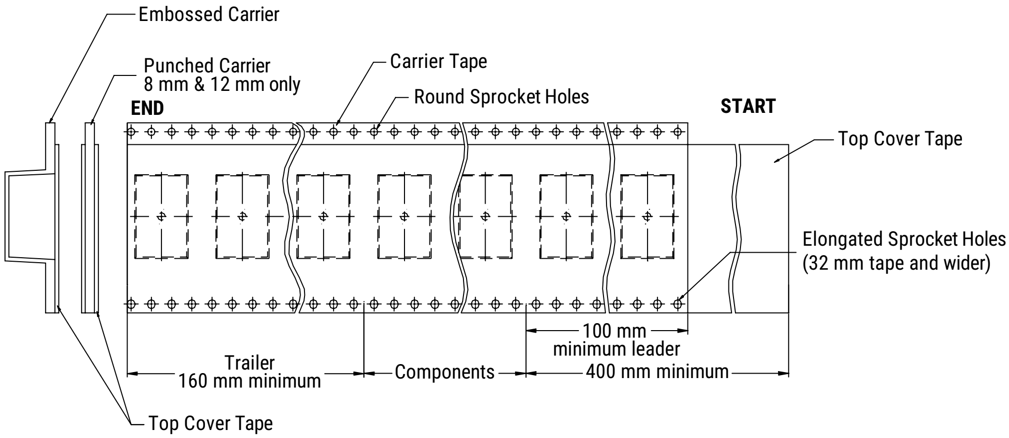
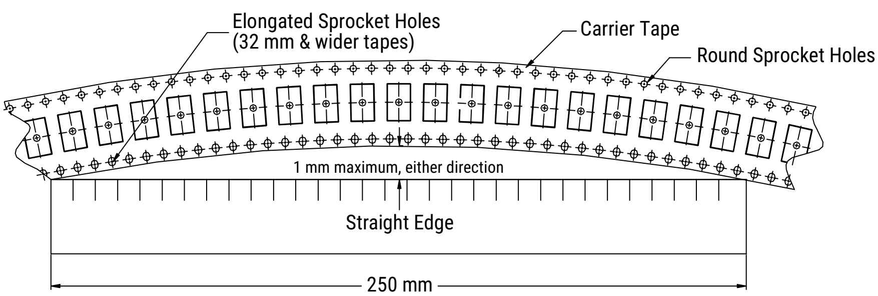


Figure 8 – Maximum Camber



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

Figure 9 – Waffle Tray Dimensions – Inches (Millimeters)

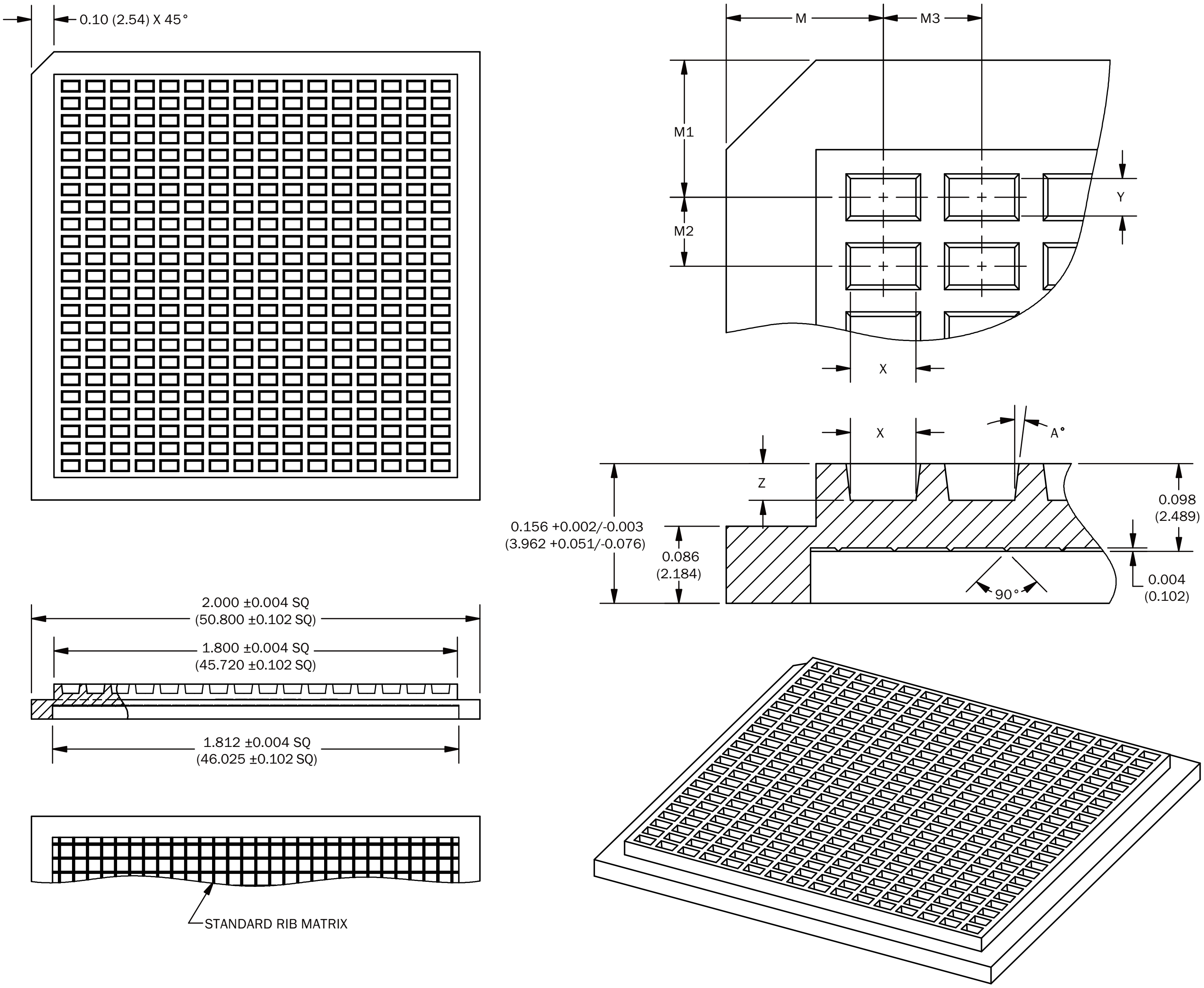


Table 9A – Waffle Tray Dimensions – Inches

Case Size		2" x 2" Waffle Tray Dimensions – Inches									Packaging Quantity (pcs/unit packaging)
		M	M1	M2	M3	X	Y	Z	A°	MATRIX	
EIA (in)	Metric (mm)	±0.003	±0.003	±0.002	±0.002	±0.002	±0.002	±0.003	± 1/2°	(X x Y)	
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

[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 ≤ 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

Case Size		2" x 2" Waffle Tray Dimensions – Millimeters									Packaging Quantity (pcs/unit packaging)
		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)	
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 ≤ 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

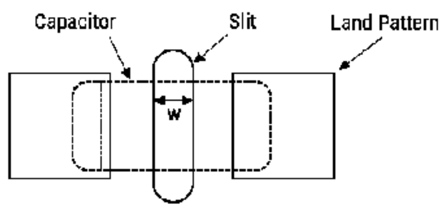
For MLCC ratings ≥1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

Dielectric	CTE (ppm/°C)
Class II $BaTiO_3$	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.



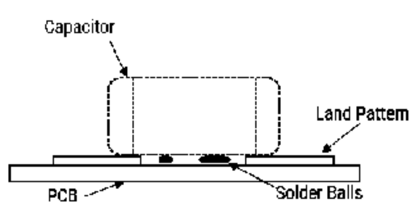
Solder Resist

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 with Flexible Termination System (HV FT-CAP), C0G Dielectric, 500 – 10,000 VDC (Commercial Grade)

KEMET a YAGEO company

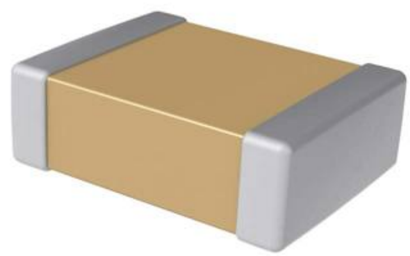
Overview

KEMET's High Voltage with Flexible Termination (HV FT-CAP) surface mount MLCCs in C0G 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. C0G (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

C	2225	X	393	J	C	G	A	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 = ±0.10 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 = C0G	A = N/A	C = 100% Matte Sn L = SnPb (5% Pb minimum)	See "Packaging C-Spec Ordering Options Table"

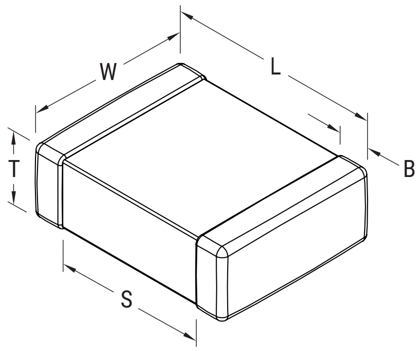
[1] *Additional capacitance tolerance offerings may be available. Contact KEMET for details.*
[2] *Additional termination finish options may be available. Contact KEMET for details.*

Packaging C-Spec Ordering Options Table

Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)
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/2mm pitch[2]	7081
13" Reel/Unmarked/2mm pitch[2]	7082
Automotive 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".*

Dimensions – Millimeters (Inches)



<table>
<tr><th>EIA Size Code</th><th>Metric Size Code</th><th>L Length</th><th>W Width</th><th>T Thickness</th><th>B Bandwidth</th><th>S Separation Minimum</th><th>Mounting Technique</th></tr>
<tr><td>0603</td><td>1608</td><td>1.60 (0.063)
±0.15 (0.006)</td><td>0.80 (0.032)
±0.15 (0.006)</td><td rowspan="9">See Table 2 for Thickness</td><td>0.35 (0.014)
±0.15 (0.006)</td><td>0.70 (0.028)</td><td rowspan="3">Solder Wave or Solder Reflow</td></tr>
<tr><td>0805</td><td>2012</td><td>2.00 (0.079)
±0.30 (0.012)</td><td>1.25 (0.049)
±0.30 (0.012)</td><td>0.50 (0.02)
±0.25 (0.010)</td><td>0.75 (0.030)</td></tr>
<tr><td>1206</td><td>3216</td><td>3.30 (0.130)
±0.40 (0.016)</td><td>1.60 (0.063)
±0.35 (0.013)</td><td>0.60 (0.024)
±0.25 (0.010)</td><td rowspan="7">N/A</td></tr>
<tr><td>1210</td><td>3225</td><td>3.30 (0.130)
±0.40 (0.016)</td><td>2.60 (0.102)
±0.30 (0.012)</td><td>0.60 (0.024)
±0.25 (0.010)</td><td rowspan="6">Solder Reflow Only</td></tr>
<tr><td>1808</td><td>4520</td><td>4.70 (0.185)
±0.50 (0.020)</td><td>2.00 (0.079)
±0.20 (0.008)</td><td>0.70 (0.028)
±0.35 (0.014)</td></tr>
<tr><td>1812</td><td>4532</td><td>4.50 (0.178)
±0.40 (0.016)</td><td>3.20 (0.126)
±0.30 (0.012)</td><td>0.70 (0.028)
±0.35 (0.014)</td></tr>
<tr><td>1825</td><td>4564</td><td>4.60 (0.181)
±0.40 (0.016)</td><td>6.40 (0.252)
±0.40 (0.016)</td><td>0.70 (0.028)
±0.35 (0.014)</td></tr>
<tr><td>2220</td><td>5650</td><td>5.90 (0.232)
±0.75 (0.030)</td><td>5.00 (0.197)
±0.40 (0.016)</td><td>0.70 (0.028)
±0.35 (0.014)</td></tr>
<tr><td>2225</td><td>5664</td><td>5.90 (0.232)
±0.75 (0.030)</td><td>6.40 (0.248)
±0.40 (0.016)</td><td>0.70 (0.028)
±0.35 (0.014)</td></tr>
</table>

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)

Capacitance	Cap Code	Case Size/Series								C0603X			C0805X			C1206X					C1210X					C1808X						
		Voltage Code								C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		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								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																						
1.0 - 9.1 pF*	109 - 169*	B	C	D									DG	DG	DG											LB	LB	LB	LB	LB	LB	LB
10 pF	100				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
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	LB
12 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
13 pF	130				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	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	M				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	240				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
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	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	M				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
47 pF	470				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
51 pF	510				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
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				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	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	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	K	M	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	M	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	LA	LA	LA	LA	LB	LC	LC
150 pF	151				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	LB	LC	LC
160 pF	161				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
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	LA	LA	LC	LC	
220 pF	221				F	G	J	K	M	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	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	K	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				F	G	J	K	M	CJ	CJ		DG	DG	DD	ES	ES	EF	EU		FZ	FM	FM	FS	FS	LA	LB	LB	LC	LA		
470 pF	471				F	G	J	K	M	CJ	CJ		DG	DG	DD	ES	ES	EU	EU		FZ	FM	FM	FS	FS	LA	LB	LB	LC	LA		
510 pF	511				F	G	J	K	M	CJ	CJ		DG	DG	DD	ES	ES	EU	EU		FZ	FM	FM	FS	FS	LA	LB	LB	LC	LB		
560 pF	561				F	G	J	K	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	K	M	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	M	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				F	G	J	K	M				DG	DG	DG	ES	EF	EU			FZ	FM	FM	FM		LB	LB	LB	LA			
910 pF	911				F	G	J	K	M				DC	DC		ES	EF	EU			FM	FM	FM	FY		LB	LB	LB	LA			
1,000 pF	102				F	G	J	K	M				DC	DC		ES	EF	EU			FM	FM	FM	FY		LB	LB	LB	LB			
Capacitance	Cap 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
		Voltage Code								C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		Case Size/Series								C0603X			C0805X			C1206X					C1210X					C1808X						

**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.

Capacitance	Cap Code	Case Size/Series					C0603X			C0805X			C1206X					C1210X					C1808X						
		Voltage Code					C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		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					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																						
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										
Capacitance	Cap 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
		Voltage Code					C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		Case Size/Series					C0603X			C0805X			C1206X					C1210X					C1808X						

**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)

Cap	Cap Code	Case Size/ Series					C1812X							C1825X							C2220X							C2225X							
		Voltage Code					C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	K
		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	10000
		Capacitance Tolerance					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																												
10 pF	100	F	G	J	K	M	GB	GB	GB	GB	GB	GB	GB								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								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								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF	
13 pF	130	F	G	J	K	M	GB	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	GB	GB	GB	GB	GB	GB								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF	
16 pF	160	F	G	J	K	M	GB	GB	GB	GB	GB	GB	GB								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF	
18 pF	180	F	G	J	K	M	GB	GB	GB	GB	GB	GB	GB								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF	
20 pF	200	F	G	J	K	M	GB	GB	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	GB	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	GB	GB	GB	GB	GB	GB								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								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								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF	
33 pF	330	F	G	J	K	M	GB	GB	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	GB	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	GB	GB	GB	GB	GB	GB								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								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								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								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								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								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								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								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								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								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								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF	KH
110 pF	111	F	G	J	K	M	GD	GD	GD	GD	GD	GD	GD								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF	KJ
120 pF	121	F	G	J	K	M	GD	GD	GD	GD	GD	GD	GD								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF	KJ
130 pF	131	F	G	J	K	M	GD	GD	GD	GD	GD	GD	GD								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF	KJ
150 pF	151	F	G	J	K	M	GD	GD	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	GD	GD	GD	GD	GD	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF	
180 pF	181	F	G	J	K	M	GD	GD	GD	GD	GD	GD	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF	
200 pF	201	F	G	J	K	M	GD	GD	GD	GD	GD	GD	GM								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								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								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								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								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								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								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								JE	JE	JE	JE	JE	JK	JK	KE	KE	KE	KE	KE	KE	KF	
430 pF	431	F	G	J	K	M	GB	GB	GB	GB	GD	GK								HJ	JE	JE	JE	JE	JE	JK	JE	KE	KE	KE	KE	KE	KE	KF	
470 pF	471	F	G	J	K	M	GB	GB	GB	GB	GD	GK								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								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								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								HK	JK	JK	JK	JK	JK	JK	JL	KF	KF	KF	KF	KE	KF	KH	
680 pF	681	F	G	J	K	M	GB	GB	GB	GD	GH	GO								HK	JE	JE	JE	JK	JK	JK	JL	KF	KF	KF	KF	KE	KF	KH	
750 pF	751	F	G	J	K	M	GB	GB	GB	GD	GK										JE	JE	JE	JK	JK	JK	JL	KE	KE	KE	KF	KE	KF	KH	
820 pF	821	F	G	J	K	M	GB	GB	GB	GD	GK										JE	JE	JE	JK	JK	JK	JN	KE	KE	KE	KF	KE	KF	KJ	
910 pF	911	F	G	J	K	M	GB	GB	GB	GH	GM										JE	JK	JK	JK	JK	JK	JN	KE	KE	KE	KF	KE	KF	KJ	
1,000 pF	102	F	G	J	K	M	GB	GB	GB	GH	GM										JE	JK	JK	JK	JK	JK	JN	KE	KE	KE	KF	KE	KF	KJ	
1,100 pF	112	F	G	J	K	M	GB	GB	GB	GH	GO								HJ		JE	JK	JK	JK	JK	JK		KE	KE	KE	KF	KF	KF		
Cap	Cap 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	10000
		Voltage Code					C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	K
		Case Size/Series					C1812X							C1825X							C2220X							C2225X							

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

Cap	Cap Code	Case Size/ Series					C1812X							C1825X							C2220X							C2225X							
		Voltage Code					C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	K
		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	10000
		Capacitance Tolerance					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																												
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	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	F	G	J	K	M	GB	GD	GD	GK								HG	HK		JE	JK	JK	JK	JE	JL		KE	KE	KE	KF	KE	KH		
1,800 pF	182	F	G	J	K	M	GB	GD	GD	GM								HG			JE	JK	JK	JK	JE	JN		KE	KE	KE	KF	KE	KH		
2,000 pF	202	F	G	J	K	M	GB	GH	GH	GM							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	HJ			JE	JK	JK	JE	JK			KE	KE	KE	KF	KF	KJ		
2,400 pF	242	F	G	J	K	M	GB	GH	GK	GO							HE	HJ			JK	JK	JK	JE	JL			KE	KE	KE	KE	KH			
2,700 pF	272	F	G	J	K	M	GB	GH	GK	GO							HE	HK			JK	JK	JK	JE	JL			KE	KE	KE	KE	KH			
3,000 pF	302	F	G	J	K	M	GB	GH	GK								HE	HK			JK	JK	JK	JE	JL			KE	KE	KE	KE	KH			
3,300 pF	332	F	G	J	K	M	GB	GH	GK								HG				JK	JK	JK	JK	JN			KE	KE	KE	KE	KJ			
3,600 pF	362	F	G	J	K	M	GB	GH	GM								HG				JK	JK	JK	JK	JN			KE	KF	KF	KF	KJ			
3,900 pF	392	F	G	J	K	M	GB	GH	GM								HJ				JK	JK	JK	JK	JN			KE	KF	KF	KF	KJ			
4,300 pF	432	F	G	J	K	M	GH	GH	GO								HJ				JK	JK	JK	JK				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	K	M	GH	GK	GO						HE	HG	HK				JK	JK	JK	JL				KE	KF	KF	KH				
5,600 pF	562	F	G	J	K	M	GH	GK	GO						HE	HG	HK				JK	JK	JK	JN				KE	KF	KF	KH				
6,200 pF	622	F	G	J	K	M	GH	GK	GH						HE	HG					JK	JE	JE	JN				KE	KF	KF	KJ				
6,800 pF	682	F	G	J	K	M	GH	GM	GH						HE	HJ					JK	JE	JK	JN				KE	KF	KF	KJ				
7,500 pF	752	F	G	J	K	M	GH	GM	GK						HE	HJ					JK	JE	JK					KF	KE	KF					
8,200 pF	822	F	G	J	K	M	GK	GO	GK						HE	HJ					JK	JE	JL					KF	KE	KF					
9,100 pF	912	F	G	J	K	M	GM	GO	GM					HE	HG	HK					JE	JE	JL					KF	KE	KH					
10,000 pF	103	F	G	J	K	M	GM	GO	GM					HE	HG	HK					JE	JE	JL					KF	KE	KH					
12,000 pF	123	F	G	J	K	M	GO	GH	GO					HE	HG	HE					JE	JK	JN					KE	KE	KH					
15,000 pF	153	F	G	J	K	M	GO	GH	GO					HE	HJ	HE					JE	JL	JE					KE	KF	KJ					
18,000 pF	183	F	G	J	K	M	GH	GH						HG	HK	HG					JE	JL	JE					KE	KH	KE					
22,000 pF	223	F	G	J	K	M	GH	GH						HJ	HE	HJ					JK	JN	JK					KF	KJ	KF					
27,000 pF	273	F	G	J	K	M	GK	GK						HJ	HE	HK					JL	JN	JL					KF	KJ	KH					
33,000 pF	333	F	G	J	K	M	GM	GM						HK	HE	HK					JN	JE	JN					KH	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						
0.12 µF	124	F	G	J	K	M																						KJ	KJ						
Cap	Cap 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	10000
		Voltage Code					C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	K
		Case Size/Series					C1812X							C1825X							C2220X							C2225X							

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

Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			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
DD	805	0.90 ± 0.10	0	0	4,000	10,000
DG	805	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
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 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 – Bulk Packaging Quantities

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

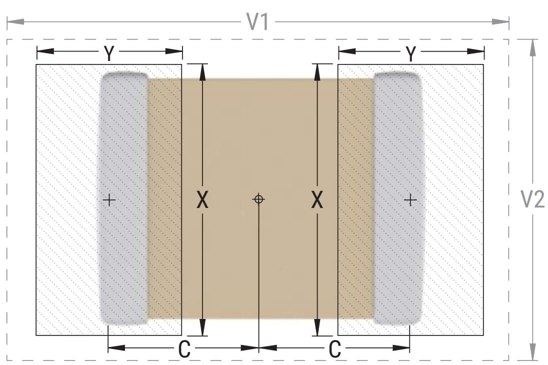
[1] *The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial 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 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)				
		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	
	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.

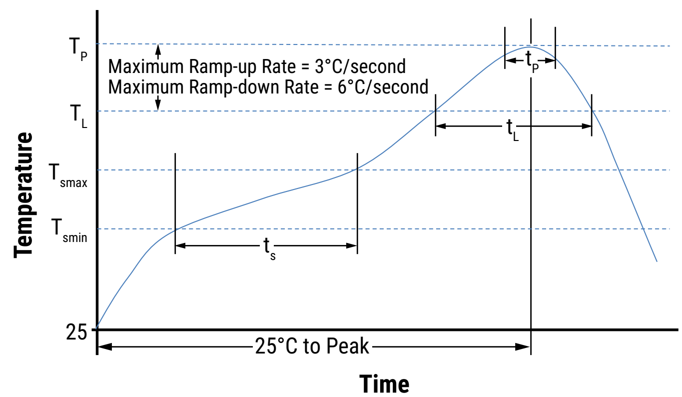


Table 4 – Performance & Reliability: Test Methods and Conditions

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

Step	Temperature (°C)
1	+25°C
2	−55°C
3	+25°C (Reference Temperature)
4	+125°C

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

<table>
<tr><th>Stress</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Dielectric Withstanding Voltage (DWV)</td><td>KEMET Internal</td><td>See Dielectric Withstanding Voltage (DWV) Table
(5 ±1 seconds and charge/discharge not exceeding 50 mA)
<table>
<tr><th>EIA Case Size</th><th>500 V</th><th>630 V</th><th>≥ 1,000 V</th></tr>
<tr><td>0603</td><td rowspan="9">150% of rated voltage</td><td>130% of rated voltage</td><td rowspan="9">120% of rated voltage</td></tr>
<tr><td>0805</td><td>< 620pF 150% of rated voltage
≥ 620pF 130% of rated voltage</td></tr>
<tr><td>1206</td><td>< 5.1nF 150% of rated voltage
≥ 5.1nF 130% of rated voltage</td></tr>
<tr><td>1210</td><td>< 7.5nF 150% of rated voltage
≥ 7.5nF 130% of rated voltage</td></tr>
<tr><td>1808</td><td>< 5.1nF 150% of rated voltage
≥ 5.1nF 130% of rated voltage</td></tr>
<tr><td>1812</td><td>< 12nF 150% of rated voltage
≥ 12nF 130% of rated voltage</td></tr>
<tr><td>1825</td><td>< 22nF 150% of rated voltage
≥ 22nF 130% of rated voltage</td></tr>
<tr><td>2220</td><td>< 27nF 150% of rated voltage
≥ 27nF 130% of rated voltage</td></tr>
<tr><td>2225</td><td>< 33nF 150% of rated voltage
≥ 33nF 130% of rated voltage</td></tr>
</table></td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit

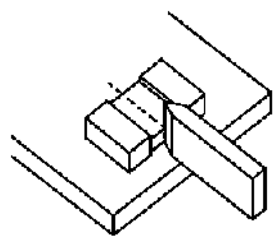
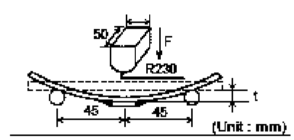
Withstand test voltage without insulation breakdown or damage.</td></tr>
<tr><td>Aging Rate (Maximum % Capacitance Loss/Decade Hour)</td><td>KEMET Internal</td><td>Maximum % capacitance loss/decade hour</td><td>0% Loss/Decade Hour</td></tr>
<tr><td>Terminal Strength</td><td>KEMET Internal</td><td>Shear stress test per specific case size,
Time: 60 ±1 second.
<table>
<tr><th>Case Size</th><th>Force</th></tr>
<tr><td>0603</td><td>5N</td></tr>
<tr><td>0805</td><td>9N</td></tr>
<tr><td>≥ 1206</td><td>18N</td></tr>
</table>
</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Board Flex</td><td>AEC-Q200-005</td><td>Standard Termination System 2.0 mm
Flexible Termination System 3.0 mm
Test Time: 60 ±5 seconds
Ramp Time: 1 mm/second

</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Solderability</td><td>J-STD-002</td><td>Condition: 4 hours ± 15 minutes at 155°C dry bake
apply all methods
Test 245 ±5°C (SnPb & Pb-Free)</td><td>Visual Inspection. 95% coverage on termination. No leaching</td></tr>
<tr><td>Temperature Cycling</td><td>JESD22
Method JA-104</td><td>1,000 cycles (−55°C to +125°C)
2 – 3 cycles per hour
Soak Time 1 or 5 minutes</td><td>Measurement at 24 hours ±4 hours after test conclusion.
Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit</td></tr>
</table>

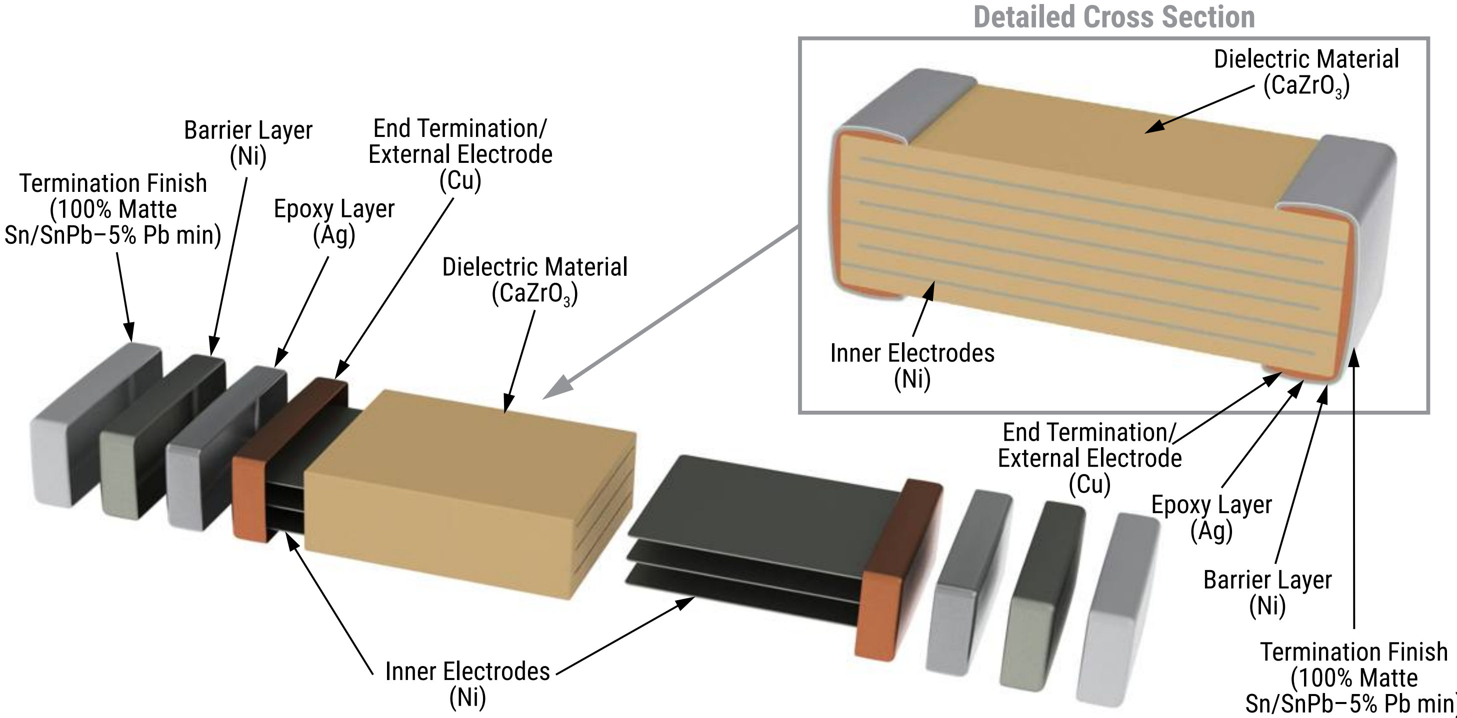
Table 4 – Performance & Reliability: Test Methods and Conditions cont.

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 Method 108	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 DF Limits Maximum: 0.5% IR: 10% of Initial Limit
Storage Life		1,000 hours at 150°C, Unpowered	
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 40ºC 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)

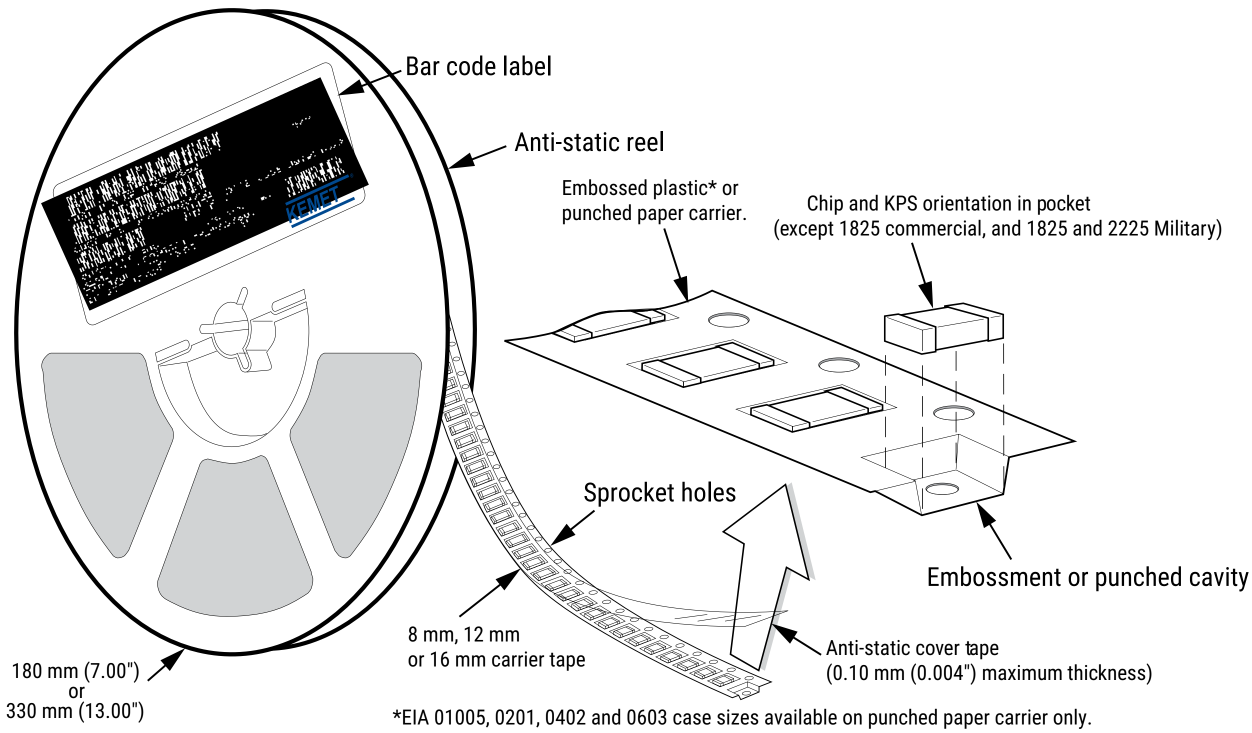
Laser marking option is not available on:

- C0G, 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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

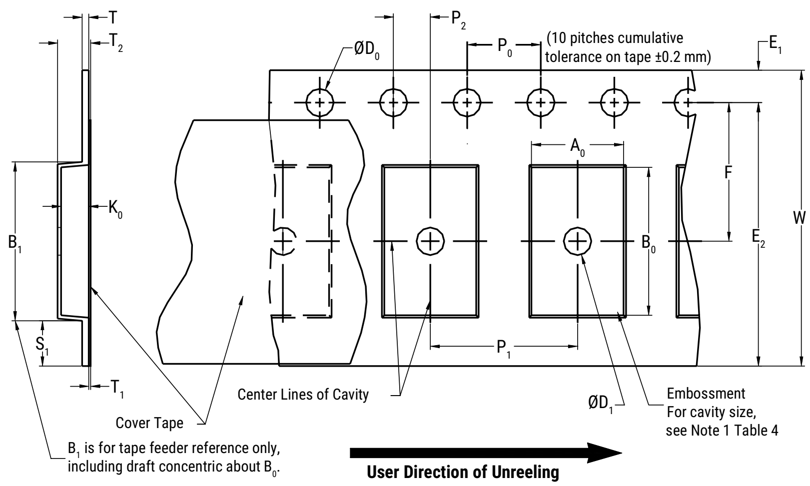


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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 (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)	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 S_1 < 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_0, B_0 and K_0 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

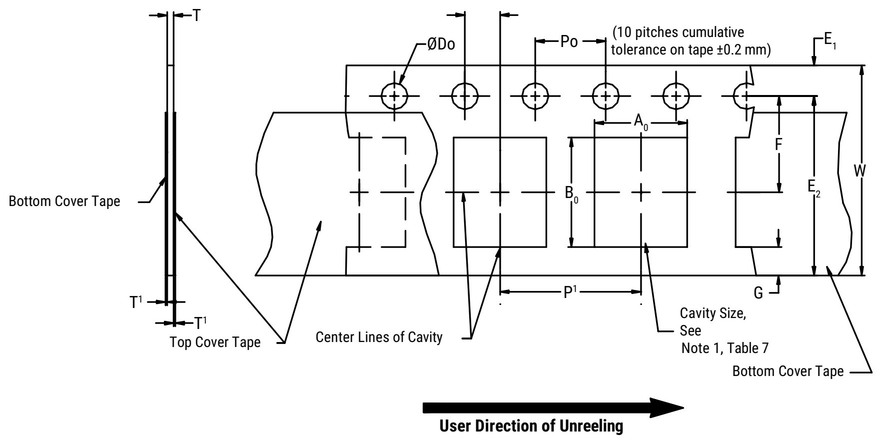


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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.)

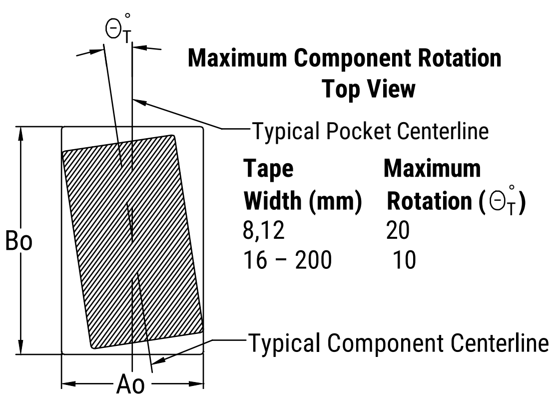
Packaging Information Performance Notes

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



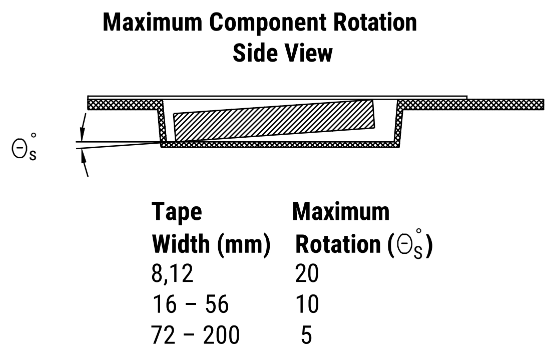


Figure 4 – Maximum Lateral Movement

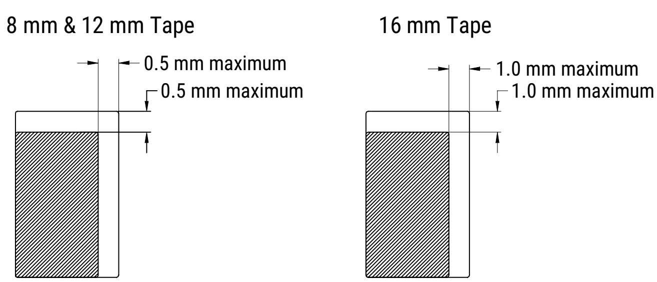


Figure 5 – Bending Radius

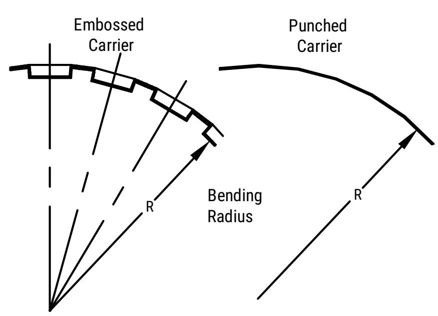
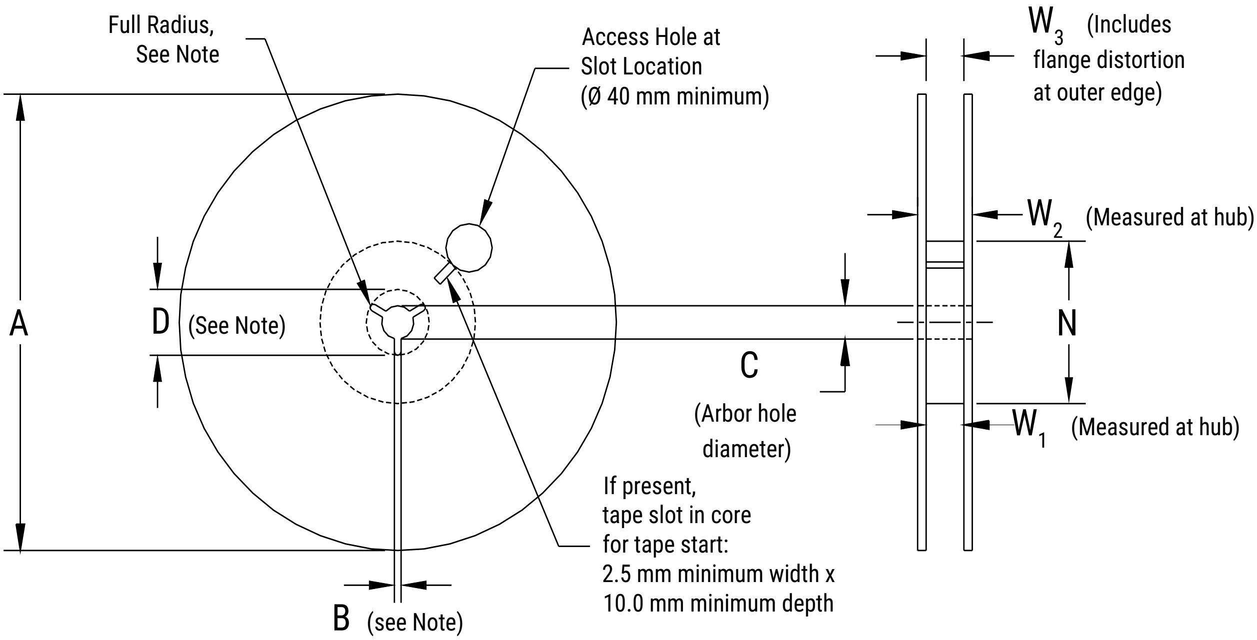


Figure 6 – Reel Dimensions



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	A	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

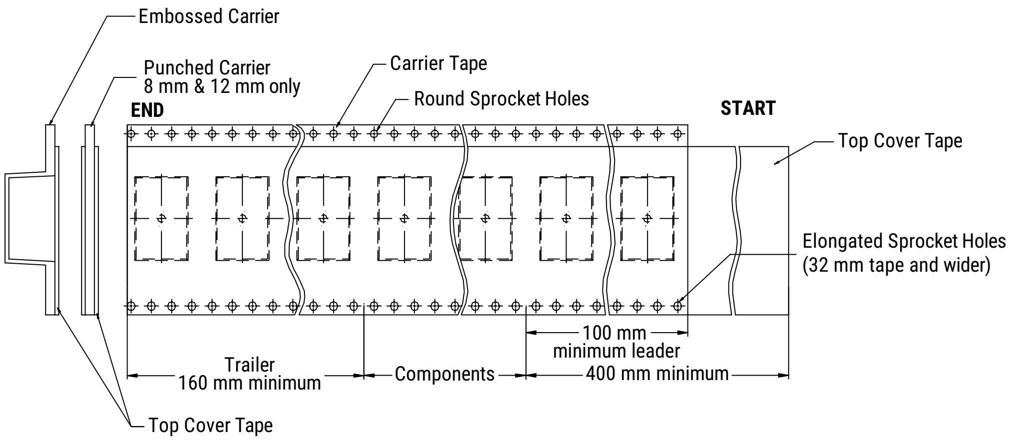
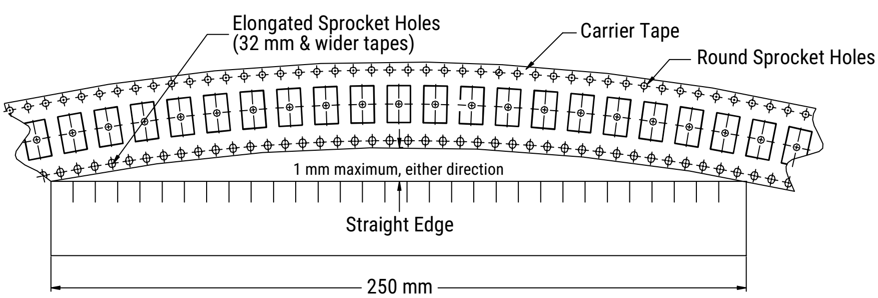


Figure 8 – Maximum Camber



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

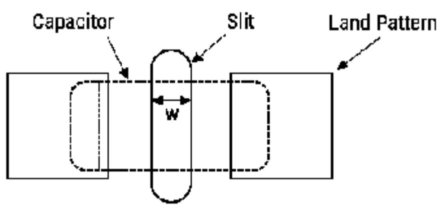
For MLCC ratings ≥1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

Dielectric	CTE (ppm/°C)
Class II $BaTiO_3$	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.



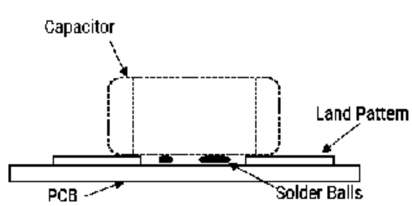
Solder Resist

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 Temperature 175ºC, X7R Dielectric, 16 – 200 VDC (Industrial Grade)

KEMET a YAGEO company

Overview

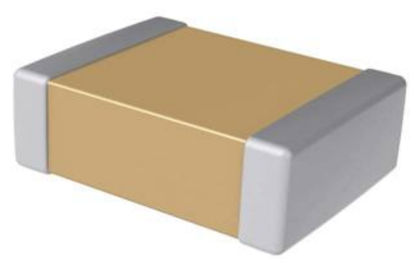
KEMET's High Temperature X7R Dielectric capacitors are formulated and designed for extreme temperature applications. Constructed of a robust and proprietary base metal electrode (BME) dielectric system, these devices are capable of reliable operation in temperatures up to 175°C. Providing an attractive 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	A	C	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

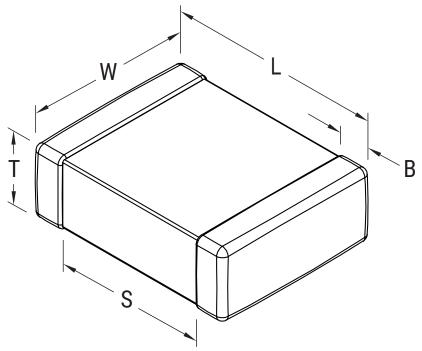
Packaging Type/ Unmarked[2]	Packaging Ordering Code (C-Spec)
Bulk Bag	Blank [1]
Waffle Tray	7292
7" Tape & Reel	TU
7" Tape & Reel / 2mm pitch[3]	7081
7" Tape & Reel - 50 pcs	T050
7" Tape & Reel - 100 pcs	T100
7" Tape & Reel - 250 pcs	T250
7" Tape & Reel - 500 pcs	T500
7" Tape & Reel - 1,000 pcs	T1K0

[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)	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)		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)	See Table 2 for Thickness	0.45 (0.018) ±0.15 (0.006)	0.58 (0.023)	Solder Wave or Solder Reflow
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)	
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	
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
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)		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 MΩ-µF value by the capacitance and compare to GΩ 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 ≤ 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."

Dissipation Factor Limit Table

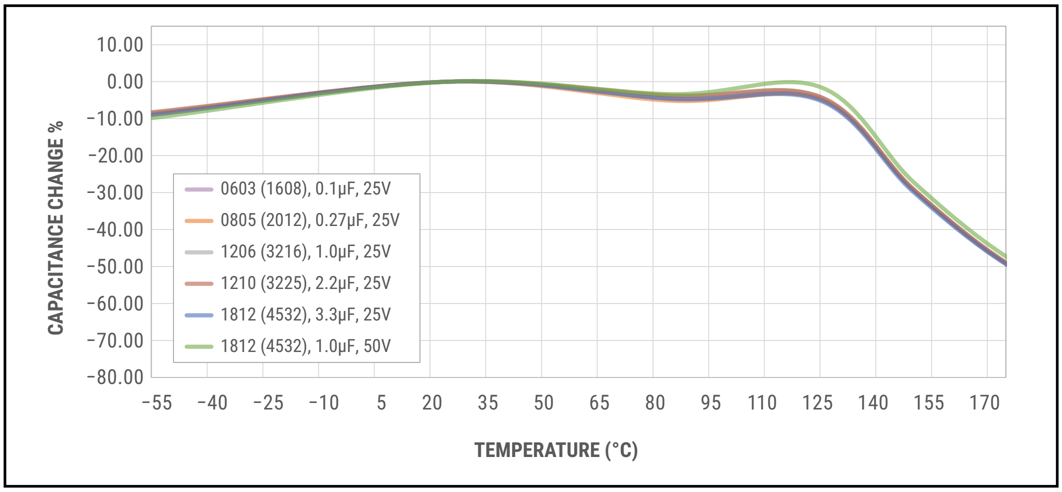
Rated DC Voltage	Dissipation Factor
16/25	3.5%
> 25	2.5%

Post Environmental Limits

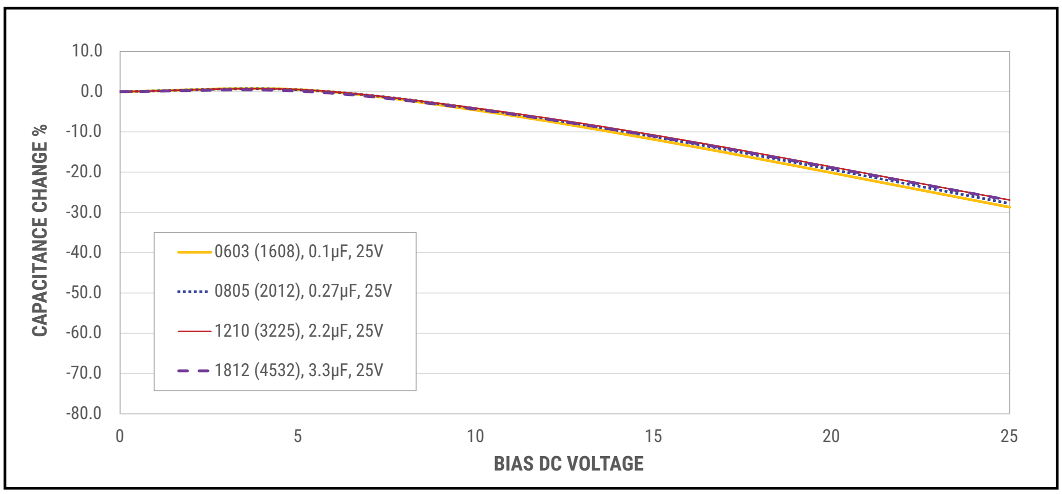
High Temperature Life, Biased Humidity, Moisture Resistance					
Dielectric	Rated DC Voltage	Capacitance Value	Dissipation Factor (Maximum %)	Capacitance Shift	Insulation Resistance
X7R	16/25	All	5.0	± 20%	10% of Initial Limit
	>25		3.0		

Electrical Characteristics

Capacitance vs. Temperature Performance (−55°C to +175°C)



Capacitance vs. Bias Voltage Performance (25 VDC Rated)



Capacitance vs. Bias Voltage Performance (1812 Case Size, 1.0 µF, 50 VDC Rated)

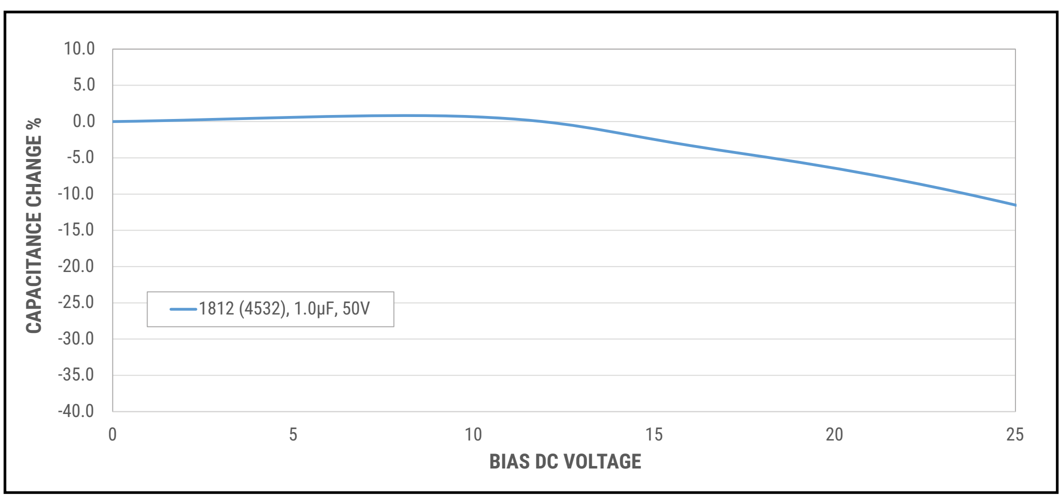


Table 1 – Capacitance Range/Selection Waterfall (0402 – 1812 Case Sizes)

Capacitance	Cap Code	Case Size/ Series			C0402G				C0603G/R			C0805G/R			C1206G/R			C1210G/R			C1812G/R			
		Voltage Code			4	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	2
		Rated Voltage (VDC)			16	25	50	100	25	50	100	25	50	100	25	50	100	25	50	100	25	50	100	200
		Capacitance Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																			
2700 pF	272	J	K	M	BB	BB	BB																	
3300 pF	332	J	K	M	BB	BB	BB																	
3900 pF	392	J	K	M	BB	BB	BB																	
4700 pF	472	J	K	M	BB	BB	BB																	
5600 pF	562	J	K	M	BB	BB	BB																	
6800 pF	682	J	K	M	BB	BB	BB																	
8200 pF	822	J	K	M	BB	BB	BB																	
10000 pF	103	J	K	M	BB	BB	BB																	
12000 pF	123	J	K	M	BB	BB																		
15000 pF	153	J	K	M	BB	BB																		
18000 pF	183	J	K	M	BB	BB			CF	CF														
22000 pF	223	J	K	M	BB	BB			CF	CF														
27000 pF	273	J	K	M					CF	CF														
33000 pF	333	J	K	M					CF	CF														
39000 pF	393	J	K	M					CF	CF														
47000 pF	473	J	K	M	BB				CF	CF		DN	DN											
56000 pF	563	J	K	M					CF	CF		DN	DN								GN	GN	GN	GN
68000 pF	683	J	K	M					CF	CF		DN	DN											
82000 pF	823	J	K	M					CF	CF		DN	DN											
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	M											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	M														FK			GG			
2.7 µF	275	J	K	M																	GJ			
3.3 µF	335	J	K	M																	GL			
Capacitance	Cap Code	Rated Voltage (VDC)			16	25	50	100	25	50	100	25	50	100	25	50	100	25	50	100	25	50	100	200
		Voltage Code			4	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	2
		Case Size/ Series			C0402G				C0603G/R			C0805G/R			C1206G/R			C1210G/R			C1812G/R			

Table 2 – Chip Thickness/Packaging Quantities

Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			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 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 3A – Land Pattern Design Recommendations per IPC–7351 – Standard Termination

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)				
		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.

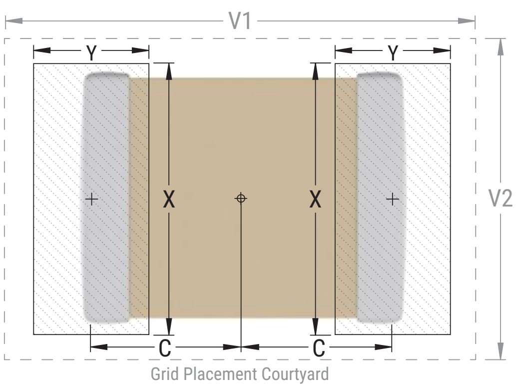
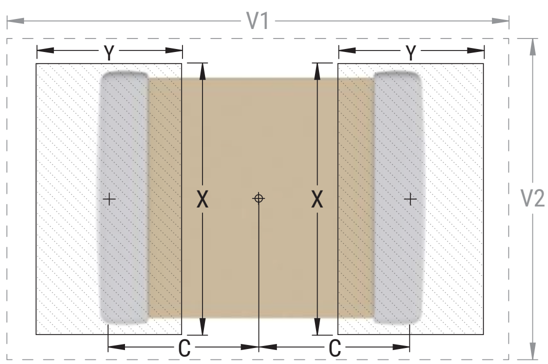


Table 3B – Land Pattern Design Recommendations per IPC–7351 – Flexible Termination

EIA 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)				
		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	
	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.

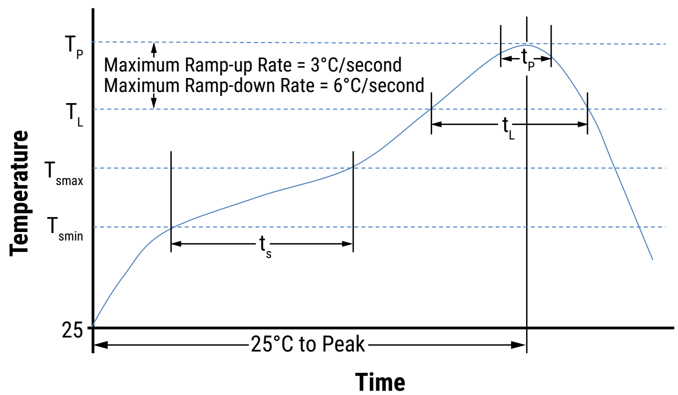


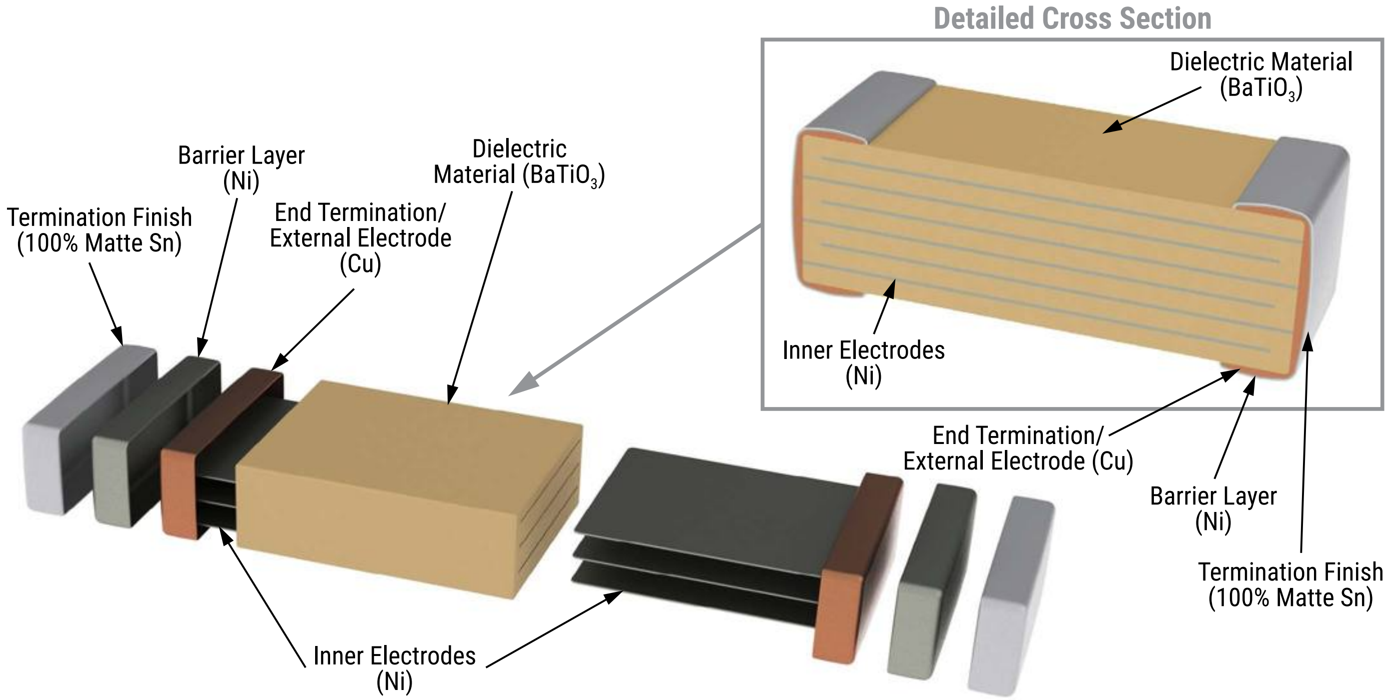
Table 4 – Performance & Reliability: Test Methods and Conditions

<table>
<tr><th>Stress</th><th>Reference</th><th>Test or Inspection Method</th></tr>
<tr><td>Terminal Strength</td><td>JIS–C–6429</td><td>Appendix 1, Note:
<table><tr><th>Package Size (L" x W")</th><th>Force</th><th>Duration</th></tr><tr><td>0402</td><td>5 N (0.51 kg)</td><td rowspan="3">60 seconds</td></tr><tr><td>0603</td><td>10 N (1.02 kg)</td></tr><tr><td>≥ 0805</td><td>18 N (1.83 kg)</td></tr></table></td></tr>
<tr><td>Board Flex</td><td>JIS–C–6429</td><td>Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm for C0G. Flexible termination system – 3.0 mm (minimum).</td></tr>
<tr><td rowspan="4">Solderability</td><td rowspan="4">J–STD–002</td><td>Magnification 50 X. Conditions:</td></tr>
<tr><td>a) Method B, 4 hours at 155°C, dry heat at 235°C</td></tr>
<tr><td>b) Method B at 215°C category 3</td></tr>
<tr><td>c) Method D, category 3 at 260°C</td></tr>
<tr><td>Temperature Cycling</td><td>KEMET defined</td><td>50 cycles (−55°C to +220°C). Measurement at 24 hours +/- 4 hours after test conclusion.</td></tr>
<tr><td rowspan="2">Biased Humidity</td><td rowspan="2">MIL–STD–202 Method 103</td><td>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.</td></tr>
<tr><td>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.</td></tr>
<tr><td>Moisture Resistance</td><td>MIL–STD–202 Method 106</td><td>t = 24 hours/cycle. Steps 7a and 7b not required. Unpowered. Measurement at 24 hours +/−2 hours after test conclusion.</td></tr>
<tr><td>High Temperature Life</td><td>MIL–STD–202 Method 108 /EIA–198</td><td>1,000 hours at 175°C with 2 X rated voltage applied.</td></tr>
<tr><td>Storage Life</td><td>KEMET defined</td><td>200°C, 0 VDC for 1,000 hours.</td></tr>
<tr><td>Vibration</td><td>MIL–STD–202 Method 204</td><td>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</td></tr>
<tr><td>Mechanical Shock</td><td>MIL–STD–202 Method 213</td><td>Figure 1 of Method 213, Condition F.</td></tr>
<tr><td>Resistance to Solvents</td><td>MIL–STD–202 Method 215</td><td>Add aqueous wash chemical, OKEM Clean or equivalent.</td></tr>
</table>

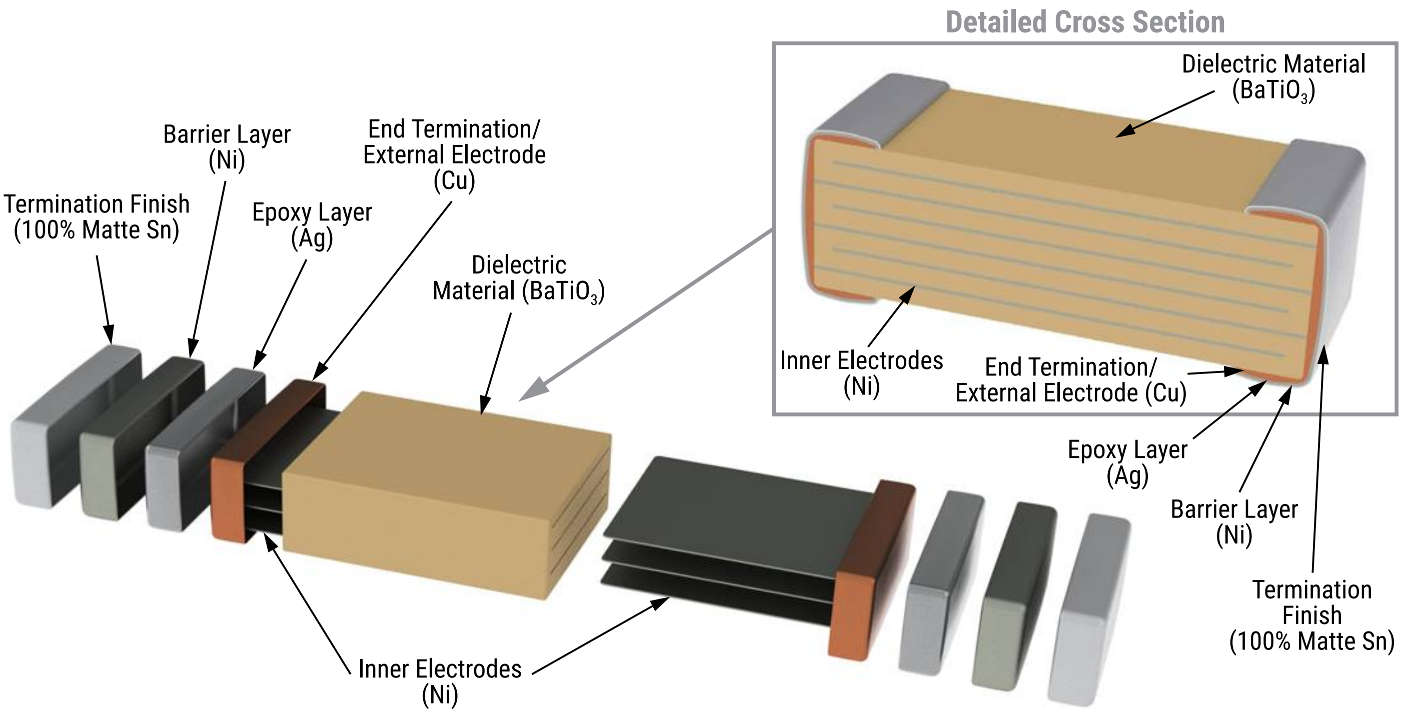
Storage and Handling

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 40ºC 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)

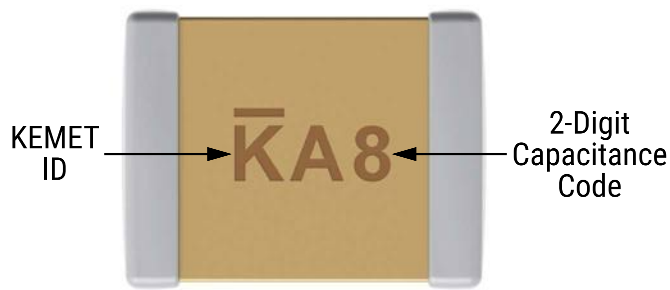
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic 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:

- C0G, 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 µF. Orientation of marking is vendor optional.

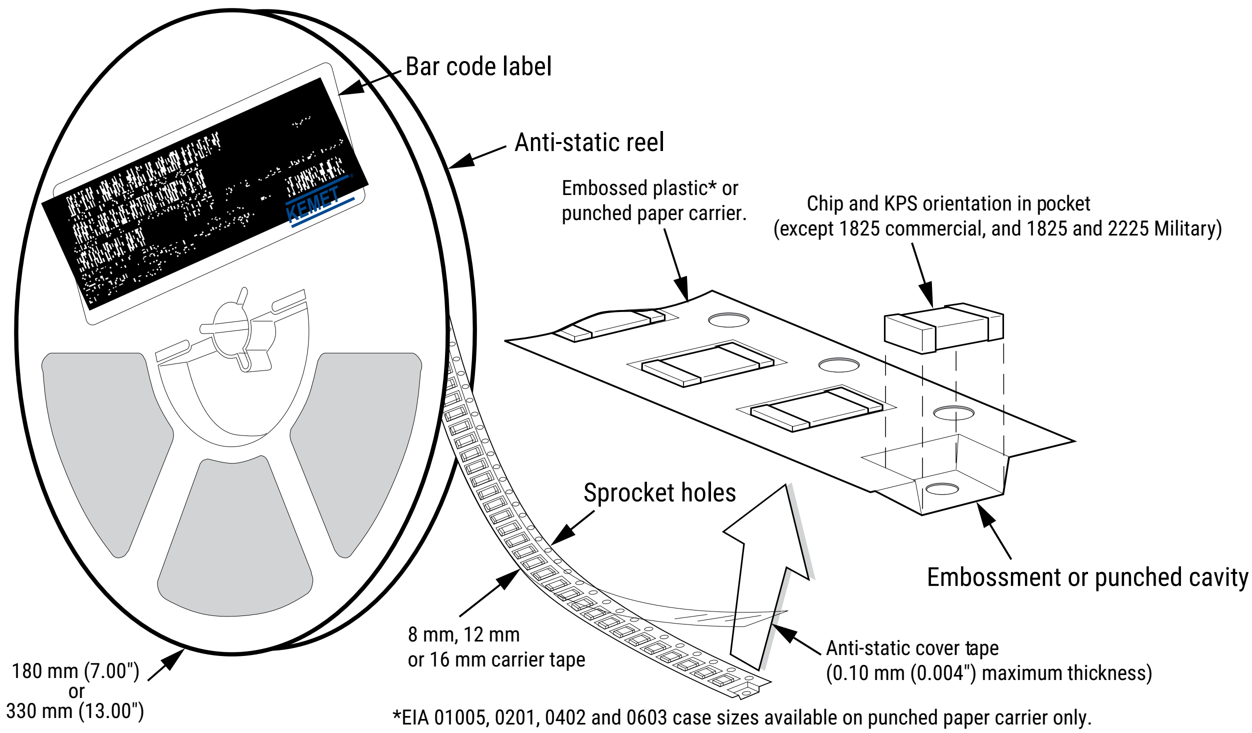


Capacitor Marking (Optional) cont.

Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.10	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

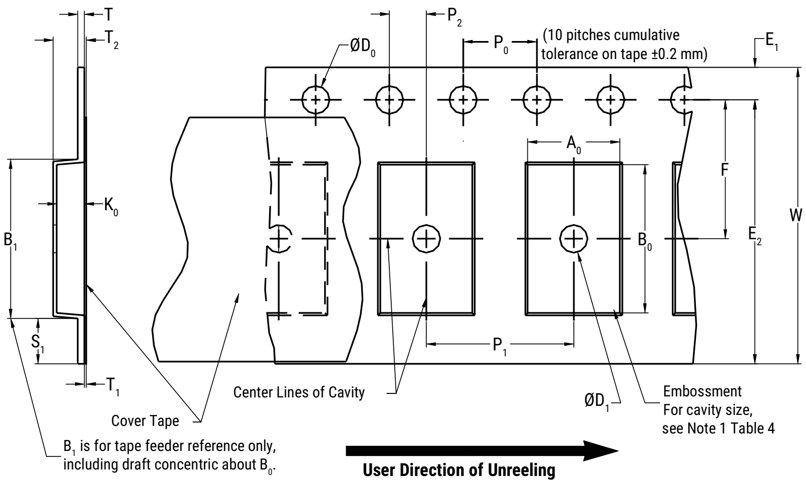


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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 (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)	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 S_1 < 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_0, B_0 and K_0 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

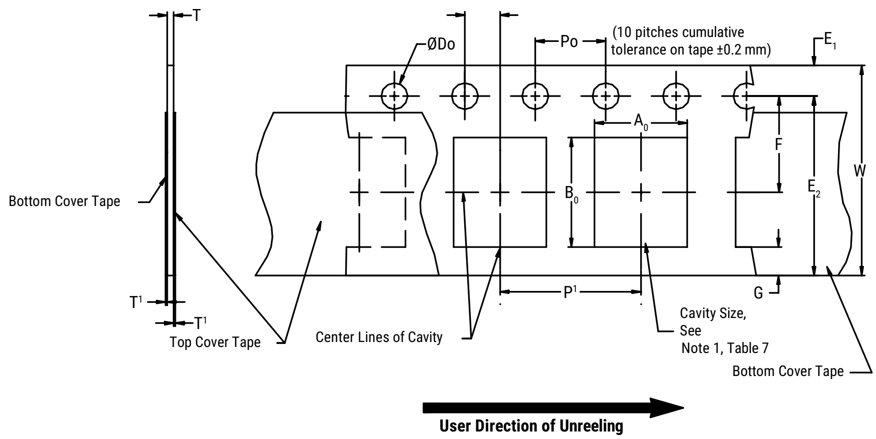


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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

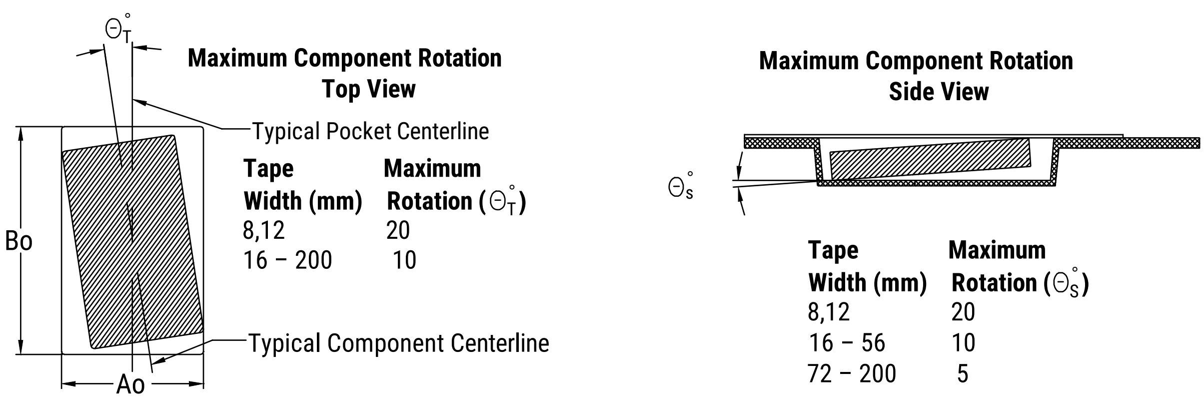


Figure 4 – Maximum Lateral Movement

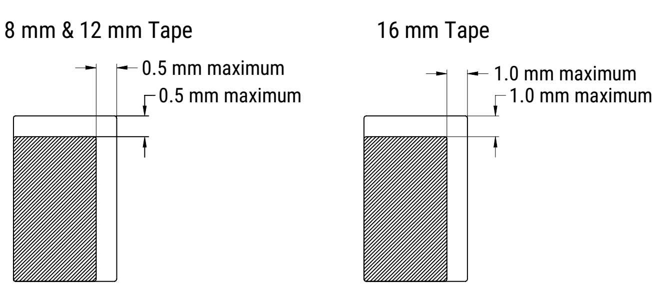


Figure 5 – Bending Radius

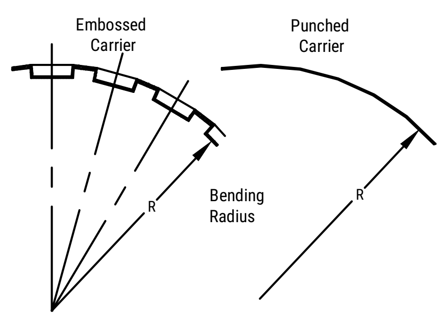
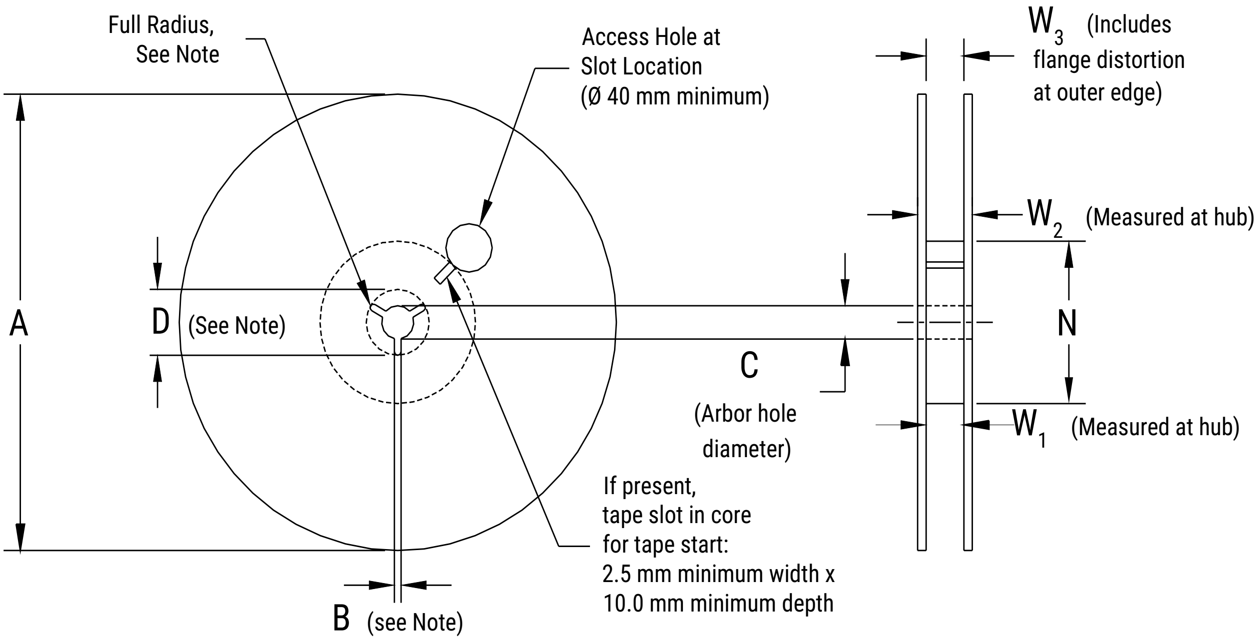


Figure 6 – Reel Dimensions



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

Table 8 – Reel Dimensions

Metric will govern

<table>
<tr><th colspan="5">Constant Dimensions — Millimeters (Inches)</th></tr>
<tr><th>Tape Size</th><th>A</th><th>B Minimum</th><th>C</th><th>D Minimum</th></tr>
<tr><td>8 mm</td><td rowspan="3">178 ±0.20
(7.008 ±0.008)
or
330 ±0.20
(13.000 ±0.008)</td><td rowspan="3">1.5
(0.059)</td><td rowspan="3">13.0 +0.5/−0.2
(0.521 +0.02/−0.008)</td><td rowspan="3">20.2
(0.795)</td></tr>
<tr><td>12 mm</td></tr>
<tr><td>16 mm</td></tr>
<tr><th colspan="5">Variable Dimensions — Millimeters (Inches)</th></tr>
<tr><th>Tape Size</th><th>N Minimum</th><th>W_1</th><th>W_2 Maximum</th><th>W_3</th></tr>
<tr><td>8 mm</td><td rowspan="3">50
(1.969)</td><td>8.4 +1.5/−0.0
(0.331 +0.059/−0.0)</td><td>14.4
(0.567)</td><td rowspan="3">Shall accommodate tape width without interference</td></tr>
<tr><td>12 mm</td><td>12.4 +2.0/−0.0
(0.488 +0.078/−0.0)</td><td>18.4
(0.724)</td></tr>
<tr><td>16 mm</td><td>16.4 +2.0/−0.0
(0.646 +0.078/−0.0)</td><td>22.4
(0.882)</td></tr>
</table>

Figure 7 – Tape Leader & Trailer Dimensions

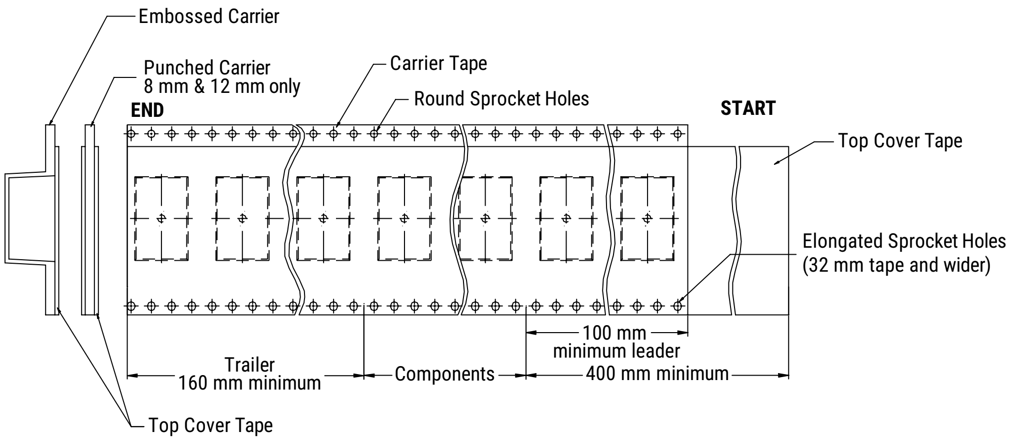
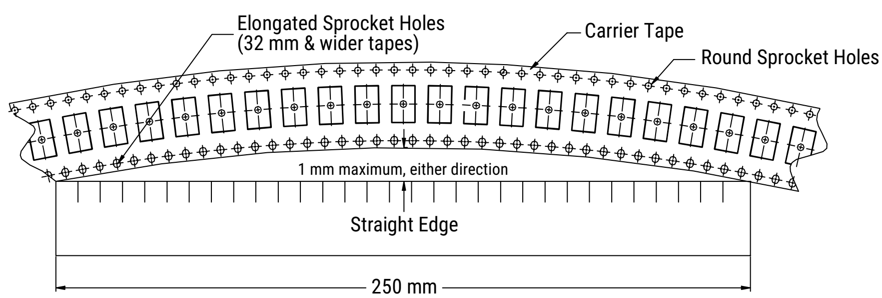


Figure 8 – Maximum Camber



High Voltage X7R Dielectric, 500 – 3,000 VDC (Automotive Grade)

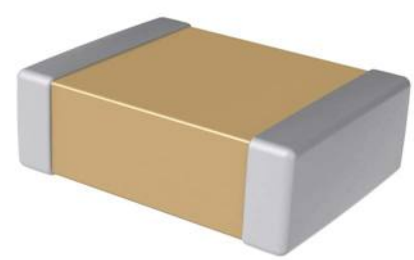
Overview

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

C	1210	C	154	K	C	R	A	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 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.*

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
- 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 & 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
- 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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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:

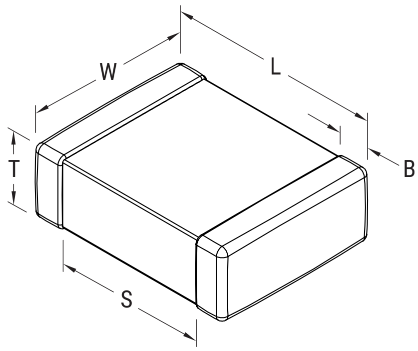
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

[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)



<table>
<tr><th>EIA Size Code</th><th>Metric Size Code</th><th>L Length</th><th>W Width</th><th>T Thickness</th><th>B Bandwidth</th><th>S Separation Minimum</th><th>Mounting Technique</th></tr>
<tr><td>0402</td><td>1005</td><td>1.00 (0.040) ±0.05 (0.002)</td><td>0.50 (0.020) ±0.05 (0.002)</td><td rowspan="10">See Table 2 for Thickness</td><td>0.30 (0.012) ±0.10 (0.004)</td><td>0.30 (0.012)</td><td>Solder Reflow Only</td></tr>
<tr><td>0603</td><td>1608</td><td>1.60 (0.063) ±0.15 (0.006)</td><td>0.80 (0.032) ±0.15 (0.006)</td><td>0.35 (0.014) ±0.15 (0.006)</td><td>0.70 (0.028)</td><td rowspan="3">Solder wave or Solder reflow</td></tr>
<tr><td>0805</td><td>2012</td><td>2.00 (0.079) ±0.20 (0.008)</td><td>1.25 (0.049) ±0.20 (0.008)</td><td>0.50 (0.02) ±0.25 (0.010)</td><td>0.75 (0.030)</td></tr>
<tr><td>1206</td><td>3216</td><td>3.20 (0.126) ±0.20 (0.008)</td><td>1.60 (0.063) ±0.20 (0.008)</td><td>0.50 (0.02) ±0.25 (0.010)</td><td rowspan="7">N/A</td></tr>
<tr><td>1210</td><td>3225</td><td>3.20 (0.126) ±0.20 (0.008)</td><td>2.50 (0.098) ±0.20 (0.008)</td><td>0.50 (0.02) ±0.25 (0.010)</td><td rowspan="6">Solder reflow only</td></tr>
<tr><td>1808</td><td>4520</td><td>4.70 (0.185) ±0.50 (0.020)</td><td>2.00 (0.079) ±0.20 (0.008)</td><td>0.60 (0.024) ±0.35 (0.014)</td></tr>
<tr><td>1812</td><td>4532</td><td>4.50 (0.177) ±0.30 (0.012)</td><td>3.20 (0.126) ±0.30 (0.012)</td><td>0.60 (0.024) ±0.35 (0.014)</td></tr>
<tr><td>1825</td><td>4564</td><td>4.50 (0.177) ±0.30 (0.012)</td><td>6.40 (0.252) ±0.40 (0.016)</td><td>0.60 (0.024) ±0.35 (0.014)</td></tr>
<tr><td>2220</td><td>5650</td><td>5.70 (0.224) ±0.40 (0.016)</td><td>5.00 (0.197) ±0.40 (0.016)</td><td>0.60 (0.024) ±0.35 (0.014)</td></tr>
<tr><td>2225</td><td>5664</td><td>5.60 (0.220) ±0.40 (0.016)</td><td>6.40 (0.248) ±0.40 (0.016)</td><td>0.60 (0.024) ±0.35 (0.014)</td></tr>
</table>

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)

[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 ≤ 10 µF
12 0Hz ±10 Hz and 0.5 ±0.1 V_{rms} if capacitance > 10 µF
[4] To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ 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	150% of rated voltage		120% of rated voltage
0805			
1206			
1210			
1808			
1812			
1825			
2220			
2225			

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	All	3.0	±20%	10% of Initial limit
	16/25		5.0		
	< 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)

Cap	Cap Code	Case Size/ Series			C0402C	C0603C			C0805C			C1206C					C1210C					C1808C							C1812C[2]						
		Voltage Code			C	C	B	D	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	H
		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	500	630	1000	1500	2000	2500	3000
		Capacitance Tolerance			Product Availability and Chip Thickness Codes - See Table 2 for Chip Thickness Dimensions																														
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	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	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
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	GB	GB	GB	GB	GB	GB	GB
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	GB	GB	GB	GB	GB	GB	GB
16 pF	160	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
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	200	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
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	GB	GB	GB	GB	GB	GB	GB
24 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	GB	GB	GB	GB	GB	GB	GB
27 pF	270	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
30 pF	300	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
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	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	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
43 pF	430	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
47 pF	470	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
51 pF	510	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	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
62 pF	620	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
68 pF	680	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
75 pF	750	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	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
91 pF	910	J	K	M					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	M					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	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	M					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	LA	LA	LA	LA	LB	LC	LB	GD	GD	GD	GD	GD	GD	GD
150 pF	151	J	K	M					DG	DG	DG	ED	ED	ED	EF	EG	FG	FG	FG	FM	FM	LA	LA	LA	LA	LB	LC	LB	GD	GD	GD	GD	GD	GD	GK
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	M					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	LA	LA	LB	LC	LC	LC	GB	GB	GB	GB	GB	GH	GB
330 pF	331	J	K	M					DG	DG	DG	ED	ED	EF	EG	EG	FG	FG	FG	FK	FK	LA	LA	LA	LB	LC	LC	LC	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	M					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	J	K	M					DG	DG	DG	ED	ED	EG	EF	EG	FG	FM	FM	FS	FL	LA	LB	LB	LC	LB	LB	LC	GB	GB	GB	GD	GH	GH	GK
680 pF	681	J	K	M					DG	DG	DG	ED	ED	EG	EF	EG	FG	FM	FM	FS	FL	LB	LB	LB	LA	LB	LC	LC	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	K	M	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	LC	LB	LC	LA		GB	GB	GB	GB	GH	GK	GK
1,500 pF	152	J	K	M	BD	CG	CG		DG	DG	DG	ED	ED	ED	EG	EG	FK	FS	FS	FL	FM	LC	LC	LC	LB	LC	LB		GB	GB	GB	GB	GH	GK	
1,800 pF	182	J	K	M		CG			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	K	M		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	LC	LA	LA	LB	LC			GB	GB	GB	GH	GK	GM	
3,300 pF	332	J	K	M		CG			DG	DG	DG	ED	ED	ED	EG		FS	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	ED	ED	ED	EG		FL	FL	FL	FL	FK	LA	LA	LA	LB	LB			GB	GB	GB	GH	GM	GO	
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	M					DG	DG		ED	EF	EF	EF		FL	FL	FL	FM	FK	LA	LB	LB	LC				GH	GH	GH	GK	GK		
6,800 pF	682	J	K	M					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	EG	EG	EF		FL	FL	FL	FK		LA	LB	LB	LC				GH	GH	GH	GK	GM		
10,000 pF	103	J	K	M					DG	DG		EF	EG	EG	EG		FL	FL	FL	FK		LA	LB	LB	LC				GH	GH	GH	GK	GO		
12,000 pF	123	J	K	M					DG	DG		EG	EJ	EJ			FL	FL	FL	FK		LA	LC	LC	LB				GB	GK	GK	GK			
Cap	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	500	630	1000	1500	2000	2500	3000
		Voltage Code			C	C	B	D	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	H
		Case Size/ Series			C0402C	C0603C			C0805C			C1206C					C1210C					C1808C							C1812C[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 X7R with KONNEKT Technology.

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

Cap	Cap Code	Case Size/Series			C0402C	C0603C			C0805C			C1206C					C1210C					C1808C							C1812C[2]						
		Voltage Code			C	C	B	D	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	H
		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	500	630	1000	1500	2000	2500	3000
		Capacitance Tolerance			Product Availability and Chip Thickness Codes - See Table 2 for Chip Thickness Dimensions																														
15,000 pF	153	J	K	M					DG			EG	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	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	M								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																									GS						
Cap	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	500	630	1000	1500	2000	2500	3000
		Voltage Code			C	C	B	D	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	H
		Case Size/Series			C0402C	C0603C			C0805C			C1206C					C1210C					C1808C							C1812C[2]						

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

Capacitance	Cap Code	Case Size/Series			C1825C							C2220C							C2225C						
		Voltage Code			C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		Rated Voltage (VDC)			500	630	1000	1500	2000	2500	3000	500	630	1000	1500	2000	2500	3000	500	630	1000	1500	2000	2500	3000
		Capacitance Tolerance			Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions																				
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
Capacitance	Cap 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
		Voltage Code			C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		Case Size/Series			C1825C							C2220C							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).

[2] Available capacitance values available in X7R with KONNEKT Technology.

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

Capacitance	Cap Code	Case Size/Series			C1825C							C2220C							C2225C						
		Voltage Code			C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		Rated Voltage (VDC)			500	630	1000	1500	2000	2500	3000	500	630	1000	1500	2000	2500	3000	500	630	1000	1500	2000	2500	3000
		Capacitance Tolerance			Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions																				
1,000 pF	102	J	K	M	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	M	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	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	K	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	K	M	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	K	M	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	M	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	M	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	M	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	HK				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	HK					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					
0.39 µF	394	J	K	M	HK							JN							KH	KJ					
0.47 µF	474	J	K	M								JN							KH	KJ					
0.56 µF	564	J	K	M															KJ						
0.56 µF	564	J	K	M																					
Capacitance	Cap 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
		Voltage Code			C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		Case Size/Series			C1825C							C2220C							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 Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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	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
EF	1206	1.20 ± 0.15	0	0	2,500	10,000
EG	1206	1.60 ± 0.15	0	0	2,000	8,000
EJ	1206	1.70 ± 0.20	0	0	2,000	8,000
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
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	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
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	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 Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[1]		Plastic Quantity	

Package quantity based on finished chip thickness specifications.

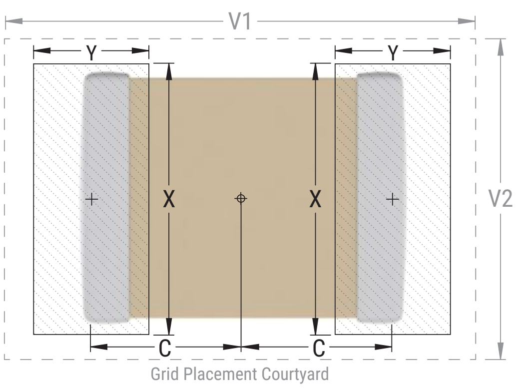
[1] *If ordering using the 2 mm Tape & Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information".*

Table 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)				
		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:

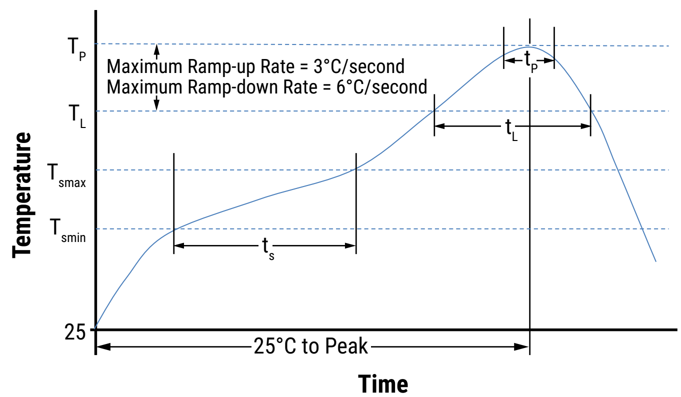
- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- All other EIA case sizes are limited to solder reflow only

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.

Profile Feature	Termination Finish	
	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

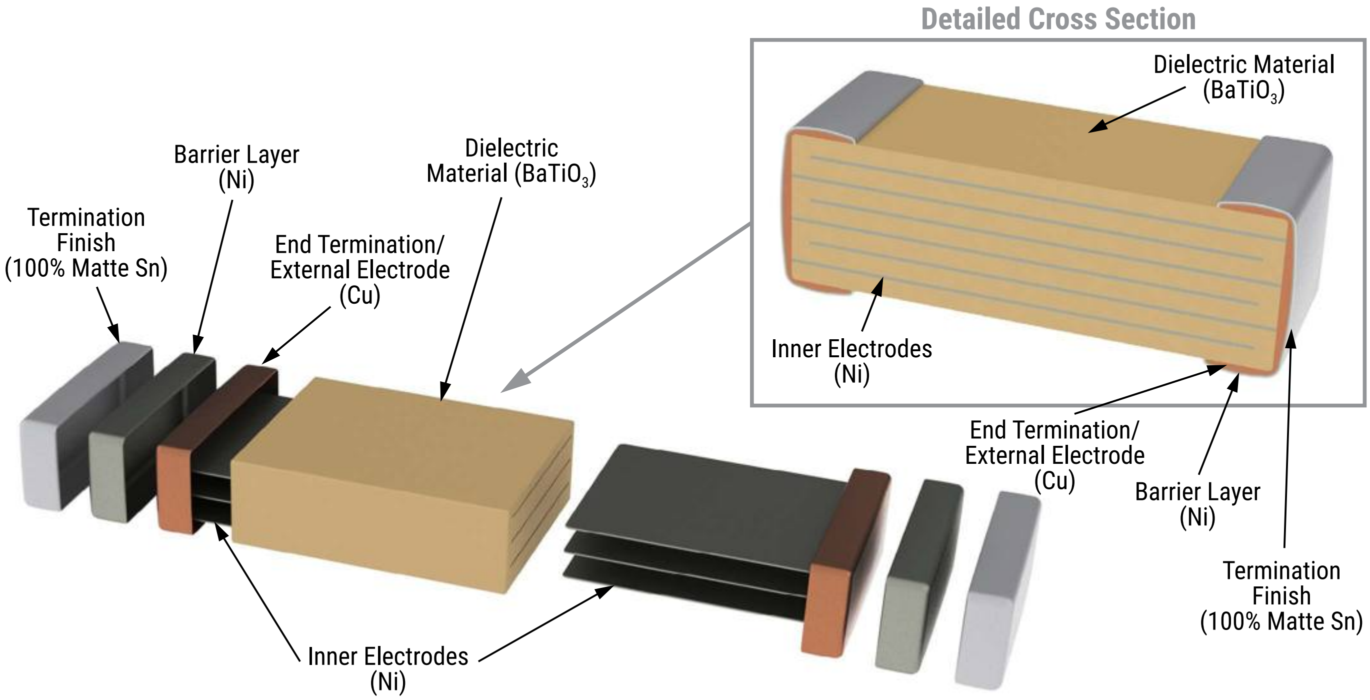
Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.



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 40ºC 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)

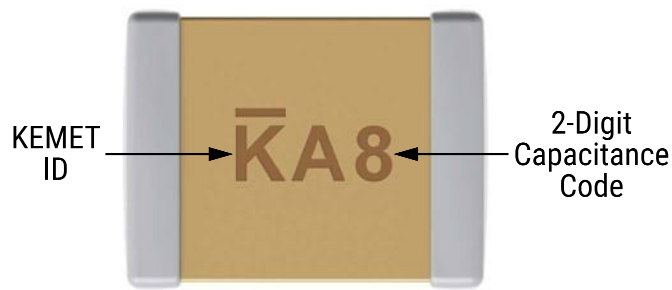
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic 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:

- C0G, 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 µF. Orientation of marking is vendor optional.

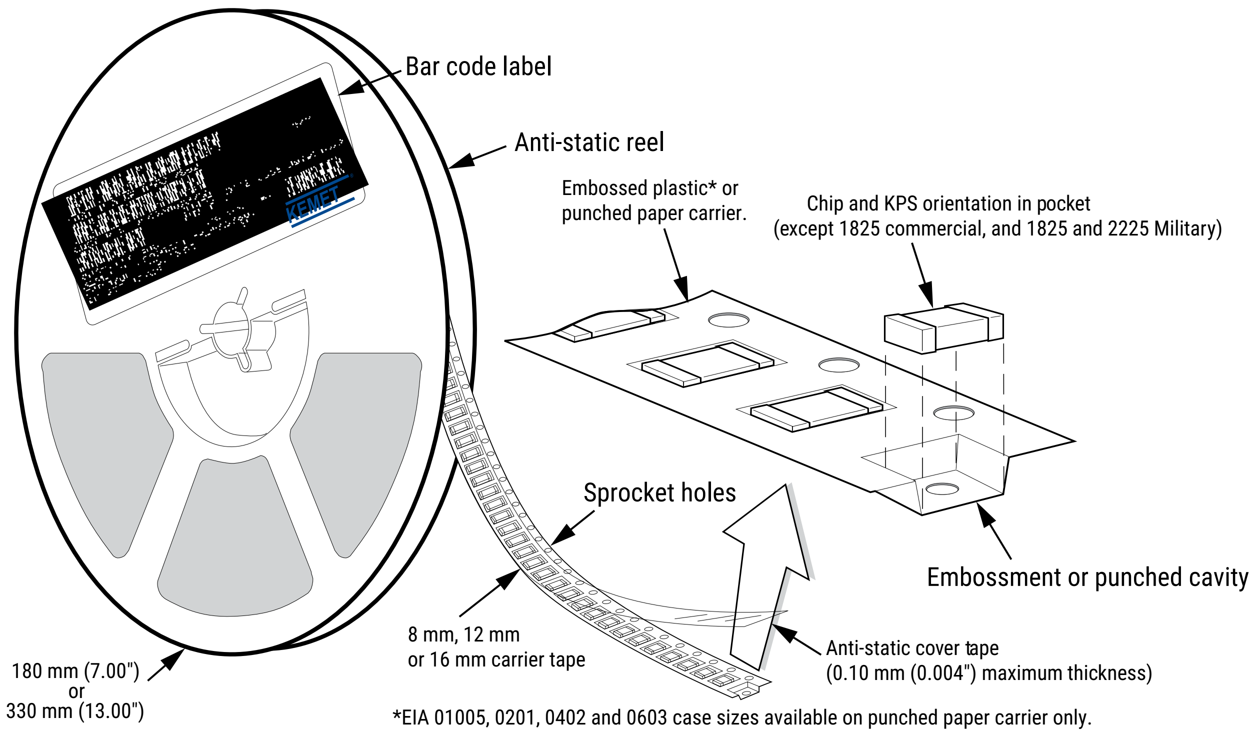


Capacitor Marking (Optional) cont.

Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.10	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

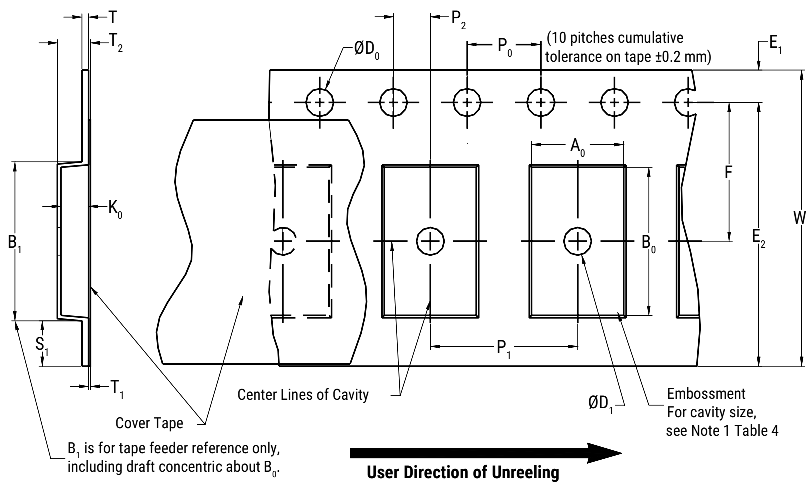


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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 (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)	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 S_1 < 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_0, B_0 and K_0 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

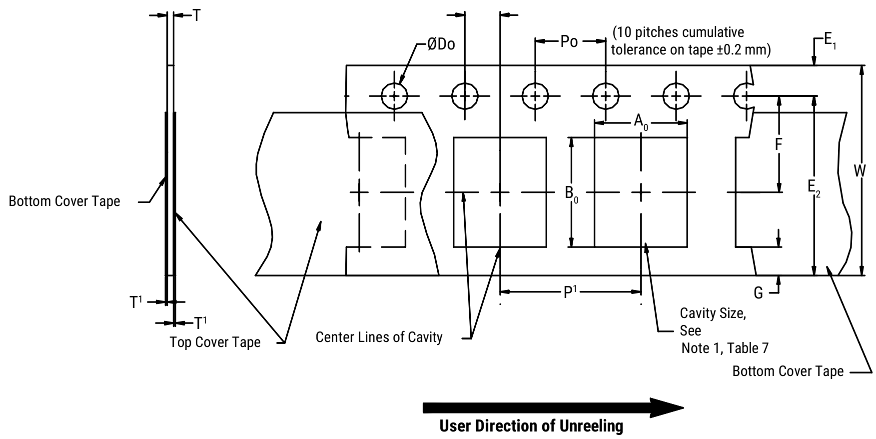


Table 7 – Punched (Paper) Carrier Tape Dimensions

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_0B_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_0, B_0 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.)

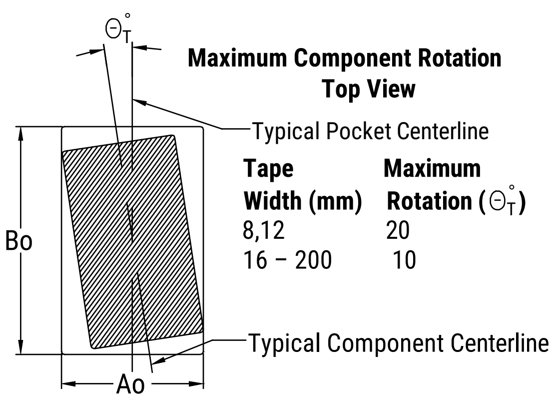
Packaging Information Performance Notes

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



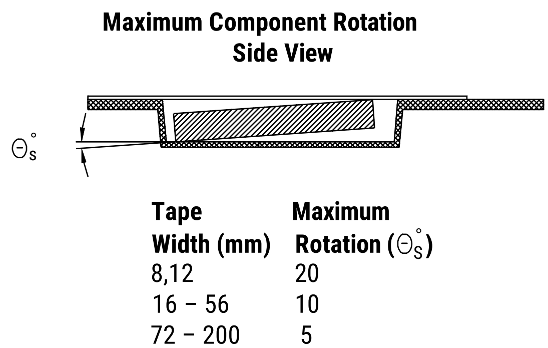


Figure 4 – Maximum Lateral Movement

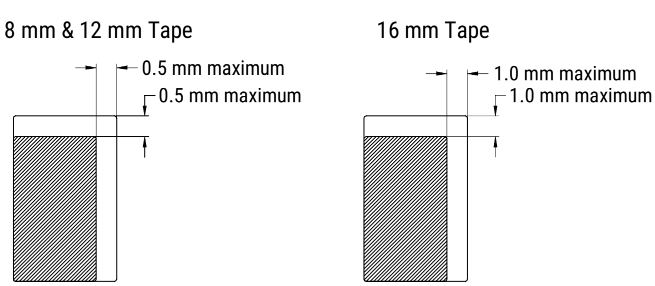


Figure 5 – Bending Radius

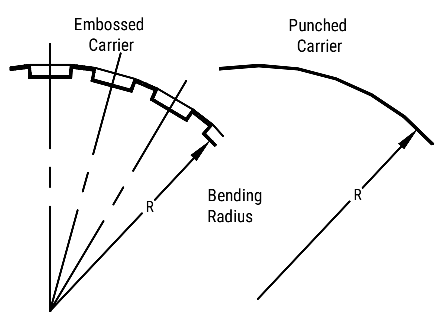
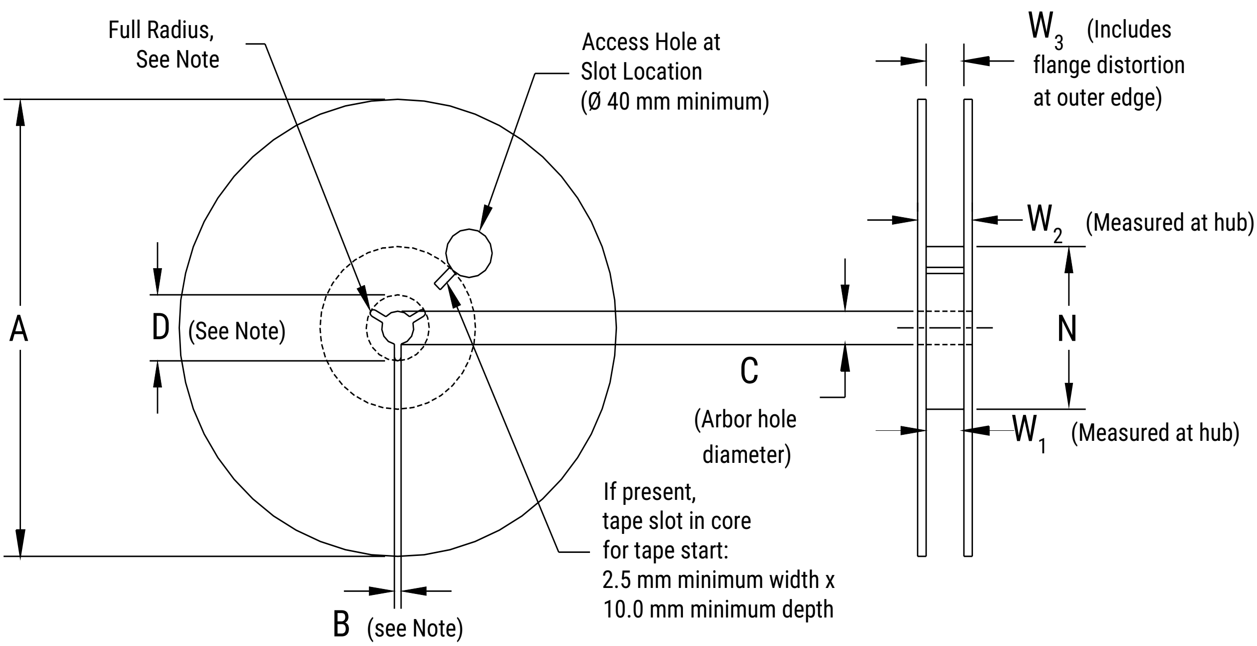


Figure 6 – Reel Dimensions



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	A	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

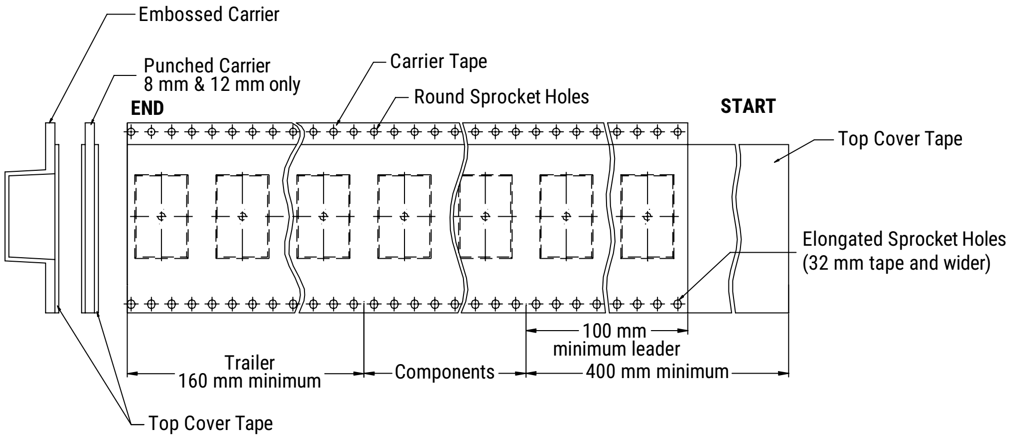
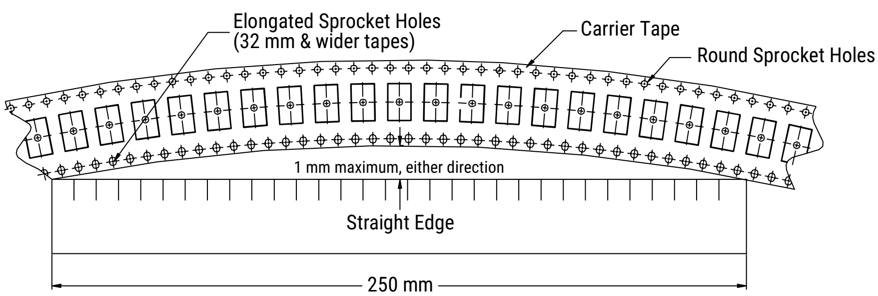


Figure 8 – Maximum Camber



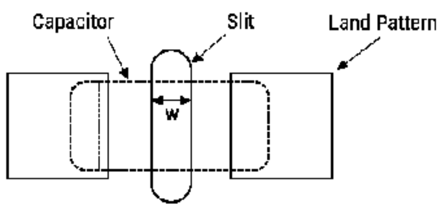
Application Guide

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 ≥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.

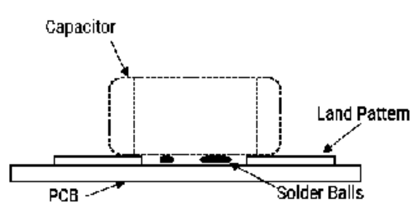
Dielectric	CTE (ppm/°C)
Class II $BaTiO_3$	10.7
Class I $CaZrO_3$	9.8

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 (Automotive Grade)

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 ±15% from −55°C to +125°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

C	1206	X	106	K	4	R	A	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)[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.*

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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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:

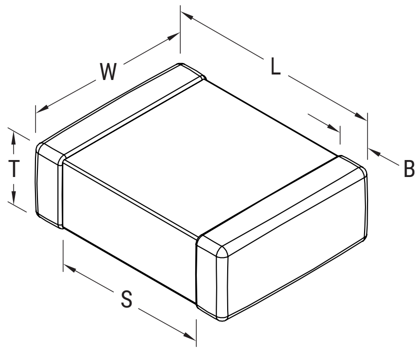
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

[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)	See Table 2 for Thickness	0.45 (0.018) ±0.15 (0.006)	0.58 (0.023)	Solder wave or Solder reflow
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)	
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	
1210	3225	3.30 (.130) ±0.40 (.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)		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)		
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)		

[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 µF or ≥ 2.2 µF 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*

[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 ≤ 10 µF
120 Hz ± 10 Hz and 0.5 ± 0.1 V_{rms} if capacitance > 10 µF

[4] *To obtain IR limit, divide MΩ – µF value by the capacitance and compare to GΩ 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
0603	≤ 200 V	< 0.047 µF	≥ 0.047 µf < 0.47 µf	≥ 0.47 µf
	250 V	N/A	N/A	ALL
0805[1]	≤ 200 V	< 0.15 µF	≥ 0.15 µF < 2.2 µf	≥ 2.2 µf
	250 V	< .027 µF	N/A	≥ .027 µF
1206	≤ 200 V	< 0.47 µF	≥ 0.47 µF < 2.2 µf	≥ 2.2 µf
	250 V	< 0.12 µF	N/A	≥ 0.12 µF
1210[2]	≤ 200 V	< 0.39 µF	≥ 0.39 µF < 10 µf	≥ 10 µf
	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 %)
0603[1]	< 16	< 1.0 µF	5.0
	16/25		3.5
	> 25		2.5
	All	≥ 1.0 µF	10.0
0805[2]	< 16	< 4.7 µF	5.0
		≥ 4.7 µF	10.0
	16	< 4.7 µF	3.5
		≥ 4.7 µF	10.0
	25	< 2.2 µF	3.5
		≥ 2.2 µF	10.0
	> 25	<1.0 µF	2.5
		≥ 1.0 µF	10.0

EIA Case Size	Rated DC Voltage	Capacitance	Dissipation Factor (Maximum %)
1206[3]	< 16	All	5.0
	16/25	All	3.5
	> 25	All	2.5
1210[4]	< 16	All	5.0
	16	All	3.5
	25	< 10 µF	3.5
		≥ 10 µF	10.0
	> 25	All	2.5
	50	All	2.5
	> 50	All	2.5
1808 – 2225	< 16	All	5.0
	16/25	All	3.5
	> 25	All	2.5

[1] *For Capacitance values 0.22 µF (16 and 25 Volts) DF is 5% and for Capacitance value 4.7µF (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 ≥ 10 µF (≤ 16 V) DF is 10% and for Capacitance value 4.7 µF (50 V) DF is 5%*

Post Environmental Limits

High Temperature Life, Biased Humidity, Moisture Resistance

EIA Case Size	Rated DC Voltage	Capacitance	Dissipation Factor (Maximum %)	Capacitance Shift	Insulation Resistance
0603[1]	< 16	< 1.0 µF	7.5	±20%	10% of Initial limit
	16/25		5.0		
	> 25		3.0		
	All	≥ 1.0 µF	20.0		
0805[2]	< 16	< 4.7 µF	7.5		
		≥ 4.7 µF	20.0		
	16	< 4.7 µF	5.0		
		≥ 4.7 µF	20.0		
	25	< 2.2 µF	5.0		
		≥ 2.2 µF	20.0		
	> 25	< 1.0 µF	3.0		
		≥ 1.0 µF	20.0		
1206[3]	< 16	All	7.5		
	16/25	All	5.0		
	> 25	All	3.0		
1210[4]	< 16	All	7.5		
	16	All	5.0		
	25	< 10µF	5.0		
		≥ 10µF	20.0		
	> 25	All	3.0		
	50	All	3.0		
	> 50	All	3.0		
1808 - 2225	< 16	All	7.5		
	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 ≥ 10 µF (≤ 16 V) DF is 20% and for Capacitance value 4.7 µF (50 V) DF is 7.5%*

Table 1A – Capacitance Range/Selection Waterfall (0603 – 1210 Case Sizes)

Cap	Cap Code	Case Size/ Series			C0603X								C0805X								C1206X								C1210X							
		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
		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
		Cap Tolerance			Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions																															
180 pF	181	J	K	M	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	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	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	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	272	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
4,700 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	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	M	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
15,000 pF	153	J	K	M	CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DD	DR	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN	FN	FN	FN
18,000 pF	183	J	K	M	CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DD	DR	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN	FN	FN	FN
22,000 pF	223	J	K	M	CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DD	DR	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN	FN	FN	FN
27,000 pF	273	J	K	M	CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DD	DS	DG	EQ	EQ	EQ	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN	FN	FN	FN
33,000 pF	333	J	K	M	CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DD	DS	DG	EQ	EQ	EQ	EQ	EQ	EQ	EQ	EQ	FN	FN	FN	FN	FN	FN	FN	FN
39,000 pF	393	J	K	M	CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DD	DS	DG	EQ	EQ	EQ	EQ	EQ	ER	EQ	EQ	FN	FN	FN	FN	FN	FN	FN	FN
47,000 pF	473	J	K	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
Cap	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
		Case Size/ Series			C0603X								C0805X								C1206X								C1210X							

Table 1A – Capacitance Range/Selection Waterfall (0603 – 1210 Case Sizes) cont.

Cap	Cap Code	Case Size/ Series			C0603X								C0805X								C1206X								C1210X							
		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
		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
		Cap Tolerance			Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions																															
56,000 pF	563	J	K	M	CJ	CJ	CJ	CJ	CJ				DD	DD	DD	DD	DD	DS	DG	DG	EQ	EQ	EQ	EQ	EQ	EQ	ES	ES	FN	FN	FN	FN	FN	FN	FQ	FQ
68,000 pF	683	J	K	M	CJ	CJ	CJ	CJ	CJ				DD	DD	DD	DD	DD	DS	DG	DG	EQ	EQ	EQ	EQ	EQ	EQ	ES	ES	FN	FN	FN	FN	FN	FN	FQ	FQ
82,000 pF	823	J	K	M	CJ	CJ	CJ	CJ	CJ				DD	DD	DD	DD	DD	DS			EQ	EQ	EQ	EQ	EQ	EQ	ES	ES	FN	FN	FN	FN	FN	FQ	FA	FA
0.10 µF	104	J	K	M	CJ	CJ	CJ	CJ	CJ				DR	DR	DR	DR	DR	DS			EQ	EQ	EQ	EQ	EQ	EQ	EM	EM	FN	FN	FN	FN	FN	FX	FZ	FZ
0.12 µF	124	J	K	M	CJ	CJ	CJ	CJ	CJ				DR	DR	DR	DR	DD	DG			ER	ER	ER	ER	ER	ER	EU	EM	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			ER	ER	ER	ER	ER	ER	EU	EH	FQ	FQ	FQ	FQ	FQ	FX	FM	FM
0.18 µF	184	J	K	M	CJ	CJ	CJ	CJ					DR	DR	DR	DR	DD	DG			ER	ER	ER	ER	ER	ER	EM	EM	FQ	FQ	FQ	FQ	FQ	FX	FK	FK
0.22 µF	224	J	K	M	CJ	CJ	CJ	CJ	CJ				DR	DR	DR	DR	DD	DG			ER	ER	ER	ER	ER	ER	EH	EH	FQ	FQ	FQ	FQ	FQ	FX	FK	FK
0.27 µF	274	J	K	M	CJ	CJ	CJ						DD	DD	DD	DD	DD				EQ	EQ	EQ	EQ	ER	EM			FQ	FQ	FQ	FQ	FQ	FX	FP	FP
0.33 µF	334	J	K	M	CJ	CJ	CJ						DD	DD	DD	DD	DD				EQ	EQ	EQ	EQ	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				EQ	EQ	EQ	EQ	ER	EU			FX	FX	FX	FX	FX	FX	FK	FK
0.47 µF	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	J	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									DD	DD	DD	DG	DH				ET	ET	ET	ET	ES	EM			FX	FX	FX	FX	FX	FZ		
0.82 µF	824	J	K	M									DD	DD	DD	DG					EF	EF	EF	EF	ES	EH			FA	FA	FA	FA	FA	FL		
1.0 µF	105	J	K	M	CJ	CJ	CJ						DD	DD	DD	DG	DH				EF	EF	EF	EU	ES	EH			FU	FU	FU	FU	FU	FM		
1.2 µF	125	J	K	M									DS	DS	DS						ES	ES	ES	EU	EH				FU	FU	FU	FU	FZ	FH		
1.5 µF	155	J	K	M									DG	DG	DG						ES	ES	ES	EU	EH				FU	FU	FU	FU	FZ	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	J	K	M									DG	DG	DG	DG	DT				EA	EA	EA	EH	EH				FJ	FJ	FJ	FJ	FZ	FK		
2.7 µF	275	J	K	M																	EN	EN	EN	EH					FE	FE	FE	FZ	FU			
3.3 µF	335	J	K	M																	ES	ES	ES	EH					FA	FA	FA	FM	FM			
3.9 µF	395	J	K	M																	EF	EF	EF	EH					FZ	FZ	FZ	FZ	FK			
4.7 µF	475	J	K	M									DH	DH	DH	DH					EA	EA	EA	EA	EA				FQ	FQ	FQ	FZ	FS			
5.6 µF	565	J	K	M																	EH	EH	EH						FA	FA	FA	FU				
6.8 µF	685	J	K	M																	EH	EH	EH						FZ	FZ	FZ	FM				
8.2 µF	825	J	K	M																	EH	EH	EH						FU	FU	FU	FK				
10 µF	106	J	K	M									DH	DH							EA	EA	EA	EA					FS	FS	FS	FS				
22 µF	226	J	K	M																									FS	FS						
Cap	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
		Case Size/ Series			C0603X								C0805X								C1206X								C1210X							

Table 1B – Capacitance Range/Selection Waterfall (1808 – 2225 Case Sizes)

Cap	Cap Code	Case Size/ Series			C1808X				C1812X					C1825X				C2220X					C2225X			
		Voltage Code			5	1	2	A	3	5	1	2	A	5	1	2	A	3	5	1	2	A	5	1	2	A
		Rated Voltage (VDC)			50	100	200	250	25	50	100	200	250	50	100	200	250	25	50	100	200	250	50	100	200	250
		Cap Tolerance			Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions																					
4,700 pF	472	J	K	M	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	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB									
27,000 pF	273	J	K	M	LD	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB									
33,000 pF	333	J	K	M	LD	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB									
39,000 pF	393	J	K	M	LD	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB									
47,000 pF	473	J	K	M	LD	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB									
56,000 pF	563	J	K	M	LD	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB									
68,000 pF	683	J	K	M	LD				GB	GB	GB	GB	GB	HB	HB	HB	HB									
82,000 pF	823	J	K	M	LD				GB	GB	GB	GB	GB	HB	HB	HB	HB	JC	JC	JC	JC	JC				
0.10 µF	104	J	K	M	LD				GB	GB	GB	GB	GB	HB	HB	HB	HB	JC	JC	JC	JC	JC	KC	KC	KC	KC
0.12 µF	124	J	K	M	LD				GB	GB	GB	GB	GB	HB	HB	HB	HB	JC	JC	JC	JC	JC	KC	KC	KC	KC
0.15 µF	154	J	K	M	LD				GB	GB	GB	GE	GE	HB	HB	HB	HB	JC	JC	JC	JC	JC	KC	KC	KC	KC
0.18 µF	184	J	K	M	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	M					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			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			
1.8 µF	185	J	K	M					GE	GE	GE			HD				JD	JD				KD			
2.2 µF	225	J	K	M					GG	GG	GG			HF				JF	JF				KD			
2.7 µF	275	J	K	M					GJ	GJ	GJ															
3.3 µF	335	J	K	M					GL	GL	GL															
4.7 µF	475	J	K	M					GK	GK																
10 µF	106	J	K	M					GK									JF	JO							
15 µF	156	J	K	M														JO								
22 µF	226	J	K	M														JO								
Cap	Cap Code	Rated Voltage (VDC)			50	100	200	250	25	50	100	200	250	50	100	200	250	25	50	100	200	250	50	100	200	250
		Voltage Code			5	1	2	A	3	5	1	2	A	5	1	2	A	3	5	1	2	A	5	1	2	A
		Case Size/ Series			C1808X				C1812X					C1825X				C2220X					C2225X			

Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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
DH	0805	1.25 ±0.20	0	0	2,500	10,000
DT	0805	1.25 ± 0.25	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
EN	1206	0.95 ±0.10	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
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
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
FS	1210	2.50 ±0.30	0	0	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
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
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 Code	Case Size1	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[1]		Plastic Quantity	

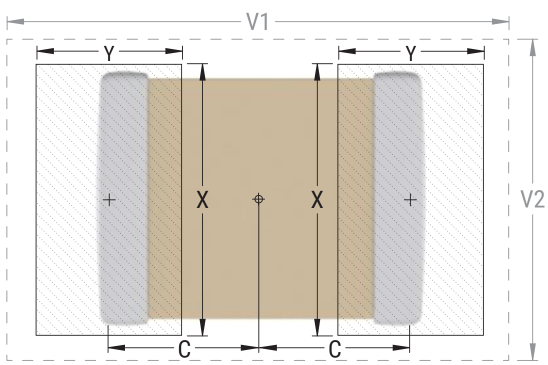
Package quantity based on finished chip thickness specifications.

[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 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)				
		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:

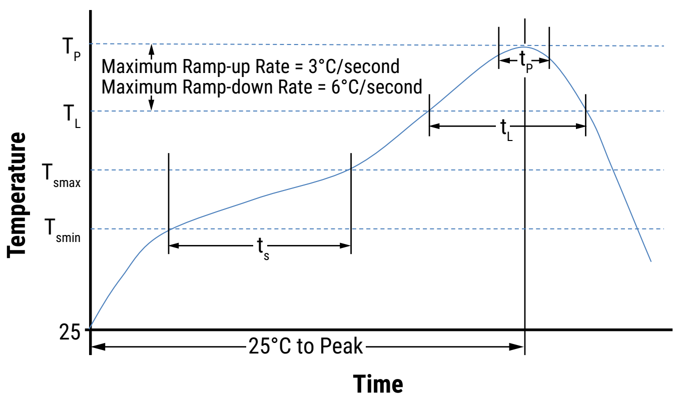
- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- All other EIA case sizes are limited to solder reflow only

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. 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	
	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

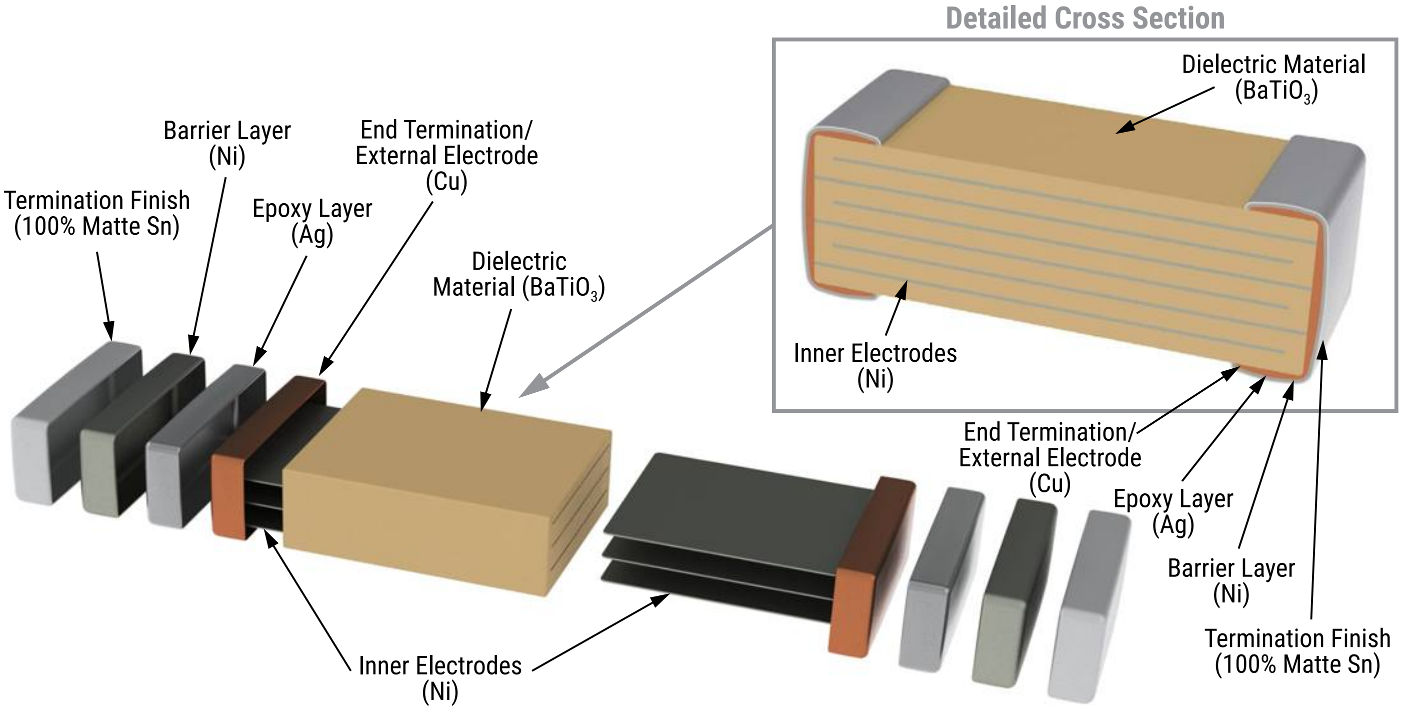
Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.



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



Capacitor Marking (Optional)

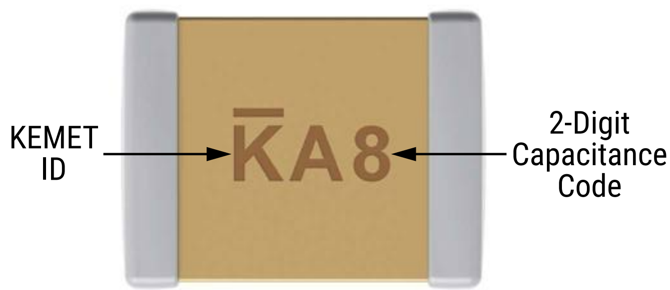
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic 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:

- C0G, 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 µF. Orientation of marking is vendor optional.

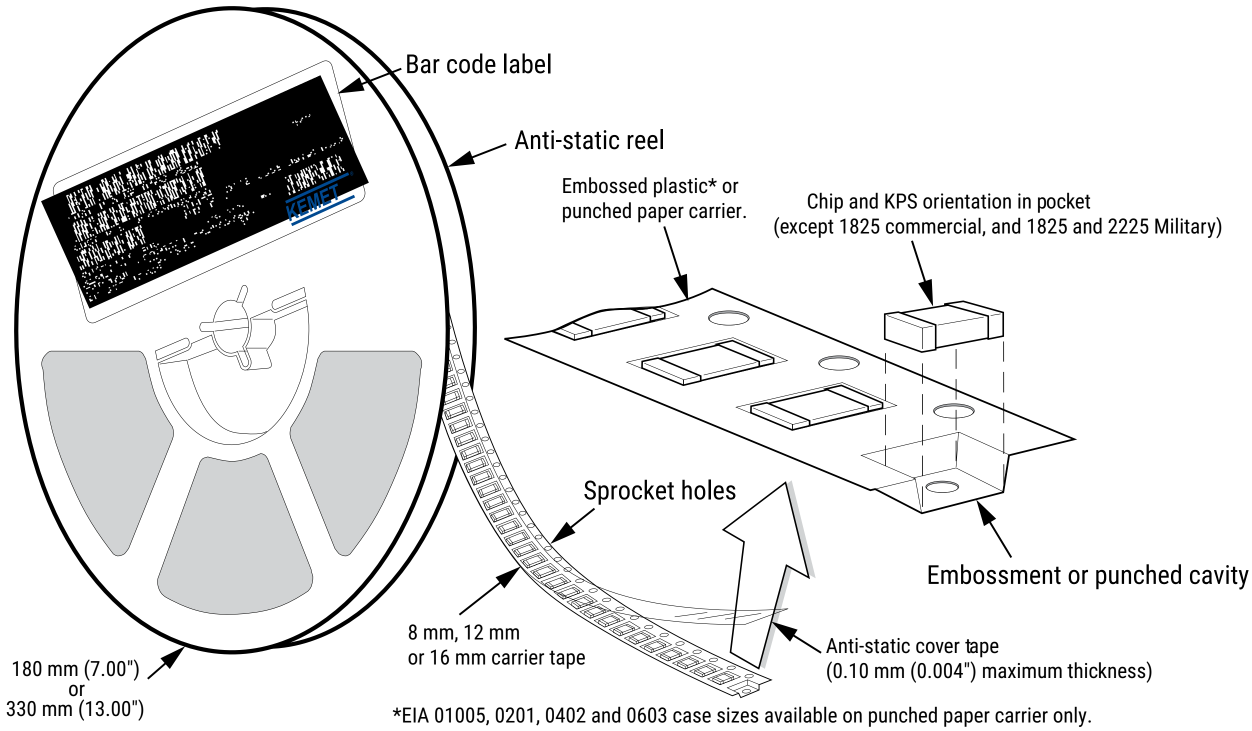


Capacitor Marking (Optional) cont.

Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.10	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

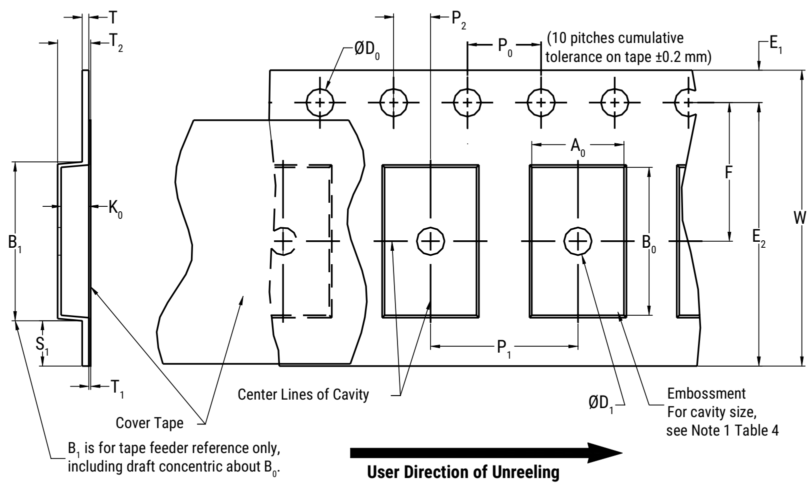


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +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)			
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)	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 S_1 < 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_0, B_0 and K_0 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

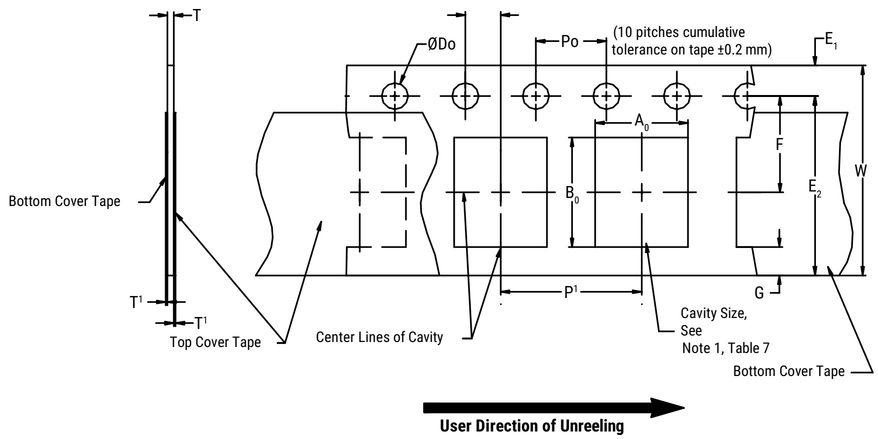


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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.)

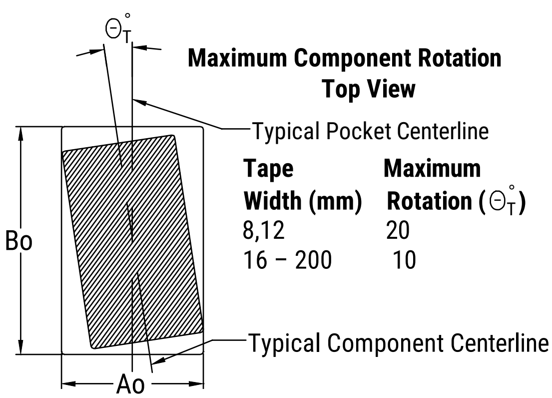
Packaging Information Performance Notes

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:

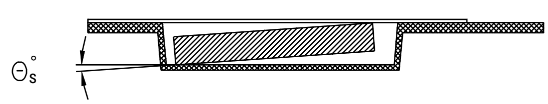
Tape Width	Peel Strength
8 mm	0.1 to 1.0 newton (10 to 100 gf)
12 and 16 mm	0.1 to 1.3 newton (10 to 130 gf)

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



Tape Width (mm)	Maximum Rotation (Θ°T)
8,12	20
16 – 200	10



Tape Width (mm)	Maximum Rotation (Θ°S)
8,12	20
16 – 56	10
72 – 200	5

Figure 4 – Maximum Lateral Movement

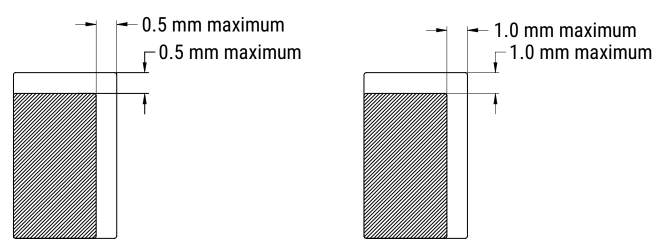


Figure 5 – Bending Radius

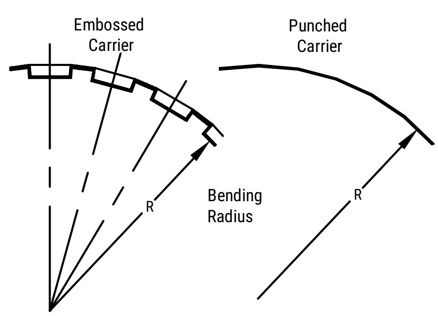
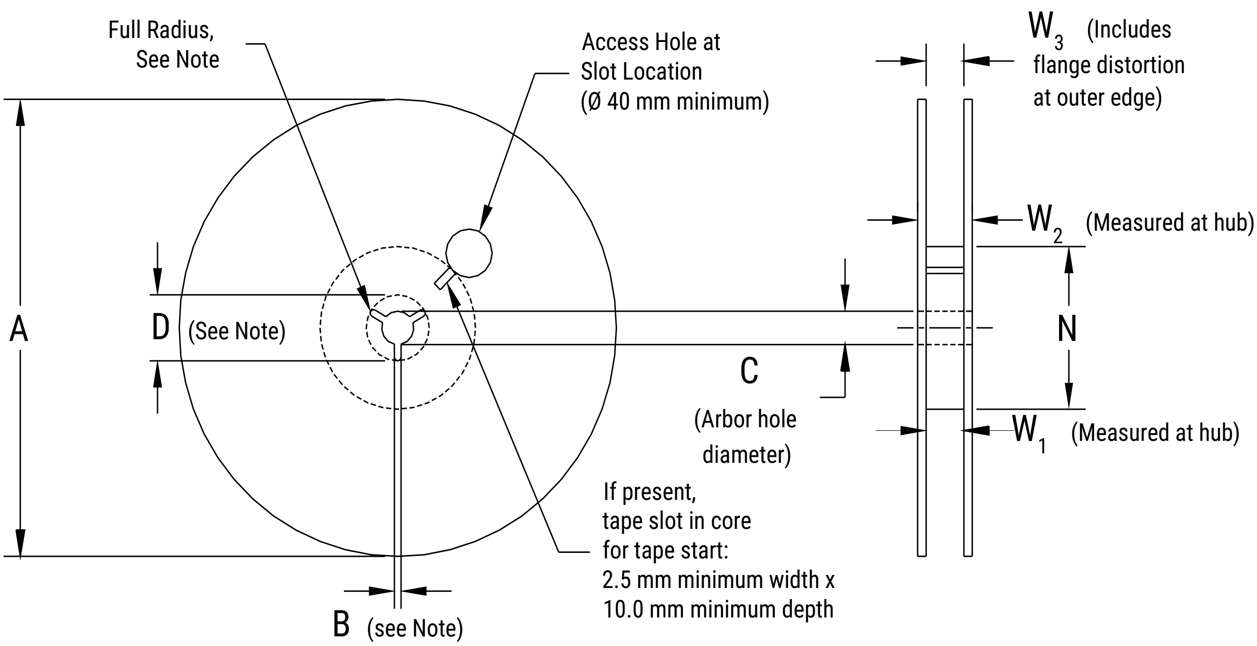


Figure 6 – Reel Dimensions



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	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

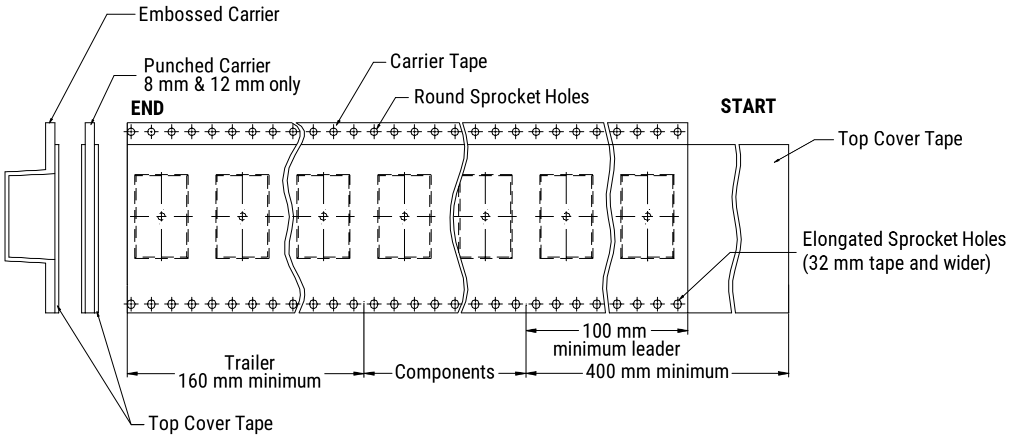
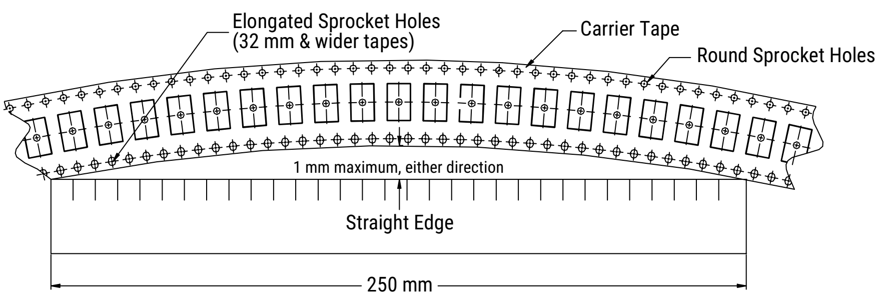


Figure 8 – Maximum Camber



Commercial "L" Series, SnPb Termination, X5R Dielectric 4 – 50 VDC (Commercial Grade)

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.

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 ±15% from −55°C to +85°C.

Benefits

- −55°C to +85°C operating temperature range
- Temperature stable dielectric
- 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.

Applications

Typical applications include decoupling, bypass, and filtering. Markets include military, aerospace and industrial.

Ordering Information

C	1210	C	106	K	4	P	A	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"

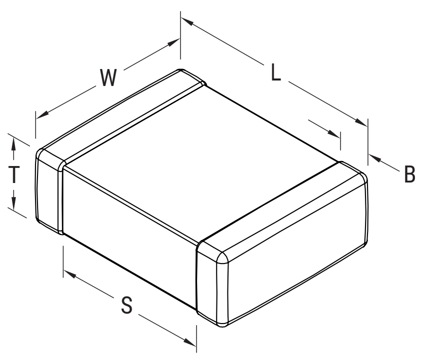
[1] *Additional termination finish options may be available. Contact KEMET for details.*

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	TM
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)



<table>
<tr><th>EIA Size Code</th><th>Metric Size Code</th><th>L Length</th><th>W Width</th><th>T Thickness</th><th>B Bandwidth</th><th>S Separation Minimum</th><th>Mounting Technique</th></tr>
<tr><td>0402</td><td>1005</td><td>1.00 (0.040) ±0.05 (0.002)</td><td>0.50 (0.020) ±0.05 (0.002)</td><td rowspan="5">See Table 2 for Thickness</td><td>0.30 (0.012) ±0.10 (0.004)</td><td>0.30 (0.012)</td><td>Solder Reflow Only</td></tr>
<tr><td>0603</td><td>1608</td><td>1.60 (0.063) ±0.15 (0.006)</td><td>0.80 (0.032) ±0.15 (0.006)</td><td>0.35 (0.014) ±0.15 (0.006)</td><td>0.70 (0.028)</td><td rowspan="3">Solder Wave or Solder Reflow</td></tr>
<tr><td>0805</td><td>2012</td><td>2.00 (0.079) ±0.20 (0.008)</td><td>1.25 (0.049) ±0.20 (0.008)</td><td>0.50 (0.02) ±0.25 (0.010)</td><td>0.75 (0.030)</td></tr>
<tr><td>1206</td><td>3216</td><td>3.20 (0.126) ±0.20 (0.008)</td><td>1.60 (0.063) ±0.20 (0.008)</td><td>0.50 (0.02) ±0.25 (0.010)</td><td rowspan="2">N/A</td></tr>
<tr><td>1210</td><td>3225</td><td>3.20 (0.126) ±0.20 (0.008)</td><td>2.50 (0.098) ±0.20 (0.008)</td><td>0.50 (0.02) ±0.25 (0.010)</td><td>Solder Reflow Only</td></tr>
</table>

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
[4]Insulation 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 MΩ-µF value by the capacitance and compare to GΩ 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
X5R	> 25	< 1.0 µF	7.5	±20%	10% of Initial Limit
		≥ 1.0 µF	20.0		
	25	< 2.2 µF	7.5		
		≥ 2.2 µF	20.0		
	< 25	< 0.56 µF	7.5		
		≥ 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

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

Cap	Cap Code	Case Size/ Series		C0402C				C0603C				C0805C					C1206C				C1210C					
		Voltage Code		7	9	8	4	7	9	8	4	7	9	8	4	3	9	8	4	3	9	8	4	3	6	5
		Rated Voltage (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 Tolerance		Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions																						
12,000 pF	123	K	M	BB	BB	BB	BB																			
15,000 pF	153	K	M	BB	BB	BB	BB																			
18,000 pF	183	K	M	BB	BB	BB	BB																			
22,000 pF	223	K	M	BB	BB	BB	BB																			
27,000 pF	273	K	M	BB	BB	BB	BB																			
33,000 pF	333	K	M	BB	BB	BB	BB																			
39,000 pF	393	K	M	BB	BB	BB	BB																			
47,000 pF	473	K	M	BB	BB	BB	BB																			
56,000 pF	563	K	M	BB	BB	BB	BB																			
68,000 pF	683	K	M	BB	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	M					CG	CG	CG	CG						EB	EB	EB	EB						
0.39 µF	394	K	M					CG	CG	CG	CG						EB	EB	EB	EB	FD	FD	FD	FD	FD	FD
0.47 µF	474	K	M					CG	CG	CG	CG	DN	DN	DN	DN	DN	EC	EC	EC	EC	FD	FD	FD	FD	FD	FD
0.56 µF	564	K	M					CG	CG	CG	CG	DP	DP	DP	DP	DP	ED	ED	ED	ED	FD	FD	FD	FD	FD	FD
0.68 µF	684	K	M					CG	CG	CG	CG	DP	DP	DP	DP	DE	EE	EE	EE	EE	FD	FD	FD	FD	FD	FD
0.82 µF	824	K	M					CG	CG	CG	CG	DF	DF	DF	DF	DF	EF	EF	EF	EF	FF	FF	FF	FF	FF	FF
1.0 µF	105	K	M					CG	CG	CG	CG	DG	DG	DG	DG	DG	EF	EF	EF	EH	FH	FH	FH	FH	FH	FH
1.2 µF	125	K	M									DN	DN	DN	DN		EC	EC	EC	EC	FD	FD	FD	FD		
1.5 µF	155	K	M									DN	DN	DN	DN		EC	EC	EC	EC	FD	FD	FD	FD		
1.8 µF	185	K	M									DP	DP	DP	DP		EC	EC	EC	EC	FD	FD	FD	FD		
2.2 µF	225	K	M									DP	DP	DP	DP		EE	EE	EE	EE	FG	FG	FG	FG		
2.7 µF	275	K	M									DL	DL	DL	DL		EF	EF	EF	EF	FG	FG	FG	FG		
3.3 µF	335	K	M									DE	DE	DE	DH		EH	EH	EH	EH	FH	FH	FH	FH	FM	FM
3.9 µF	395	K	M									DH	DH	DH	DH		EH	EH	EH	EH	FJ	FJ	FJ	FJ	FK	FK
4.7 µF	475	K	M									DH	DH	DH	DG		EH	EH	EH	EH	FK	FK	FK	FE	FS	FS
5.6 µF	565	K	M									DH	DH	DH			EK	EK	EH		FG	FG	FG	FE		
6.8 µF	685	K	M									DH	DH	DH			EK	EK	EH		FJ	FJ	FJ	FJ		
8.2 µF	825	K	M														ED	ED	EH		FK	FK	FK	FG		
10 µF	106	K	M														EH	EH	EH		FK	FK	FK	FH		
22 µF	226	K	M																		FH	FH	FJ			
Capacitance	Cap Code	Rated Voltage (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
		Voltage 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 Size/Series		C0402C				C0603C				C0805C					C1206C				C1210C					

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

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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 Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[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

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

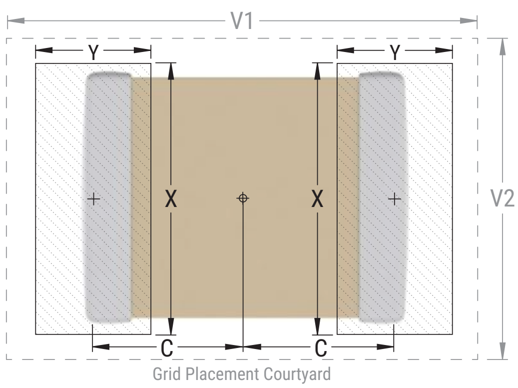
[1] *The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial 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 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)				
		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 ≥ 22 µF*
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	
	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.

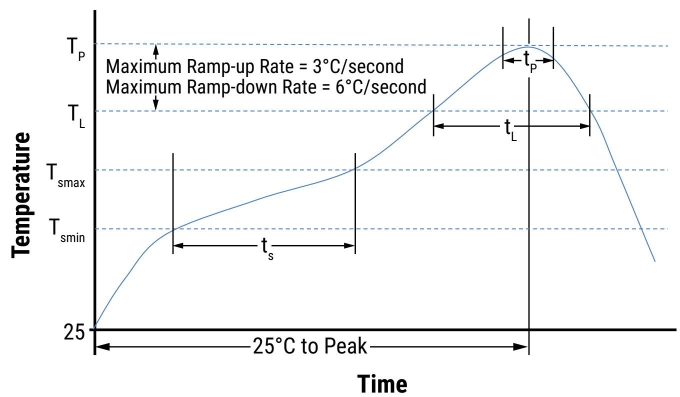


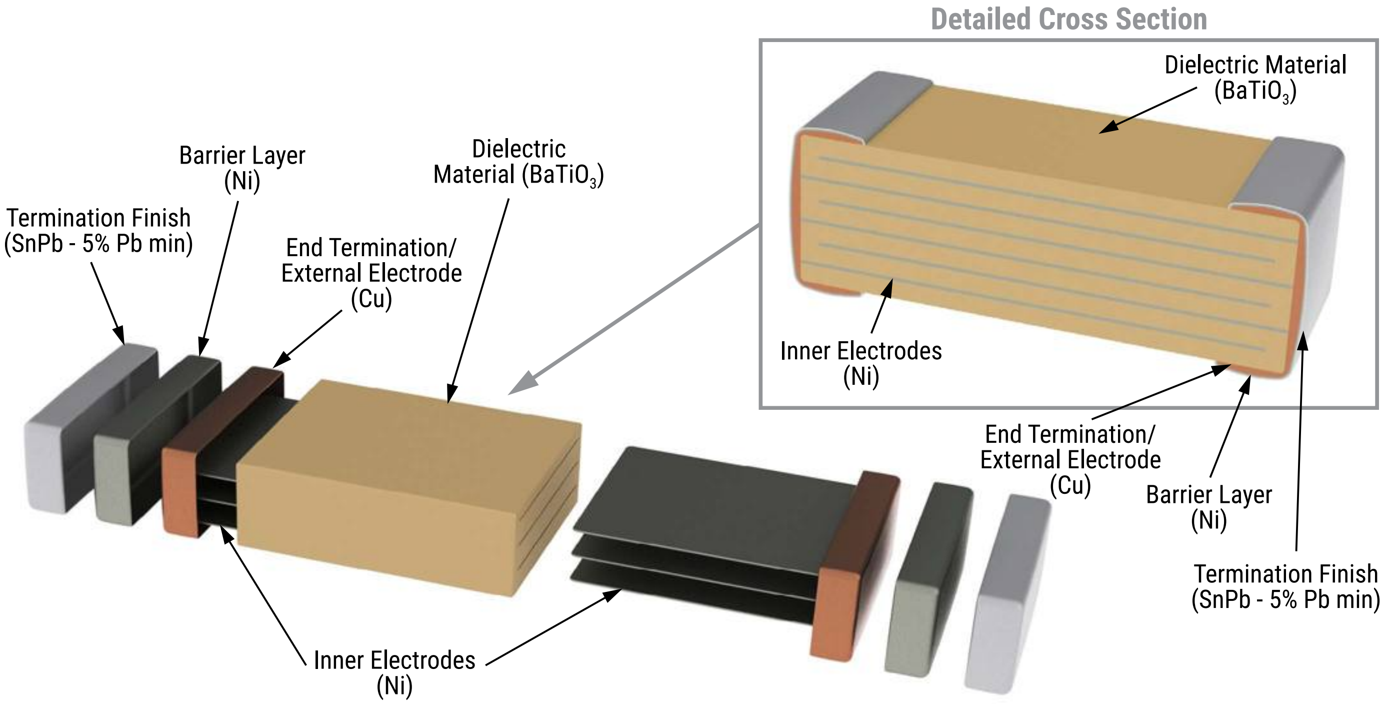
Table 4 – Performance & Reliability: Test Methods and Conditions

<table>
<tr><th>Stress</th><th>Reference</th><th>Test or Inspection Method</th></tr>
<tr><td>Terminal Strength</td><td>JIS–C–6429</td><td>Appendix 1, Note: Force of 1.8 kg for 60 seconds.</td></tr>
<tr><td>Board Flex</td><td>JIS–C–6429</td><td>Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm for C0G. Flexible termination system – 3.0 mm (minimum).</td></tr>
<tr><td rowspan="4">Solderability</td><td rowspan="4">J–STD–002</td><td>Magnification 50 X. Conditions:</td></tr>
<tr><td>a) Method B, 4 hours at 155°C, dry heat at 235°C</td></tr>
<tr><td>b) Method B at 215°C category 3</td></tr>
<tr><td>c) Method D, category 3 at 260°C</td></tr>
<tr><td>Temperature Cycling</td><td>JESD22 Method JA–104</td><td>1,000 Cycles (−55°C to +125°C). Measurement at 24 hours +/−4 hours after test conclusion.</td></tr>
<tr><td rowspan="2">Biased Humidity</td><td rowspan="2">MIL–STD–202 Method 103</td><td>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.</td></tr>
<tr><td>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.</td></tr>
<tr><td>Moisture Resistance</td><td>MIL–STD–202 Method 106</td><td>t = 24 hours/cycle. Steps 7a and 7b not required.
Measurement at 24 hours +/−4 hours after test conclusion.</td></tr>
<tr><td>Thermal Shock</td><td>MIL–STD–202 Method 107</td><td>−55°C/+125°C. Note: Number of cycles required – 300. Maximum transfer time – 20 seconds. Dwell time – 15 minutes. Air – Air.</td></tr>
<tr><td>High Temperature Life</td><td>MIL–STD–202 Method 108
/EIA–198</td><td>1,000 hours at 85°C with 2 X rated voltage applied excluding the following:
<table>
<tr><th>Case Size</th><th>Capacitance</th><th>Applied Voltage</th></tr>
<tr><td>0402</td><td>≥ 0.22 µF</td><td rowspan="5">1.5 X</td></tr>
<tr><td>0603</td><td>≥ 1.0 µF</td></tr>
<tr><td>0805</td><td>≥ 4.7 µF</td></tr>
<tr><td>1206</td><td>≥ 2.2 µF</td></tr>
<tr><td>1210</td><td>≥ 10 µF</td></tr>
</table></td></tr>
<tr><td>Storage Life</td><td>MIL–STD–202 Method 108</td><td>150°C, 0 VDC for 1,000 hours.</td></tr>
<tr><td>Vibration</td><td>MIL–STD–202 Method 204</td><td>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</td></tr>
<tr><td>Mechanical Shock</td><td>MIL–STD–202 Method 213</td><td>Figure 1 of Method 213, Condition F.</td></tr>
<tr><td>Resistance to Solvents</td><td>MIL–STD–202 Method 215</td><td>Add aqueous wash chemical, OKEM Clean or equivalent.</td></tr>
</table>

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 40ºC 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)

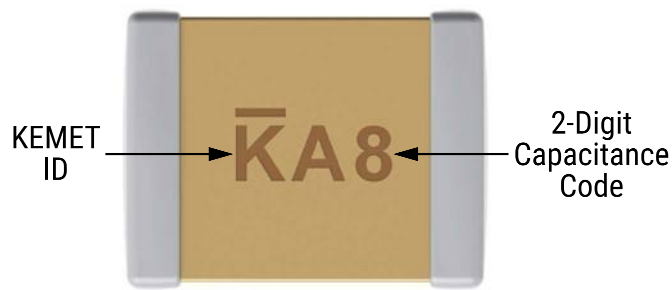
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic 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:

- C0G, 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 µF. Orientation of marking is vendor optional.

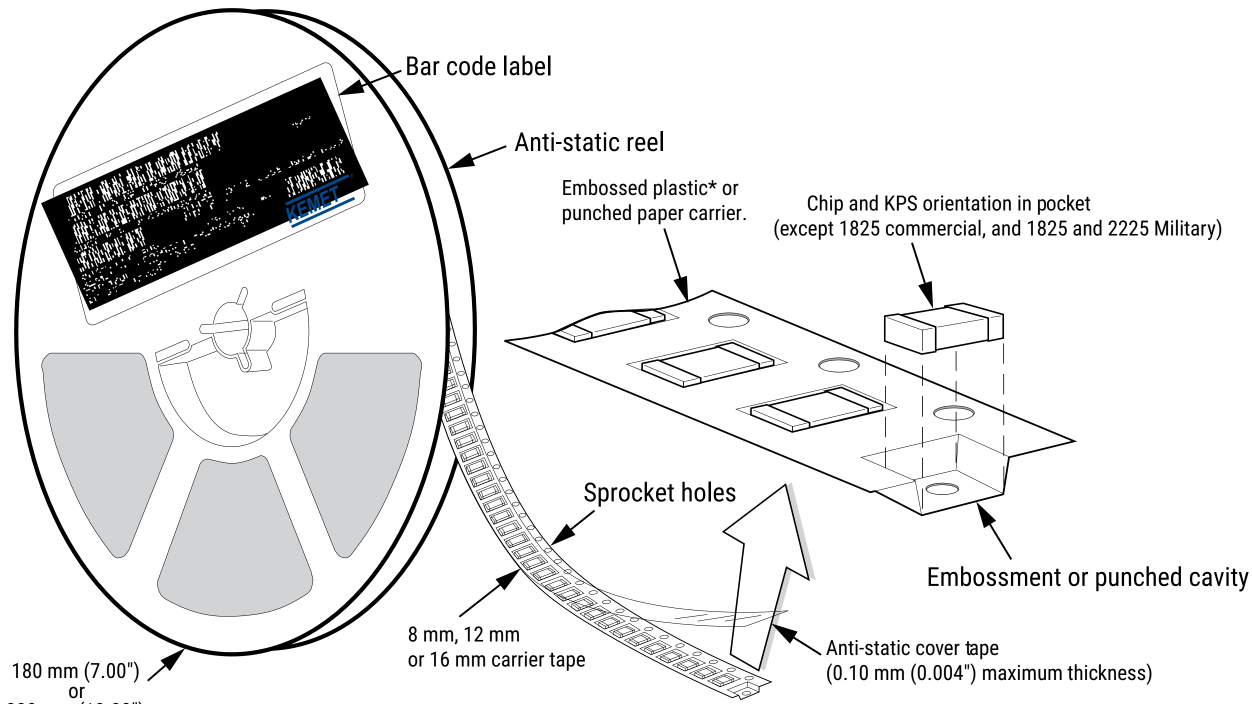


Capacitor Marking (Optional) cont.

Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.10	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

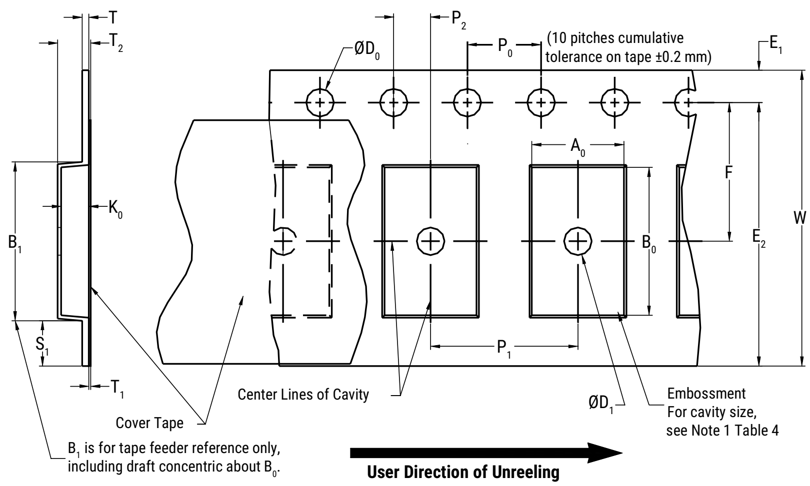


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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 (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)	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 S_1 < 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_0, B_0 and K_0 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

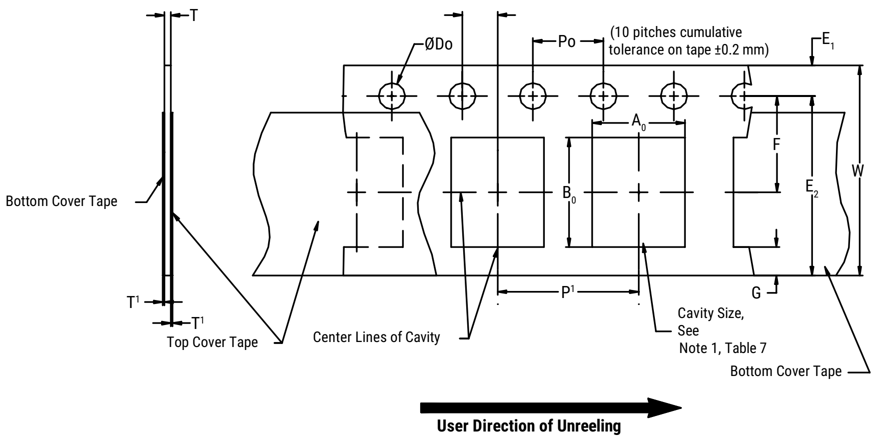


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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

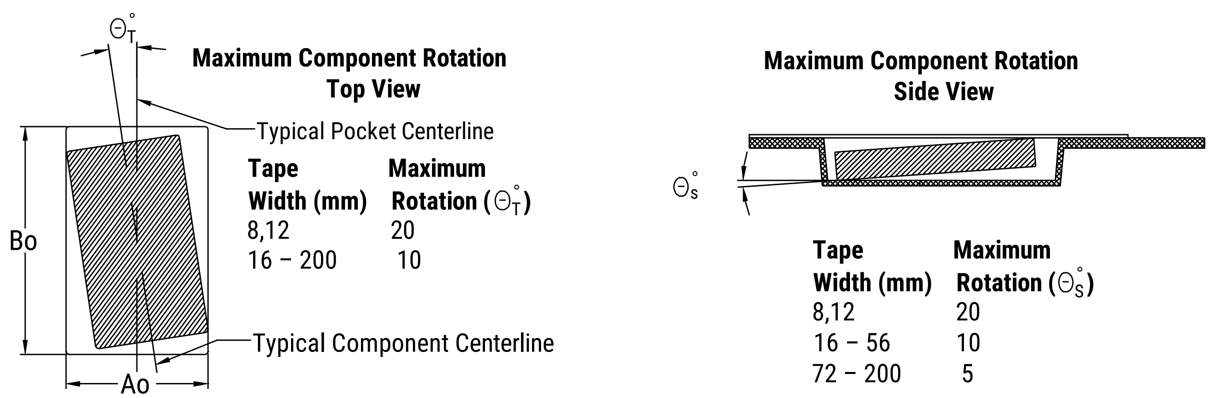


Figure 4 – Maximum Lateral Movement

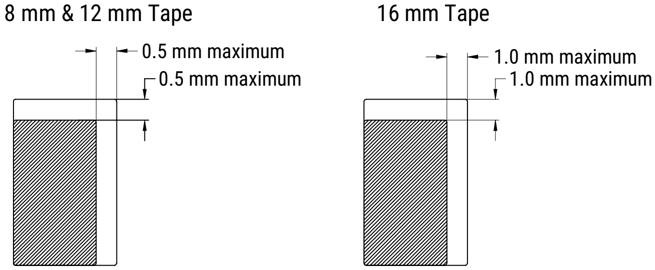


Figure 5 – Bending Radius

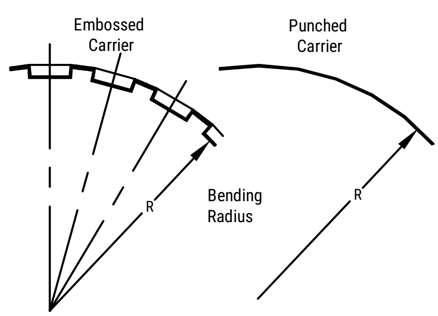
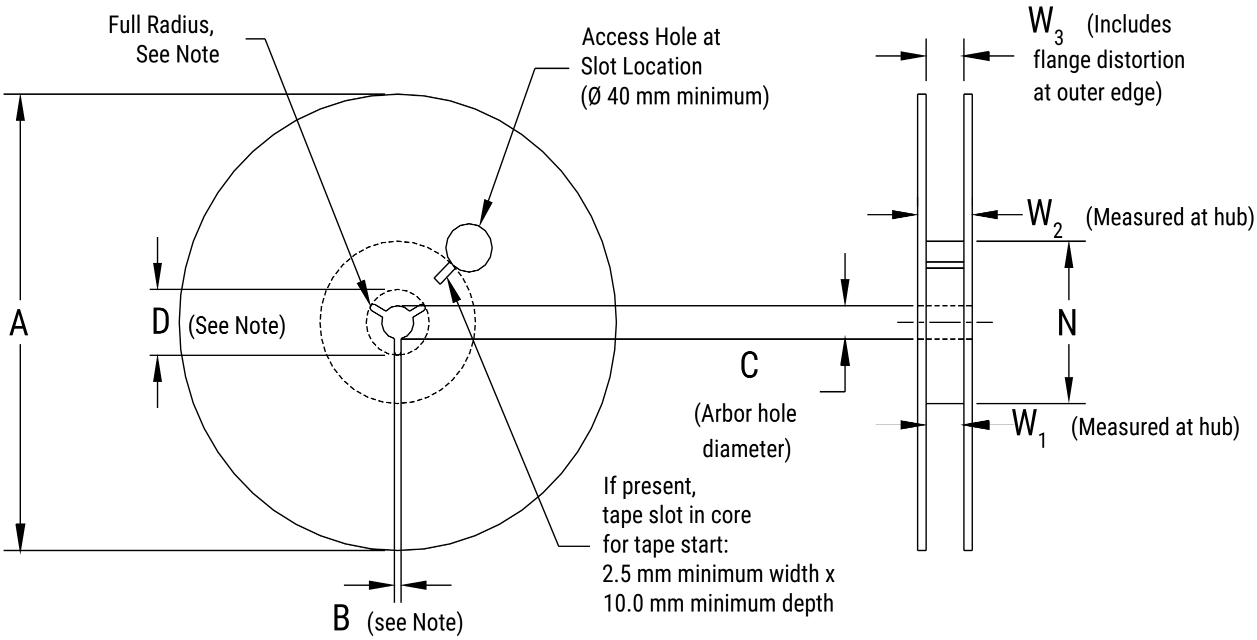


Figure 6 – Reel Dimensions



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	A	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

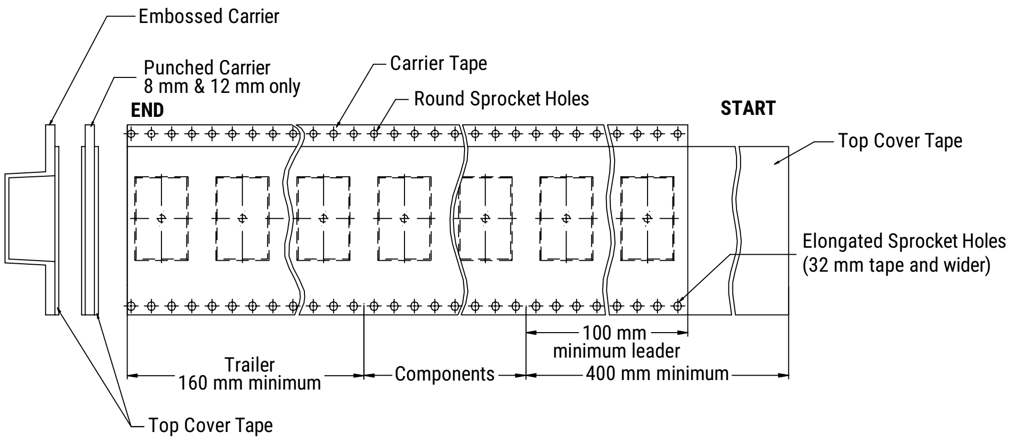
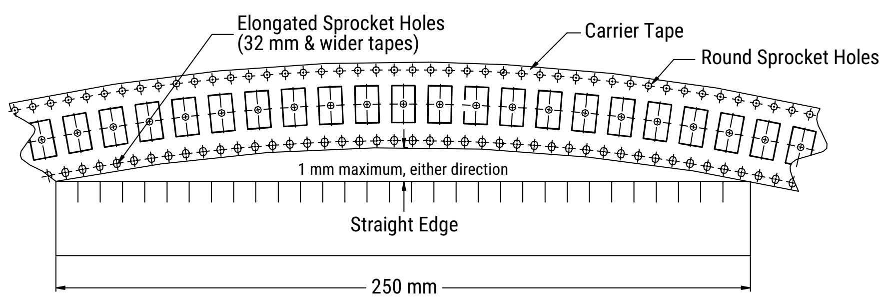


Figure 8 – Maximum Camber



High Voltage C0G Dielectric, 500 – 3,000 VDC (Automotive Grade)

Overview

KEMET's Automotive Grade High Voltage surface mount MLCCs in C0G dielectric are temperature compensating and are suited for resonant circuit applications or those where Q and stability of capacitance characteristics are required. C0G 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 C0G 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

C	1210	C	332	J	C	G	A	C	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 = ±0.10 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 = C0G	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)[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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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.*

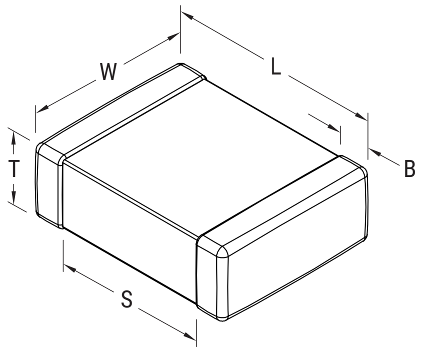
Production Part Approval Process (PPAP)
The purpose of the Production Part Approval Process is:
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements 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			○		

[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)



<table>
<tr><th>EIA Size Code</th><th>Metric Size Code</th><th>L Length</th><th>W Width</th><th>T Thickness</th><th>B Bandwidth</th><th>S Separation Minimum</th><th>Mounting Technique</th></tr>
<tr><td>0402</td><td>1005</td><td>1.00 (0.040) ±0.05 (0.002)</td><td>0.50 (0.020) ±0.05 (0.002)</td><td rowspan="14">See Table 2 for Thickness</td><td>0.30 (0.012) ±0.10 (0.004)</td><td>0.30 (0.012)</td><td>Solder Reflow Only</td></tr>
<tr><td>0603</td><td>1608</td><td>1.60 (0.063) ±0.15 (0.006)</td><td>0.80 (0.032) ±0.15 (0.006)</td><td>0.35 (0.014) ±0.15 (0.006)</td><td>0.70 (0.028)</td><td rowspan="3">Solder Wave or Solder Reflow</td></tr>
<tr><td>0805</td><td>2012</td><td>2.00 (0.079) ±0.20 (0.008)</td><td>1.25 (0.049) ±0.20 (0.008)</td><td>0.50 (0.02) ±0.25 (0.010)</td><td>0.75 (0.030)</td></tr>
<tr><td>1206</td><td>3216</td><td>3.20 (0.126) ±0.20 (0.008)</td><td>1.60 (0.063) ±0.20 (0.008)</td><td>0.50 (0.02) ±0.25 (0.010)</td><td rowspan="11">N/A</td></tr>
<tr><td>1210</td><td>3225</td><td>3.20 (0.126) ±0.20 (0.008)</td><td>2.50 (0.098) ±0.20 (0.008)</td><td>0.50 (0.02) ±0.25 (0.010)</td><td rowspan="10">Solder Reflow Only</td></tr>
<tr><td>1808</td><td>4520</td><td>4.70 (0.185) ±0.50 (0.020)</td><td>2.00 (0.079) ±0.20 (0.008)</td><td>0.60 (0.024) ±0.35 (0.014)</td></tr>
<tr><td>1812</td><td>4532</td><td>4.50 (0.177) ±0.30 (0.012)</td><td>3.20 (0.126) ±0.30 (0.012)</td><td>0.60 (0.024) ±0.35 (0.014)</td></tr>
<tr><td>1825</td><td>4564</td><td>4.50 (0.177) ±0.30 (.012)</td><td>6.40 (0.252) ±0.40 (0.016)</td><td>0.60 (0.024) ±0.35 (0.014)</td></tr>
<tr><td>2220</td><td>5650</td><td>5.70 (0.224) ±0.40 (0.016)</td><td>5.00 (0.197) ±0.40 (0.016)</td><td>0.60 (0.024) ±0.35 (0.014)</td></tr>
<tr><td>2225</td><td>5664</td><td>5.60 (0.220) ±0.40 (0.016)</td><td>6.40 (0.248) ±0.40 (0.016)</td><td>0.60 (0.024) ±0.35 (0.014)</td></tr>
<tr><td>2824</td><td>7260</td><td>7.10 (0.280) ±0.40 (0.016)</td><td>6.10 (0.240) ±0.40 (0.016)</td><td>1.27 (0.050) ±0.40 (0.016)</td></tr>
<tr><td>3040</td><td>7610</td><td>7.60 (0.300) ±0.40 (0.016)</td><td>10.20 (0.402) ±0.40 (0.016)</td><td>1.27 (0.050) ±0.40 (0.016)</td></tr>
<tr><td>3640</td><td>9210</td><td>9.10 (0.358) ±0.40 (0.016)</td><td>10.20 (0.402) ±0.40 (0.016)</td><td>1.27 (0.050) ±0.40 (0.016)</td></tr>
<tr><td>4540</td><td>-</td><td>11.40 (0.449) ±0.40 (0.016)</td><td>10.20 (0.402) ±0.40 (0.016)</td><td>1.27 (0.050) ±0.40 (0.016)</td></tr>
</table>

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)

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

[3] To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ 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)

<table>
<tr><th>EIA Case Size</th><th>500V</th><th>630V</th><th>≥ 1000V</th></tr>
<tr><td>0402</td><td>120% of rated voltage</td><td>N/A</td><td>N/A</td></tr>
<tr><td>0603</td><td rowspan="10">150% of rated voltage</td><td>130% of rated voltage</td><td rowspan="10">120% of rated voltage</td></tr>
<tr><td>0805</td><td>< 620pF 150% of rated voltage
≥ 620pF 130% of rated voltage</td></tr>
<tr><td>1206</td><td>< 5.1nF 150% of rated voltage
≥ 5.1nF 130% of rated voltage</td></tr>
<tr><td>1210</td><td>< 7.5nF 150% of rated voltage
≥ 7.5nF 130% of rated voltage</td></tr>
<tr><td>1808</td><td>< 5.1nF 150% of rated voltage
≥ 5.1nF 130% of rated voltage</td></tr>
<tr><td>1812</td><td>< 12nF 150% of rated voltage
≥ 12nF 130% of rated voltage</td></tr>
<tr><td>1825</td><td>< 22nF 150% of rated voltage
≥ 22nF 130% of rated voltage</td></tr>
<tr><td>2220</td><td>< 27nF 150% of rated voltage
≥ 27nF 130% of rated voltage</td></tr>
<tr><td>±2225</td><td>< 33nF 150% of rated voltage
≥ 33nF 130% of rated voltage</td></tr>
</table>

Post Environmental Limits

High Temperature Life, Biased Humidity, Moisture Resistance					
Dielectric	Rated DC Voltage	Capacitance Value	Dissipation Factor (Maximum %)	Capacitance Shift	Insulation Resistance
C0G	All	All	0.5	0.3% or ±0.25 pF	10% of Initial Limit

Table 1A – Capacitance Range/Selection Waterfall (0603 – 1808 Case Sizes)

Capacitance	Cap Code	Case Size/Series								C0402C	C0603C			C0805C			C1206C					C1210C					C1808C						
		Voltage Code								C	C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		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								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																							
1.0 - 9.1 pF*	109 - 919*	B	C	D										DG	DG	DG											LB	LB	LB	LB	LB	LB	LB
10 pF - 47pF*	100 - 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				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
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	LB	LB
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	LB	LB
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	LB	LB	LB
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	K	M					DG	DG	DG	ED	ED	ED	ED	EF	FM	FM	FM	FM	FM	LB	LB	LB	LB	LB	LB	LB
91 pF	910				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
100 pF	101				F	G	J	K	M	BB	CG	CG	CG	DG	DG	DG	ED	ED	ED	ED	EF	FM	FM	FM	FM	FM	LB	LB	LB	LB	LB	LC	LB
110 pF	111				F	G	J	K	M	BB	CG	CG	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	CG	CG	DG	DG	DG	ED	ED	ED	ED	EG	FG	FG	FG	FM	FM	LA	LA	LA	LA	LB	LC	LB
130 pF	131				F	G	J	K	M	BB	CG	CG	CG	DG	DG	DG	ED	ED	ED	ED	EG	FG	FG	FG	FM	FM	LA	LA	LA	LA	LB	LC	LC
150 pF	151				F	G	J	K	M	BB	CG	CG	CG	DG	DG	DG	ED	ED	ED	EF	EG	FG	FG	FG	FM	FM	LA	LA	LA	LA	LB	LC	LC
160 pF	161				F	G	J	K	M	BB	CG	CG	CG	DG	DG	DG	ED	ED	ED	EF	EG	FG	FG	FG	FM	FM	LA	LA	LA	LA	LC	LC	LC
180 pF	181				F	G	J	K	M	BB	CG	CG	CG	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	K	M	BB	CG	CG	CG	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	K	M	BB	CG	CG	CG	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	M	BB	CG	CG		DG	DG	DG	ED	ED	ED	EG	EG	FG	FG	FG	FM	FM	LA	LA	LA	LB	LC	LC	
270 pF	271				F	G	J	K	M	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	FM	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	FM	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	FM	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	FM	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	FM	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	272				F	G	J	K	M					DG	DG		EG	EB	EG			FS	FL	FS			LC	LA	LC				
3,000 pF	302				F	G	J	K	M								EB	EB				FS	FL	FF			LA	LA	LA				
3,300 pF	332				F	G	J	K	M								EB	EB				FS	FM	FG			LA	LA	LA				
3,600 pF	362				F	G	J	K	M								EC	EC				FL	FM	FG			LA	LB	LA				
3,900 pF	392				F	G	J	K	M								EC	EC				FL	FY	FL			LA	LB	LA				
4,300 pF	432				F	G	J	K	M								ED	ED				FM	FY	FL			LA	LC	LA				
4,700 pF	472				F	G	J	K	M								ED	ED				FM	FY	FM			LA	LC	LB				
5,100 pF	512				F	G	J	K	M								EE	EE				FY	FS	FM			LA	LB	LB				
5,600 pF	562				F	G	J	K	M								EF	EF				FY	FS	FM			LB	LC	LC				
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
		Voltage Code								C	C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		Case Size/Series								C0402C	C0603C			C0805C			C1206C					C1210C					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.)
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.

Capacitance	Cap Code	Case Size/Series					C0402C	C0603C			C0805C			C1206C					C1210C					C1808C						
		Voltage Code					C	C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		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					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																							
6,200pF	622	F	G	J	K	M								EF	EF				FY	FE	FY			LC	LC	LC				
6,800pF	682	F	G	J	K	M								EG	EG				FY	FE	FY			LC	LC	LC				
7,500pF	752	F	G	J	K	M								EG	EG				FS	FF	FS			LA	LA					
8,200 pF	822	F	G	J	K	M								EG	EG				FS	FF	FS			LA	LA					
9,100 pF	912	F	G	J	K	M								EG	EG				FF	FF	FS			LA	LA					
10,000 pF	103	F	G	J	K	M								EH	EH				FG	FG	FS			LA	LA					
12,000 pF	123	F	G	J	K	M								EG					FG	FG	FM			LA	LA					
15,000 pF	153	F	G	J	K	M								EG					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										
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
		Voltage Code					C	C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		Case Size/Series					C0402C	C0603C			C0805C			C1206C					C1210C					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.)
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)

Capacitance	Cap Code	Case Size/Series					C1812C							C1825C							C2220C							C2225C						
		Voltage Code					C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		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					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																											
10 pF - 47pF*	100 - 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
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
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
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
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
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
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
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
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
110 pF	111	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
120 pF	121	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
130 pF	131	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
150 pF	151	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
160 pF	161	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
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	K	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
Capacitance	Cap 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
		Voltage Code					C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		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.

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

Capacitance	Cap Code	Case Size/ Series	C1812C							C1825C							C2220C							C2225C						
		Voltage Code	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		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	Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																											
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	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 M	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 M	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
680 pF	681	F G J K M	GB	GB	GB	GD	GH	GO		HE	HE	HE	HE	HG	HG	HK	JE	JE	JE	JK	JK	JK	JL	KF	KF	KF	KF	KE	KF	KH
750 pF	751	F G J K M	GB	GB	GB	GD	GK			HE	HE	HE	HG	HG	HG		JE	JE	JE	JK	JK	JK	JL	KE	KE	KE	KF	KE	KF	KH
820 pF	821	F G J K M	GB	GB	GB	GD	GK			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 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
1,000 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	F 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	F 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	F G J K M	GB	GB	GB	GH	GO			HE	HE	HE	HG	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	HE	HE	HG	HE	HK		JE	JK	JK	JK	JE	JL		KE	KE	KE	KF	KF	KH	
1,600 pF	162	F G J K M	GB	GD	GD	GK				HE	HG	HG	HG	HG	HK		JE	JK	JK	JK	JE	JL		KE	KE	KE	KF	KE	KH	
1,800 pF	182	F G J K M	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	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	F G J K M	GB	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 K M	GB	GH	GK	GO				HE	HG	HG	HE	HK			JK	JK	JK	JE	JL			KE	KE	KE	KE	KH		
3,000 pF	302	F G J K M	GB	GH	GK					HG	HG	HG	HE	HK			JK	JK	JK	JE	JL			KE	KE	KE	KE	KH		
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	KH			
5,100 pF	512	F G J K M	GH	GK	GO					HG	HE	HG	HK				JK	JK	JK	JL				KE	KF	KF	KH			
5,600 pF	562	F G J K M	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	GH					HG	HE	HG					JK	JE	JE	JN				KE	KF	KF	KJ			
6,800pF	682	F G J K M	GH	GM	GH					HG	HE	HJ					JK	JE	JK	JN				KE	KF	KF	KJ			
7,500pF	752	F G J K M	GH	GM	GK					HG	HE	HJ					JK	JE	JK					KF	KE	KF				
8,200 pF	822	F G J K M	GK	GO	GK					HG	HE	HJ					JK	JE	JL					KF	KE	KF				
9,100 pF	912	F G J K M	GM	GO	GM					HE	HG	HK					JE	JE	JL					KF	KE	KH				
10,000 pF	103	F G J K M	GM	GO	GM					HE	HG	HK					JE	JE	JL					KF	KE	KH				
12,000 pF	123	F G J K M	GO	GH	GO					HE	HG	HE					JE	JK	JN					KE	KE	KH				
15,000 pF	153	F G J K M	GO	GH	GO					HE	HJ	HE					JE	JL	JE					KE	KF	KJ				
18,000 pF	183	F G J K M	GH	GH						HG	HK	HG					JE	JL	JE					KE	KH	KE				
22,000 pF	223	F G J K M	GH	GH						HJ	HE	HJ					JK	JN	JK					KF	KJ	KF				
27,000 pF	273	F G J K M	GK	GK						HJ	HE	HK					JL	JN	JL					KF	KJ	KH				
33,000 pF	333	F G J K M	GM	GM						HK	HE	HK					JN	JE	JN					KH	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					
Capacitance	Cap 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
		Voltage Code	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		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.)
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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	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		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	Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																											
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					
0.12 µF	124	F G J K M																						KJ	KJ					
Capacitance	Cap 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
		Voltage Code	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		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.

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

Capacitance	Cap Code	Case Size/Series			C2824C					C3040C					C3640C					C4540C				
		Voltage Code			C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Rated Voltage (VDC)			500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000
		Capacitance Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																			
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	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	M	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	K	M	TB	TB				QB	QC	QC			MA	MA	MB			SA	SA	SA		
39,000 pF	393	J	K	M	TB	TC				QB	QC	QD			MA	MA	MB			SA	SA	SB		
47,000 pF	473	J	K	M	TB					QB	QC				MA	MB	MC			SA	SA	SB		
56,000 pF	563	J	K	M	TC					QC	QD				MA	MB				SA	SA	SB		
68,000 pF	683	J	K	M						QC	QD				MB	MC				SA	SB	SC		
82,000 pF	823	J	K	M						QC					MB					SA	SB			
0.1 µF	104	J	K	M						QD					MC					SB	SC			
0.12 µF	124	J	K	M											MC					SB				
0.15 µF	154	J	K	M																SC				
Capacitance	Cap Code	Rated Voltage (VDC)			500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000	500	630	1000	1500	2000
		Voltage Code			C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Case Size/Series			C2824C					C3040C					C3640C					C4540C				

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 2 – Chip Thickness/Tape & Reel Packaging Quantities

Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			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 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 2 – Chip Thickness/Tape & Reel Packaging Quantities cont.

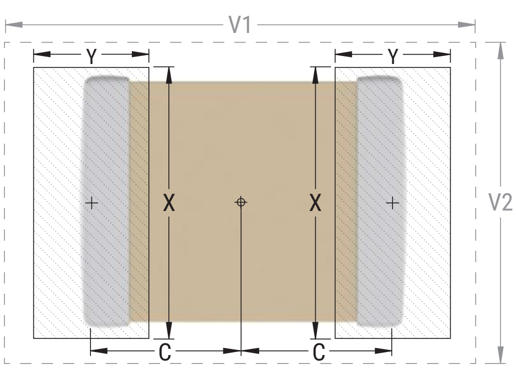
Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
GB	1812	1.00 ± 0.10	0	0	1,000	4,000
GD	1812	1.25 ± 0.15	0	0	1,000	4,000
GH	1812	1.40 ± 0.15	0	0	1,000	4,000
GK	1812	1.60 ± 0.20	0	0	1,000	4,000
GM	1812	2.00 ± 0.20	0	0	500	2,000
GO	1812	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 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 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)				
		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:

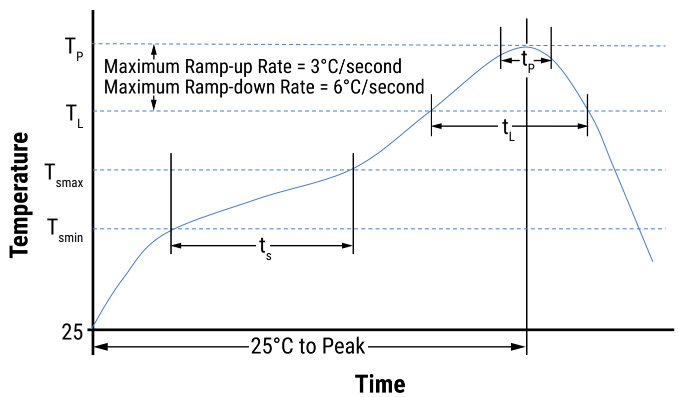
- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- All other EIA case sizes are limited to solder reflow only

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	Termination Finish	
	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

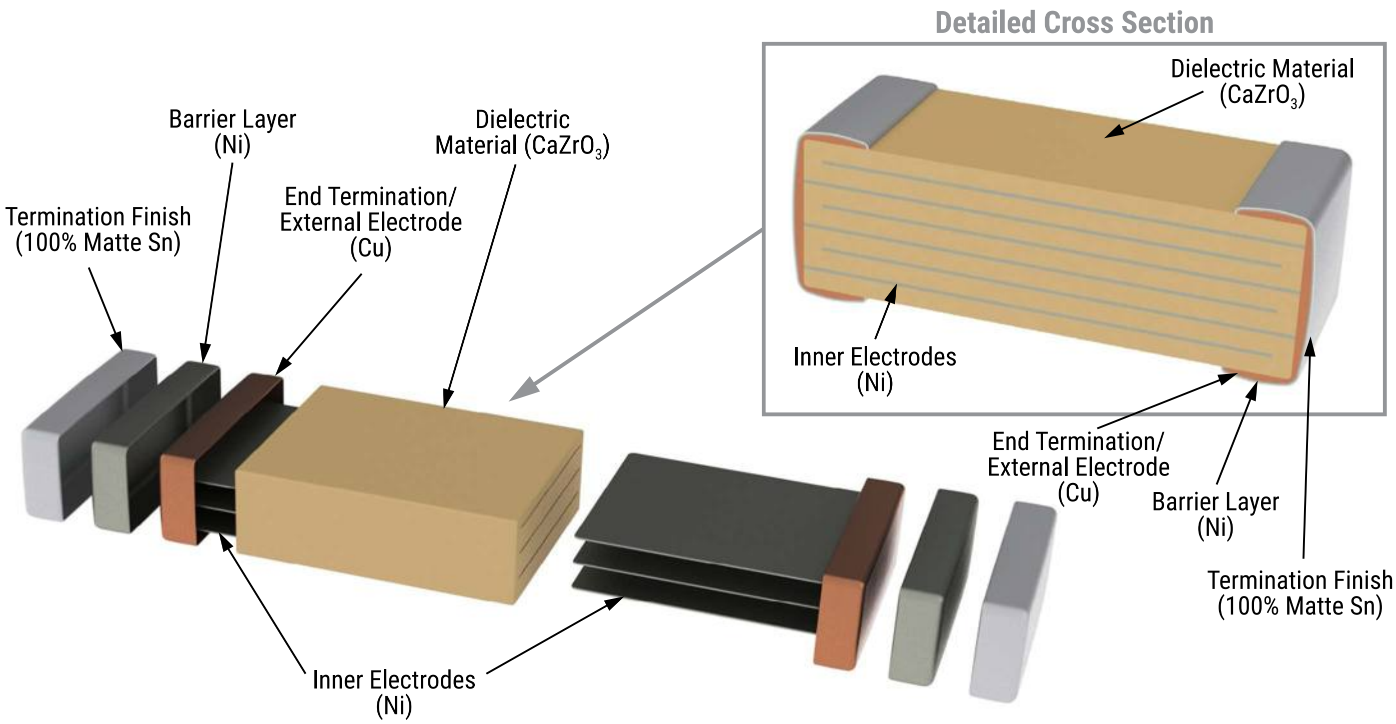
Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.



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 40ºC 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):

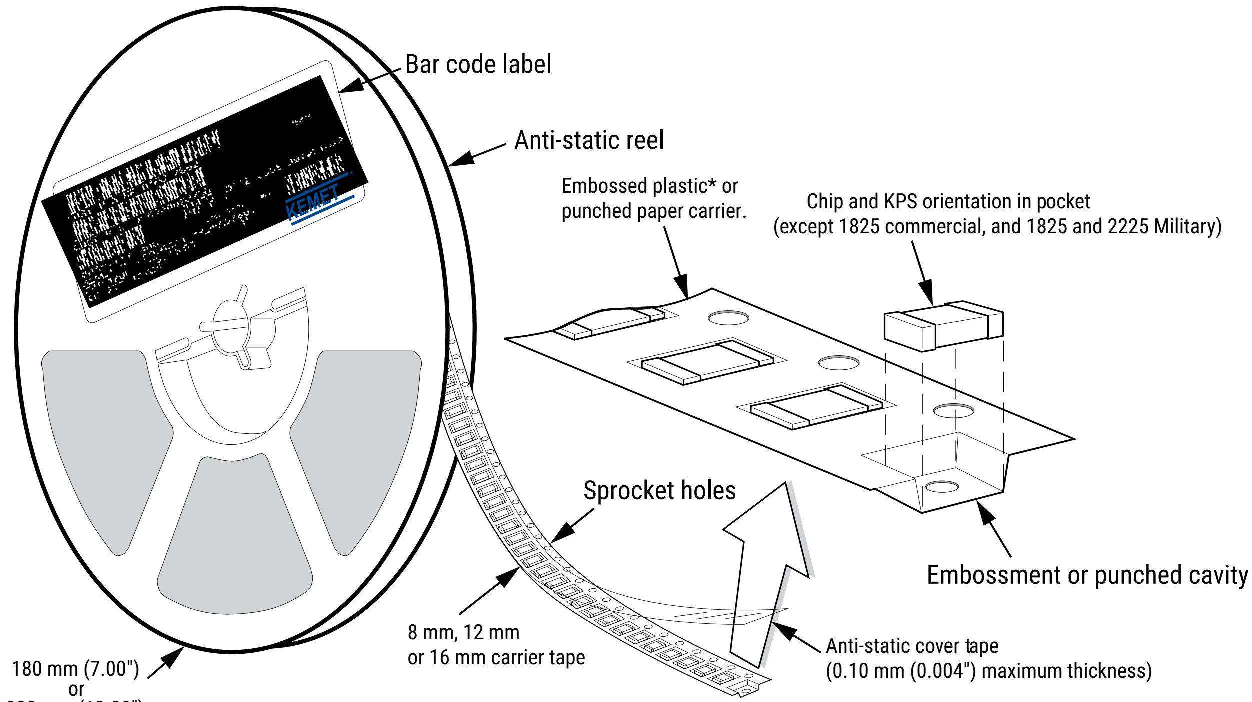
Laser marking option is not available on:

- C0G, 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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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		
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

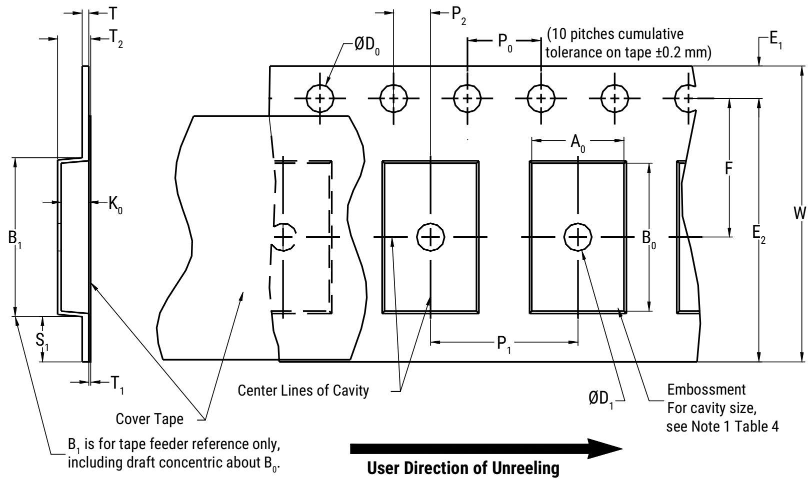


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	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)	25.0 (0.984)	0.600 (0.024)	0.600 (0.024)	0.100 (0.004)
12 mm					30 (1.181)			
16 mm								
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)	Note 5	
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)		
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)		
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 S_1 < 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_1 dimension is a reference dimension for tape feeder clearance only.*
5. *The cavity defined by A_0, B_0 and K_0 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

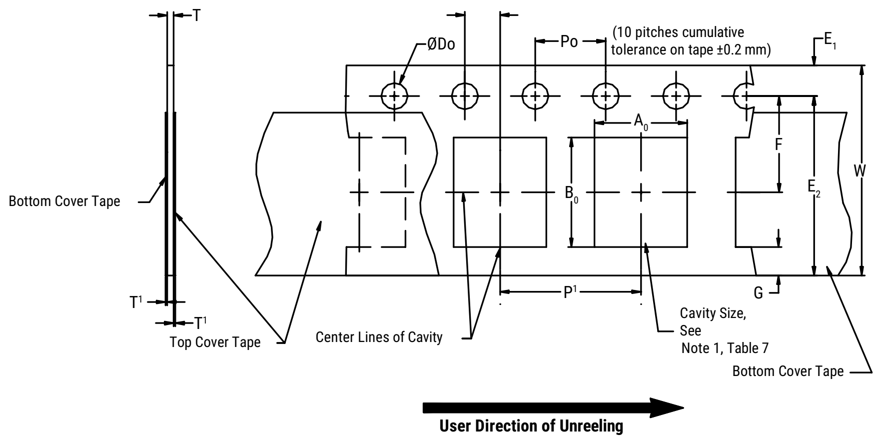


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 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_0, B_0 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

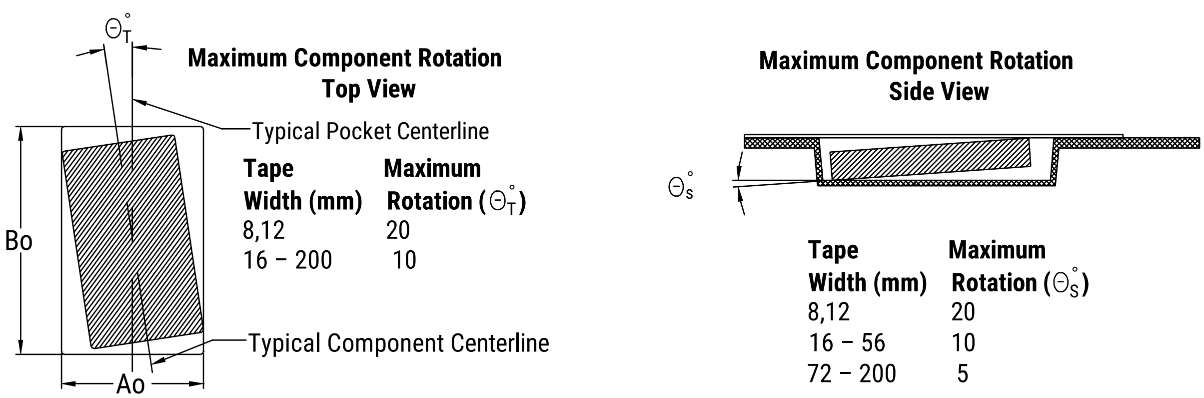


Figure 4 – Maximum Lateral Movement

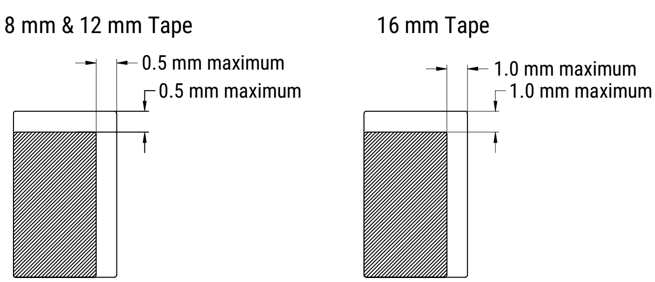


Figure 5 – Bending Radius

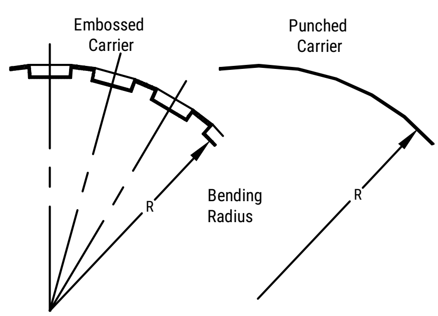
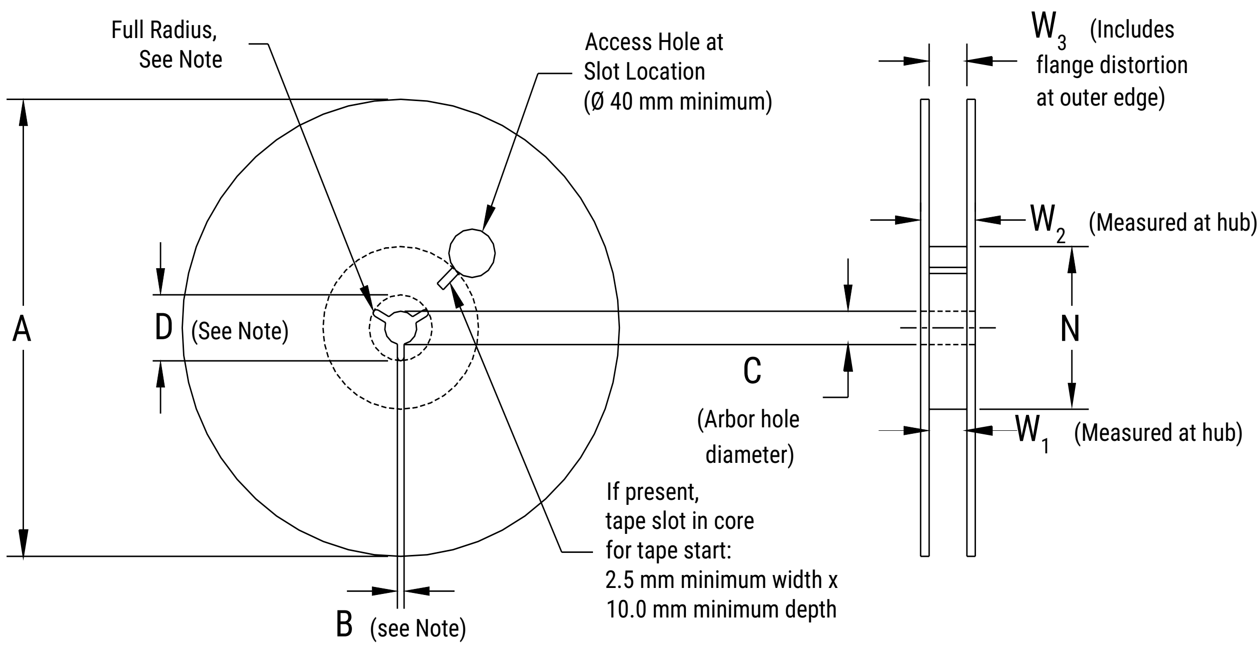


Figure 6 – Reel Dimensions



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	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				
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/−1.0 (1.078+0.039/−0.039)	

Figure 7 – Tape Leader & Trailer Dimensions

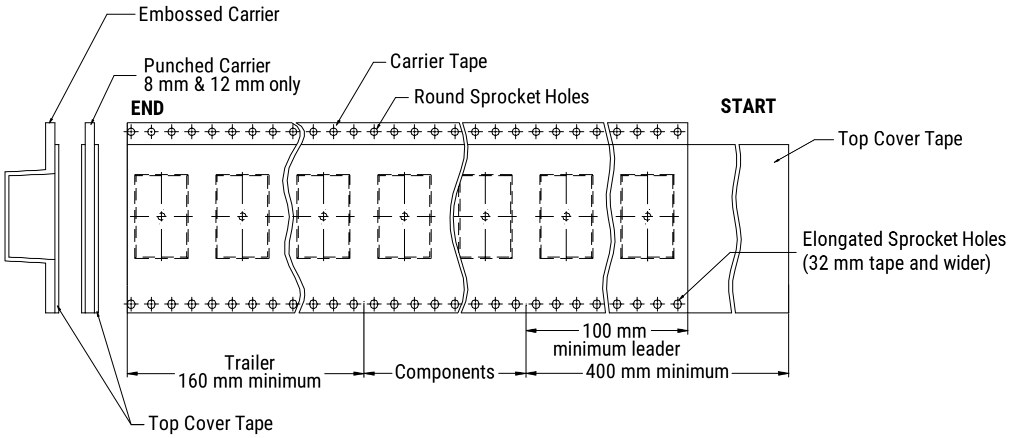
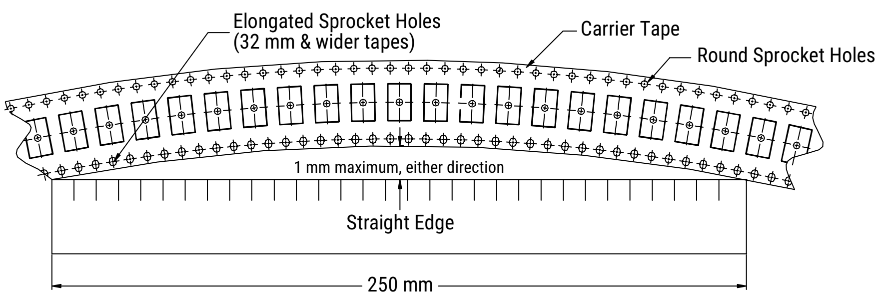


Figure 8 – Maximum Camber



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

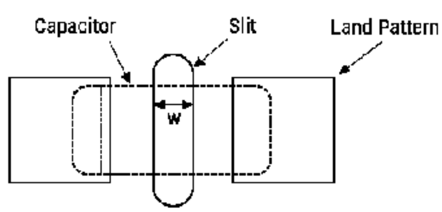
For MLCC ratings ≥1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

Dielectric	CTE (ppm/°C)
Class II $BaTiO_3$	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.



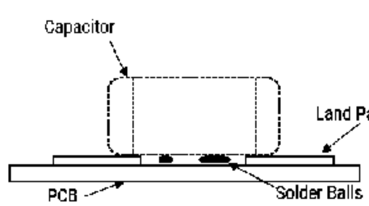
Solder Resist

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.



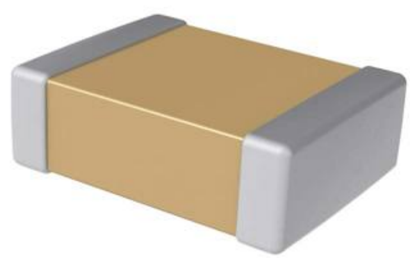
High Voltage with Flexible Termination System (HV FT-CAP), C0G Dielectric, 500 – 3,000 VDC (Automotive Grade)

Overview

KEMET's Automotive Grade High Voltage with Flexible Termination (HV FT-CAP) surface mount MLCCs in C0G 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. C0G (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. 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

Ordering Information

C	2225	X	393	J	C	G	A	C	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 = ±0.10 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 = C0G	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)
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/2mm pitch[2]	7081
13" Reel/Unmarked/2mm pitch[2]	7082
Automotive 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."*

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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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:

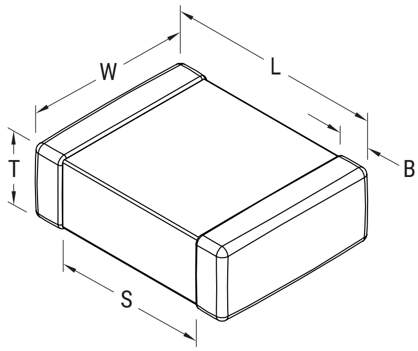
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

[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)



<table>
<tr><th>EIA Size Code</th><th>Metric Size Code</th><th>L Length</th><th>W Width</th><th>T Thickness</th><th>B Bandwidth</th><th>S Separation Minimum</th><th>Mounting Technique</th></tr>
<tr><td>0603</td><td>1608</td><td>1.60 (0.063) ±0.15 (0.006)</td><td>0.80 (0.032) ±0.15 (0.006)</td><td rowspan="9">See Table 2 for Thickness</td><td>0.35 (0.014) ±0.15 (0.006)</td><td>0.70 (0.028)</td><td rowspan="3">Solder Wave or Solder Reflow</td></tr>
<tr><td>0805</td><td>2012</td><td>2.00 (0.079) ±0.30 (0.012)</td><td>1.25 (0.049) ±0.30 (0.012)</td><td>0.50 (0.02) ±0.25 (0.010)</td><td>0.75 (0.030)</td></tr>
<tr><td>1206</td><td>3216</td><td>3.30 (0.130) ±0.40 (0.016)</td><td>1.60 (0.063) ±0.35 (0.013)</td><td>0.60 (0.024) ±0.25 (0.010)</td><td rowspan="7">N/A</td></tr>
<tr><td>1210</td><td>3225</td><td>3.30 (0.130) ±0.40 (0.016)</td><td>2.60 (0.102) ±0.30 (0.012)</td><td>0.60 (0.024) ±0.25 (0.010)</td><td rowspan="6">Solder Reflow Only</td></tr>
<tr><td>1808</td><td>4520</td><td>4.70 (0.185) ±0.50 (0.020)</td><td>2.00 (0.079) ±0.20 (0.008)</td><td>0.70 (0.028) ±0.35 (0.014)</td></tr>
<tr><td>1812</td><td>4532</td><td>4.50 (0.178) ±0.40 (0.016)</td><td>3.20 (0.126) ±0.30 (0.012)</td><td>0.70 (0.028) ±0.35 (0.014)</td></tr>
<tr><td>1825</td><td>4564</td><td>4.60 (0.181) ±0.40 (0.016)</td><td>6.40 (0.252) ±0.40 (0.016)</td><td>0.70 (0.028) ±0.35 (0.014)</td></tr>
<tr><td>2220</td><td>5650</td><td>5.90 (0.232) ±0.75 (0.030)</td><td>5.00 (0.197) ±0.40 (0.016)</td><td>0.70 (0.028) ±0.35 (0.014)</td></tr>
<tr><td>2225</td><td>5664</td><td>5.90 (0.232) ±0.75 (0.030)</td><td>6.40 (0.248) ±0.40 (0.016)</td><td>0.70 (0.028) ±0.35 (0.014)</td></tr>
</table>

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)

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

[3] *To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ 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	150% of rated voltage	130% of rated voltage	120% 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		< 5.1nF 150% 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
C0G	All	All	0.5	0.3% or ±0.25 pF	10% of Initial Limit

Table 1A – Capacitance Range/Selection Waterfall (0603 – 1808 Case Sizes)

Capacitance	Cap Code	Case Size/Series								C0603X			C0805X			C1206X					C1210X					C1808X						
		Voltage Code								C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		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								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																						
1.0 - 9.1 pF*	109 - 169*	B	C	D									DG	DG	DG											LB	LB	LB	LB	LB	LB	LB
10 pF	100				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
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	LB
12 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
13 pF	130				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	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	M				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	240				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
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	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	M				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
47 pF	470				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
51 pF	510				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
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				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	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	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	K	M	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	M	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	LA	LA	LA	LA	LB	LC	LC
150 pF	151				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	LB	LC	LC
160 pF	161				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
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	LA	LA	LC	LC	
220 pF	221				F	G	J	K	M	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	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	K	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				F	G	J	K	M	CJ	CJ		DG	DG	DD	ES	ES	EF	EU		FZ	FM	FM	FS	FS	LA	LB	LB	LC	LA		
470 pF	471				F	G	J	K	M	CJ	CJ		DG	DG	DD	ES	ES	EU	EU		FZ	FM	FM	FS	FS	LA	LB	LB	LC	LA		
510 pF	511				F	G	J	K	M	CJ	CJ		DG	DG	DD	ES	ES	EU	EU		FZ	FM	FM	FS	FS	LA	LB	LB	LC	LB		
560 pF	561				F	G	J	K	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	K	M	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	M	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				F	G	J	K	M				DG	DG	DG	ES	EF	EU			FZ	FM	FM	FM		LB	LB	LB	LA			
910 pF	911				F	G	J	K	M				DC	DC		ES	EF	EU			FM	FM	FM	FY		LB	LB	LB	LA			
1,000 pF	102				F	G	J	K	M				DC	DC		ES	EF	EU			FM	FM	FM	FY		LB	LB	LB	LB			
Capacitance	Cap 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
		Voltage Code								C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		Case Size/Series								C0603X			C0805X			C1206X					C1210X					C1808X						

**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.

Capacitance	Cap Code	Case Size/Series					C0603X			C0805X			C1206X					C1210X					C1808X						
		Voltage Code					C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		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					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																						
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					
8,200 pF	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										
Capacitance	Cap 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
		Voltage Code					C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		Case Size/Series					C0603X			C0805X			C1206X					C1210X					C1808X						

**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)

Cap	Cap Code	Case Size/ Series	C1812X							C1825X							C2220X							C2225X						
		Voltage Code	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		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	Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																											
10 pF	100	F G J K M	GB	GB	GB	GB	GB	GB	GB								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								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								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
13 pF	130	F G J K M	GB	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	GB	GB	GB	GB	GB	GB								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
16 pF	160	F G J K M	GB	GB	GB	GB	GB	GB	GB								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
18 pF	180	F G J K M	GB	GB	GB	GB	GB	GB	GB								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
20 pF	200	F G J K M	GB	GB	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	GB	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	GB	GB	GB	GB	GB	GB								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								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								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
33 pF	330	F G J K M	GB	GB	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	GB	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	GB	GB	GB	GB	GB	GB								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								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								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
51 pF	510	F G J K M	GB	GB	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	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	GB	GB	GB	GB	GB	GB								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
68 pF	680	F G J K M	GB	GB	GB	GB	GB	GB	GB								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
75 pF	750	F G J K M	GB	GB	GB	GB	GB	GB	GB								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
82 pF	820	F G J K M	GB	GB	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	GD	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	GD	GD	GD	GD	GD	GD								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
110 pF	111	F G J K M	GD	GD	GD	GD	GD	GD	GD								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
120 pF	121	F G J K M	GD	GD	GD	GD	GD	GD	GD								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
130 pF	131	F G J K M	GD	GD	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	GD	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	GD	GD	GD	GD	GD	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
180 pF	181	F G J K M	GD	GD	GD	GD	GD	GD	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
200 pF	201	F G J K M	GD	GD	GD	GD	GD	GD	GM								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								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								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								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								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								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								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								JE	JE	JE	JE	JE	JK	JK	KE	KE	KE	KE	KE	KE	KF
430 pF	431	F G J K M	GB	GB	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	F G J K M	GB	GB	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	F G J K M	GB	GB	GB	GD	GH	GM		HJ	HJ	HJ	HJ	HJ	HJ	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		HJ	HJ	HJ	HJ	HJ	HJ	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		HK	HK	HK	HK	HK	HK	HK	JK	JK	JK	JK	JK	JK	JL	KF	KF	KF	KF	KE	KF	KH
680 pF	681	F G J K M	GB	GB	GB	GD	GH	GO		HK	HK	HK	HK	HK	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	GB	GB	GD	GK										JE	JE	JE	JK	JK	JK	JL	KE	KE	KE	KF	KE	KF	KH
820 pF	821	F G J K M	GB	GB	GB	GD	GK										JE	JE	JE	JK	JK	JK	JN	KE	KE	KE	KF	KE	KF	KJ
910 pF	911	F G J K M	GB	GB	GB	GH	GM										JE	JK	JK	JK	JK	JK	JN	KE	KE	KE	KF	KE	KF	KJ
1,000 pF	102	F G J K M	GB	GB	GB	GH	GM										JE	JK	JK	JK	JK	JK	JN	KE	KE	KE	KF	KE	KF	KJ
1,100 pF	112	F G J K M	GB	GB	GB	GH	GO			HJ	HJ	HJ	HJ	HJ	HJ		JE	JK	JK	JK	JK	JK		KE	KE	KE	KF	KF	KF	
Cap	Cap 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
		Voltage Code	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		Case Size/Series	C1812X							C1825X							C2220X							C2225X						

**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 (1812 – 2225 Case Sizes) cont.

Cap	Cap Code	Case Size/Series	C1812X							C1825X							C2220X							C2225X						
		Voltage Code	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		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	Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																												
1,200 pF	122	F G J K M	GB	GB	GB	GH	GO			HJ	HJ	HJ	HJ	HJ	HJ		JE	JK	JK	JK	JK	JL		KE	KE	KE	KF	KF	KF	
1,300 pF	132	F G J K M	GB	GB	GB	GH	GO			HE	HE	HE	HE	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	HE	HE	HE	HE	HK		JE	JK	JK	JK	JE	JL		KE	KE	KE	KF	KF	KH	
1,600 pF	162	F G J K M	GB	GD	GD	GK				HG	HG	HG	HG	HG	HK		JE	JK	JK	JK	JE	JL		KE	KE	KE	KF	KE	KH	
1,800 pF	182	F G J K M	GB	GD	GD	GM				HG	HG	HG	HG	HG			JE	JK	JK	JK	JE	JN		KE	KE	KE	KF	KE	KH	
2,000 pF	202	F G J K M	GB	GH	GH	GM				HE	HE	HE	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	HE	HE	HE	HJ			JE	JK	JK	JE	JK			KE	KE	KE	KF	KF	KJ	
2,400 pF	242	F G J K M	GB	GH	GK	GO				HE	HE	HE	HE	HJ			JK	JK	JK	JE	JL			KE	KE	KE	KE	KH		
2,700 pF	272	F G J K M	GB	GH	GK	GO				HE	HE	HE	HE	HK			JK	JK	JK	JE	JL			KE	KE	KE	KE	KH		
3,000 pF	302	F G J K M	GB	GH	GK					HE	HE	HE	HE	HK			JK	JK	JK	JE	JL			KE	KE	KE	KE	KH		
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					HJ	HJ	HJ	HJ				JK	JK	JK	JK	JN			KE	KF	KF	KF	KJ		
4,300 pF	432	F G J K M	GH	GH	GO					HJ	HJ	HJ	HJ				JK	JK	JK	JK				KE	KF	KF	KF			
4,700 pF	472	F G J K M	GH	GH	GO					HJ	HJ	HJ	HJ				JK	JK	JK	JL				KE	KF	KF	KH			
5,100 pF	512	F G J K M	GH	GK	GO					HE	HE	HG	HK				JK	JK	JK	JL				KE	KF	KF	KH			
5,600 pF	562	F G J K M	GH	GK	GO					HE	HE	HG	HK				JK	JK	JK	JN				KE	KF	KF	KH			
6,200 pF	622	F G J K M	GH	GK	GH					HE	HE	HG					JK	JE	JE	JN				KE	KF	KF	KJ			
6,800 pF	682	F G J K M	GH	GM	GH					HE	HE	HJ					JK	JE	JK	JN				KE	KF	KF	KJ			
7,500 pF	752	F G J K M	GH	GM	GK					HE	HE	HJ					JK	JE	JK					KF	KE	KF				
8,200 pF	822	F G J K M	GK	GO	GK					HE	HE	HJ					JK	JE	JL					KF	KE	KF				
9,100 pF	912	F G J K M	GM	GO	GM					HE	HG	HK					JE	JE	JL					KF	KE	KH				
10,000 pF	103	F G J K M	GM	GO	GM					HE	HG	HK					JE	JE	JL					KF	KE	KH				
12,000 pF	123	F G J K M	GO	GH	GO					HE	HG	HE					JE	JK	JN					KE	KE	KH				
15,000 pF	153	F G J K M	GO	GH	GO					HE	HJ	HE					JE	JL	JE					KE	KF	KJ				
18,000 pF	183	F G J K M	GH	GH						HG	HK	HG					JE	JL	JE					KE	KH	KE				
22,000 pF	223	F G J K M	GH	GH						HJ	HE	HJ					JK	JN	JK					KF	KJ	KF				
27,000 pF	273	F G J K M	GK	GK						HJ	HE	HK					JL	JN	JL					KF	KJ	KH				
33,000 pF	333	F G J K M	GM	GM						HK	HE	HK					JN	JE	JN					KH	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					
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					
0.12 µF	124	F G J K M																						KJ	KJ					
Cap	Cap 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
		Voltage Code	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		Case Size/Series	C1812X							C1825X							C2220X							C2225X						

**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 2 – Chip Thickness/Tape & Reel Packaging Quantities

Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			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
DD	805	0.90 ± 0.10	0	0	4,000	10,000
DG	805	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
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 Code	Case Size	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity		Plastic Quantity	

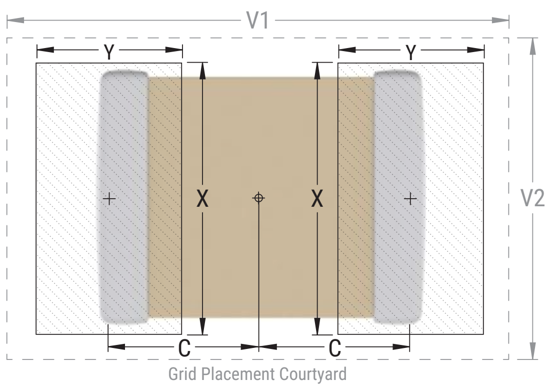
Package quantity based on finished chip thickness specifications.

Table 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)				
		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:

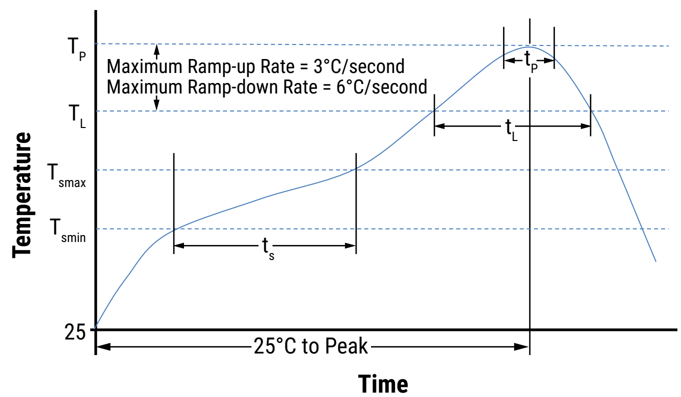
- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- All other EIA case sizes are limited to solder reflow only

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	
	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

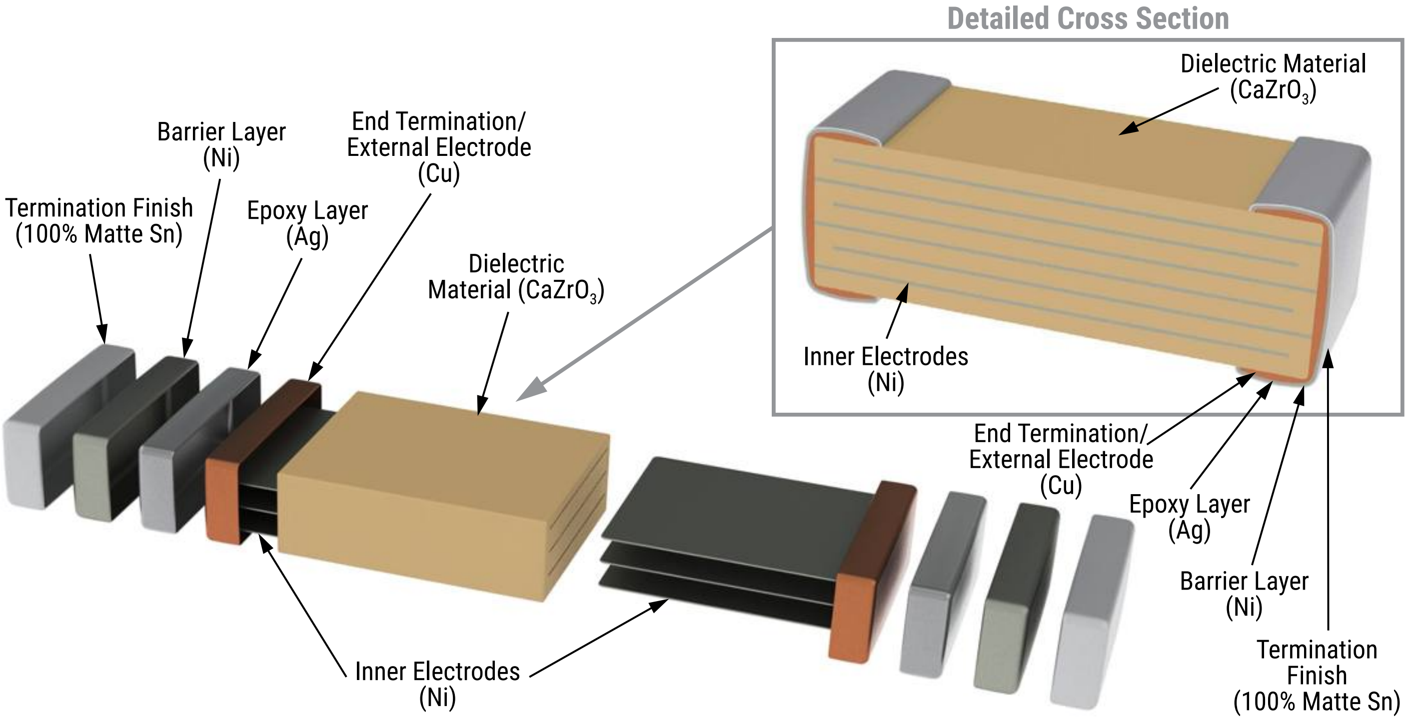
Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.



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 40ºC 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):

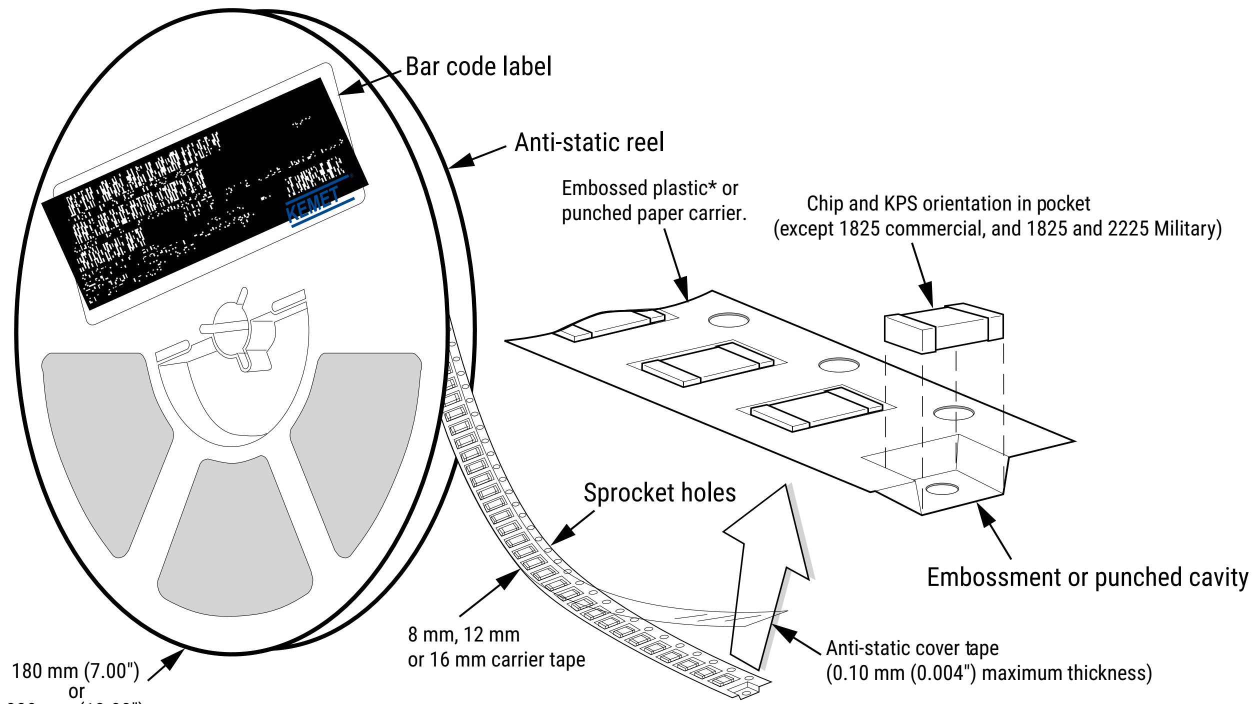
Laser marking option is not available on:

- C0G, 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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

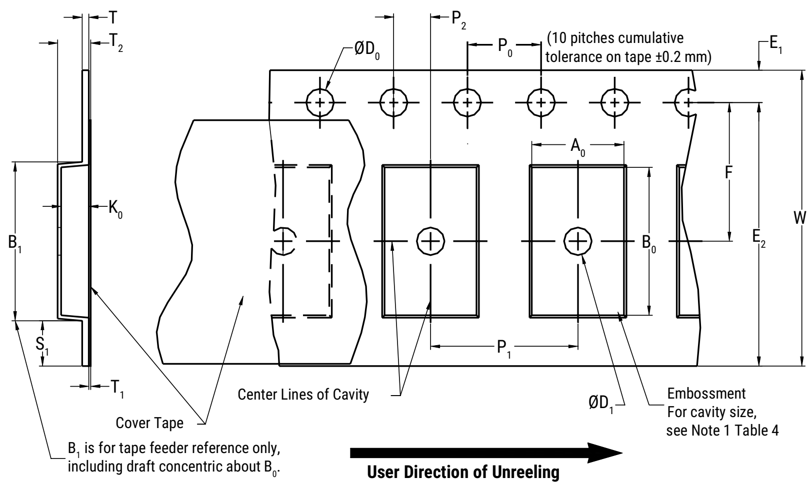


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +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)			
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)	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 S_1 < 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_0, B_0 and K_0 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

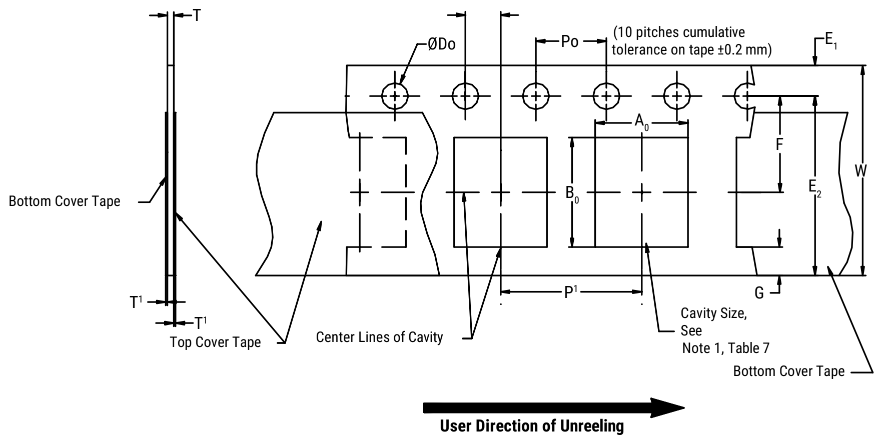


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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.)

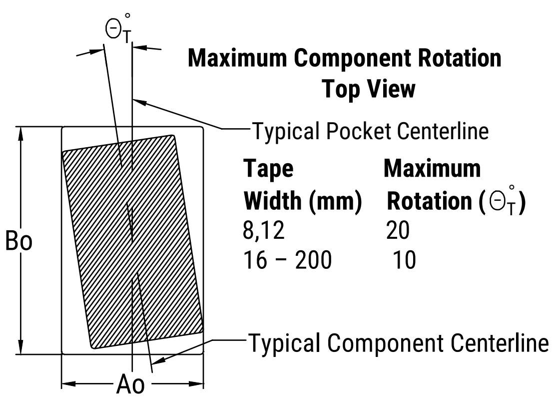
Packaging Information Performance Notes

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



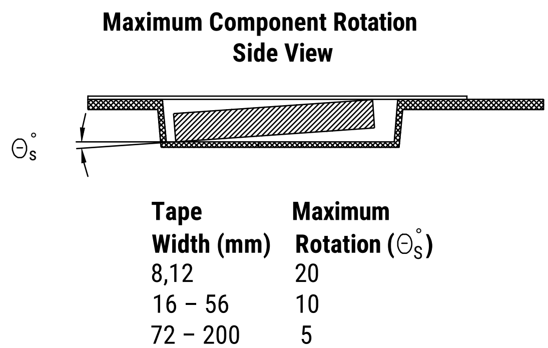


Figure 4 – Maximum Lateral Movement

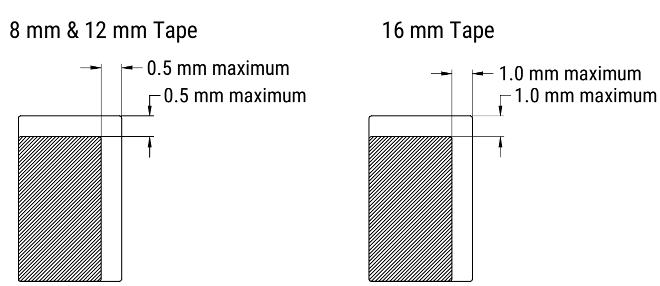


Figure 5 – Bending Radius

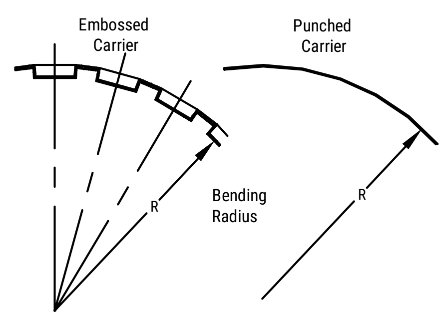
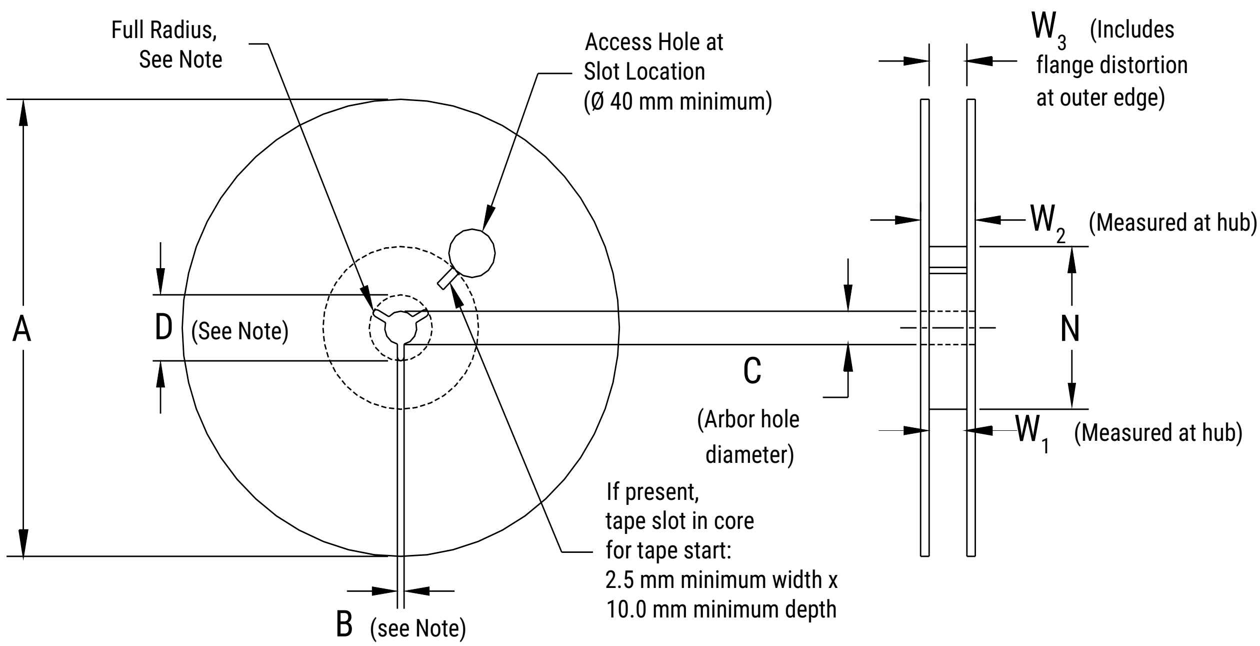


Figure 6 – Reel Dimensions



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	A	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

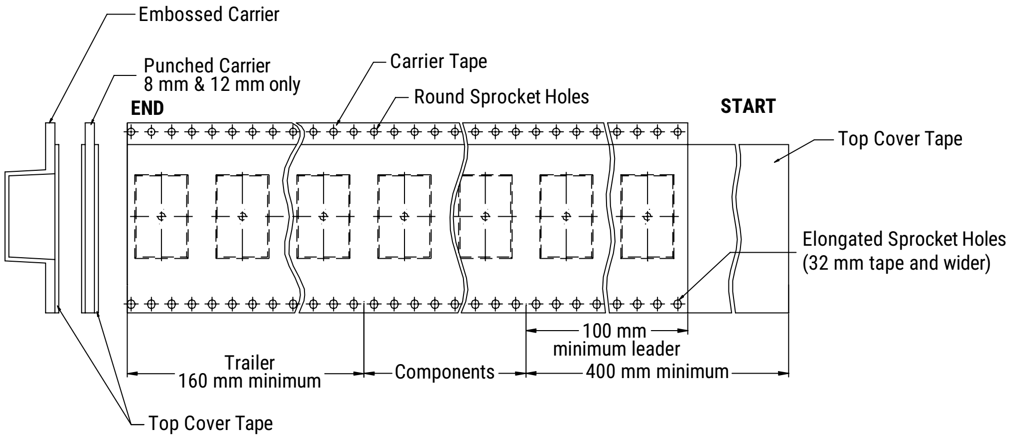
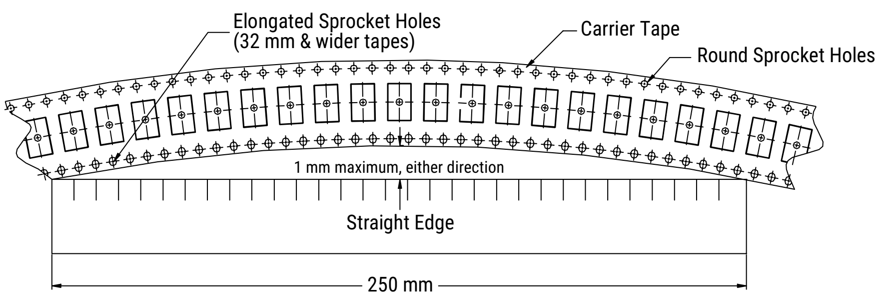


Figure 8 – Maximum Camber



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

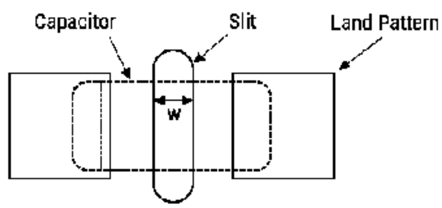
For MLCC ratings ≥1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

Dielectric	CTE (ppm/°C)
Class II $BaTiO_3$	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.



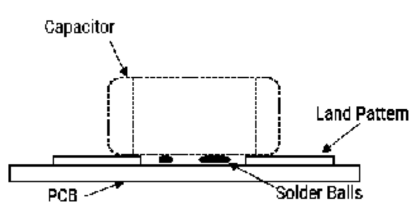
Solder Resist

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.



U2J Dielectric, 10 – 100 VDC (Commercial & Automotive Grade)

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 C0G
- Extremely low effective series resistance (ESR)
- Extremely low effective series inductance (ESL)
- High ripple current capability
- Low noise solution similar to C0G
- 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

C	1206	C	104	J	3	J	A	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)
Commercial 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
Automotive 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 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 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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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.*

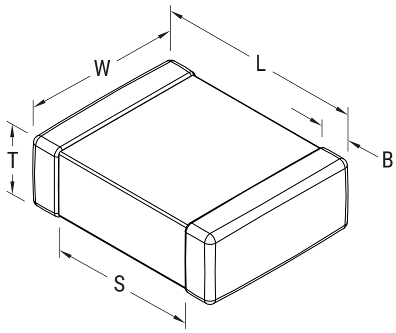
Production Part Approval Process (PPAP)
The purpose of the Production Part Approval Process is:
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements 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			○		

[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 MΩ µF or 100 GΩ (Rated voltage applied 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.
Capacitance and dissipation factor (DF) measured under the following conditions:

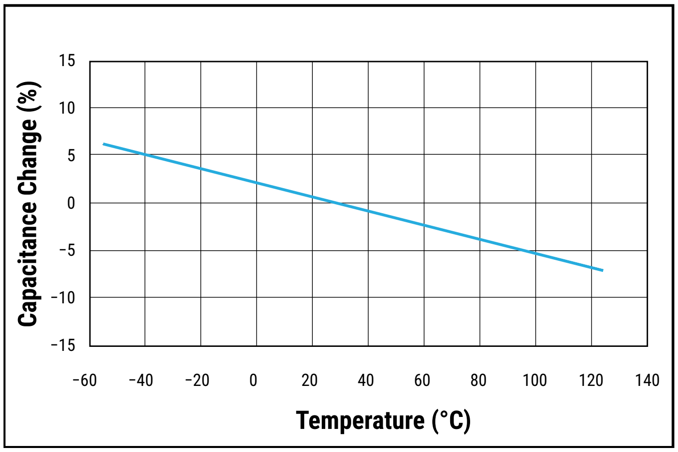
1 MHz ±100 kHz and 1.0 ±0.2 V_{rms} if capacitance ≤ 1,000 pF

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)

Capacitance vs. Temperature (TCC)



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)

Capacitance	Cap Code	Case Size/ Series	C0402C				C0603C				C0805C				C1206C				C1210C					C1812C			
		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
		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 Tolerance	Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																								
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	F G J K M	BB	BB	BB	BB																					
200 pF	201	F G J K M	BB	BB	BB	BB																					
220 pF	221	F G J K M	BB	BB	BB	BB																					
240 pF	241	F G J K M	BB	BB	BB	BB																					
270 pF	271	F G J K M	BB	BB	BB	BB																					
300 pF	301	F G J K M	BB	BB	BB	BB																					
330 pF	331	F G J K M	BB	BB	BB	BB																					
360 pF	361	F G J K M	BB	BB	BB	BB																					
390 pF	391	F G J K M	BB	BB	BB	BB																					
430 pF	431	F G J K M	BB	BB	BB	BB																					
470 pF	471	F G J K M	BB	BB	BB	BB																					
510 pF	511	F G J K M	BB	BB	BB	BB																					
560 pF	561	F G J K M	BB	BB	BB	BB																					
620 pF	621	F G J K M	BB	BB	BB	BB																					
680 pF	681	F G J K M	BB	BB	BB	BB																					
750 pF	751	F G J K M	BB	BB	BB	BB																					
820 pF	821	F G J K M	BB	BB	BB	BB																					
910 pF	911	F G J K M	BB	BB	BB	BB																					
1,000 pF	102	F G J K M	BB	BB	BB	BB	CF	CF	CF	CF																	
1,100 pF	112	F G J K M	BB	BB	BB	BB	CF	CF	CF	CF																	
1,200 pF	122	F G J K M	BB	BB	BB	BB	CF	CF	CF	CF																	
1,300 pF	132	F G J K M	BB	BB	BB	BB	CF	CF	CF	CF																	
1,500 pF	152	F G J K M	BB	BB	BB	BB	CF	CF	CF	CF																	
1,600 pF	162	F G J K M	BB	BB	BB	BB	CF	CF	CF	CF																	
1,800 pF	182	F G J K M	BB	BB	BB	BB	CF	CF	CF	CF																	
2,000 pF	202	F G J K M	BB	BB	BB		CF	CF	CF	CF																	
2,200 pF	222	F G J K M	BB	BB	BB		CF	CF	CF	CF																	
2,400 pF	242	F G J K M	BB	BB			CF	CF	CF	CF																	
2,700 pF	272	F G J K M	BB	BB			CF	CF	CF	CF																	
Capacitance	Cap Code	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
		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	C0402C				C0603C				C0805C				C1206C				C1210C					C1812C			

XX[1] - Commercial Grade Only

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

Capacitance	Cap Code	Case Size/ Series					C0402C				C0603C				C0805C				C1206C				C1210C					C1812C			
		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
		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 Tolerance					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																								
3,000 pF	302	F	G	J	K	M	BB	BB			CF	CF	CF	CF																	
3,300 pF	332	F	G	J	K	M	BB	BB			CF	CF	CF	CF																	
3,600 pF	362	F	G	J	K	M	BB	BB			CF	CF	CF	CF																	
3,900 pF	392	F	G	J	K	M	BB	BB			CF	CF	CF	CF																	
4,300 pF	432	F	G	J	K	M	BB	BB			CF	CF	CF	CF																	
4,700 pF	472	F	G	J	K	M	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	F	G	J	K	M					CF	CF	CF	CF	DN	DN	DN	DN													
8,200 pF	822	F	G	J	K	M					CF	CF	CF	CF	DN	DN	DN	DN													
9,100 pF	912	F	G	J	K	M					CF	CF	CF	CF	DN	DN	DN	DN													
10,000 pF	103	F	G	J	K	M					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	F	G	J	K	M									DG	DG	DG	DG	EB	EB	EB	EB	FB	FB	FB	FB	FC	GB	GB	GB	GB
56,000 pF	563	F	G	J	K	M									DG	DG	DG		EB	EB	EB	EC	FB	FB	FB	FB	FE	GB	GB	GB	GB
68,000 pF	683	F	G	J	K	M									DG	DG			EC	EC	EC	EC	FB	FB	FB	FB	FG	GB	GB	GB	GB
82,000 pF	823	F	G	J	K	M									DG	DG			EC	EC	EC	EE	FB	FB	FB	FB	FG	GB	GB	GB	GB
100,000 pF	104	F	G	J	K	M									DG	DG			EC	EC	EC	EF	FB	FB	FB	FC	FG	GB	GB	GB	GB
120,000 pF	124	F	G	J	K	M													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	F	G	J	K	M													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	F	G	J	K	M																	FH	FH	FH	FM		GB	GB	GB	GH
330,000 pF	334	F	G	J	K	M																	FM	FM	FM			GC	GC	GC	GK
390,000 pF	394	F	G	J	K	M																						GH	GH	GH	GJ
470,000 pF	474	F	G	J	K	M																						GK	GK	GK	GN[1]
Capacitance	Cap Code	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
		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					C0402C				C0603C				C0805C				C1206C				C1210C					C1812C			

XX[1] - Commercial Grade Only

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

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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 Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[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

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		Packaging Quantities (pieces/unit packaging)	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
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 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)				
		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

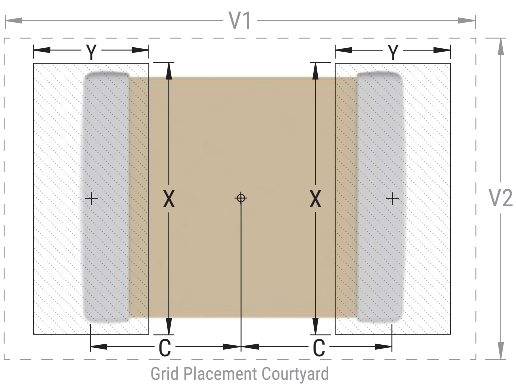
[1] *Only for capacitance values ≥ 22 µF*

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	Termination Finish	
	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.

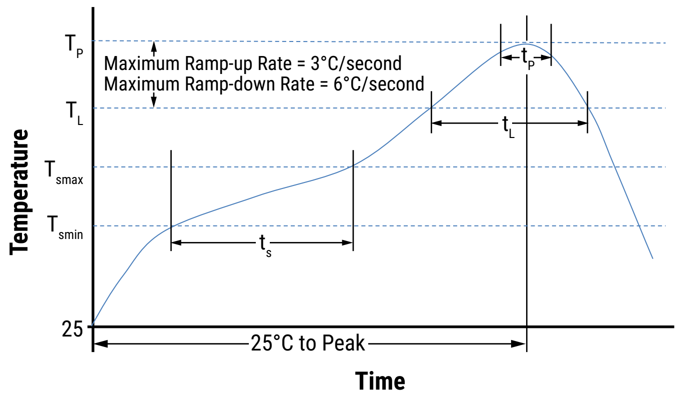


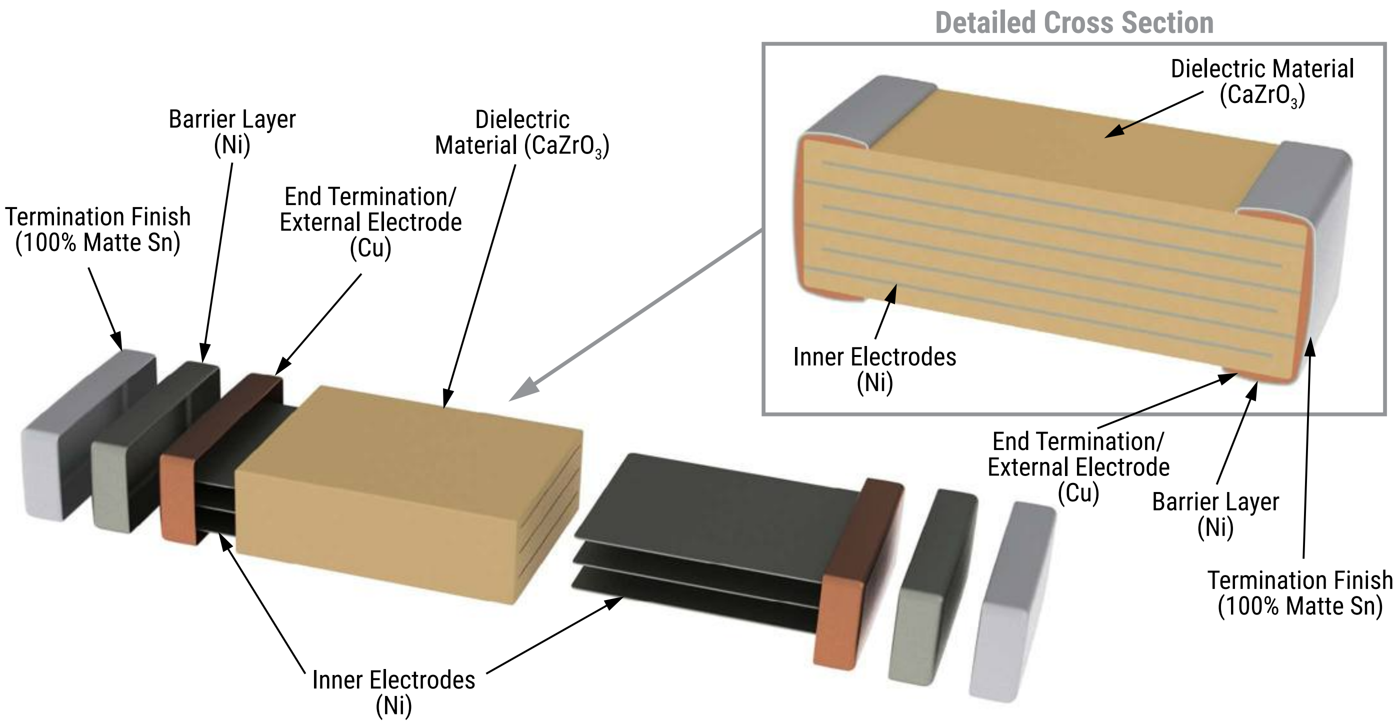
Table 4 – Performance & Reliability: Test Methods and Conditions

<table>
<tr><th>Stress</th><th>Reference</th><th colspan="2">Test or Inspection Method</th></tr>
<tr><td>Terminal Strength</td><td>JIS-C-6429</td><td>Appendix 1, Note:</td><td><table><tr><th>Package Size (L" x W")</th><th>Force</th><th>Duration</th></tr><tr><td>0402</td><td>5 N (0.51 kg)</td><td rowspan="3">60 seconds</td></tr><tr><td>0603</td><td>10 N (1.02 kg)</td></tr><tr><td>≥ 0805</td><td>18 N (1.83 kg)</td></tr></table></td></tr>
<tr><td>Board Flex</td><td>JIS-C-6429</td><td colspan="2">Appendix 2, Note: 3.0 mm (minimum).</td></tr>
<tr><td rowspan="4">Solderability</td><td rowspan="4">J-STD-002</td><td colspan="2">Magnification 50 X Conditions:</td></tr>
<tr><td colspan="2">a) Method B, 4 hours at 155°C, dry heat at 235°C</td></tr>
<tr><td colspan="2">b) Method B at 215°C, category 3</td></tr>
<tr><td colspan="2">c) Method D at 260°C, category 3</td></tr>
<tr><td>Temperature Cycling</td><td>JESD22 Method JA-104</td><td colspan="2">1,000 cycles (−55°C to +125°C). Measurement at 24 hours ±4 hours after test conclusion.</td></tr>
<tr><td rowspan="2">Biased Humidity</td><td rowspan="2">MIL-STD-202 Method 103</td><td colspan="2">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.</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td>Moisture Resistance</td><td>MIL-STD-202 Method 106</td><td colspan="2">t = 24 hours/cycle. Steps 7a and 7b not required. Measurement at 24 hours ±4 hours after test conclusion.</td></tr>
<tr><td>Thermal Shock</td><td>MIL-STD-202 Method 107</td><td colspan="2">−55°C/+125°C. Note: Number of cycles required – 300. Maximum transfer time – 20 seconds. Dwell time – 15 minutes. Air – air.</td></tr>
<tr><td>High Temperature Life</td><td>MIL-STD-202 Method 108/EIA -198</td><td colspan="2">1,000 hours at 125°C with 2 X rated voltage applied.</td></tr>
<tr><td>Storage Life</td><td>MIL-STD-202 Method 108</td><td colspan="2">125°C, 0 VDC for 1,000 hours.</td></tr>
<tr><td>Vibration</td><td>MIL-STD-202 Method 204</td><td colspan="2">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.</td></tr>
<tr><td>Mechanical Shock</td><td>MIL-STD-202 Method 213</td><td colspan="2">Figure 1 of Method 213, Condition F.</td></tr>
<tr><td>Resistance to Solvents</td><td>MIL-STD-202 Method 215</td><td colspan="2">Add aqueous wash chemical, OKEM clean or equivalent.</td></tr>
</table>

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)

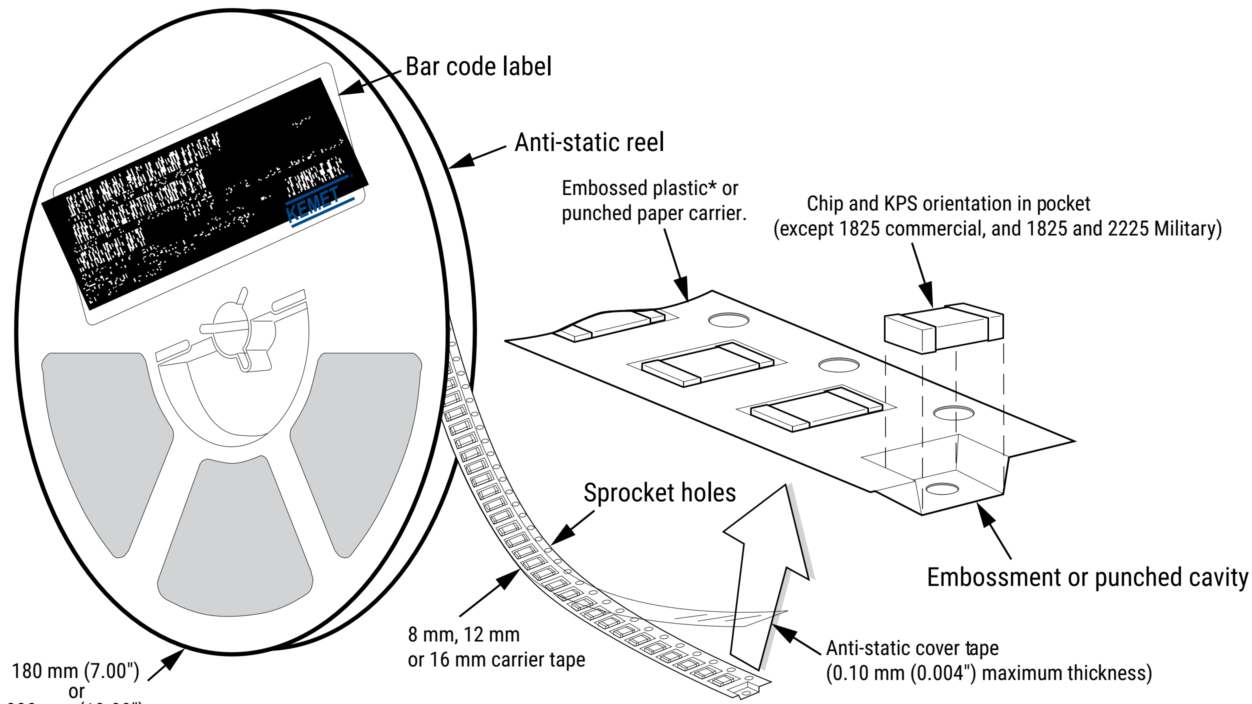
Laser marking option is not available on:

- C0G, 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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

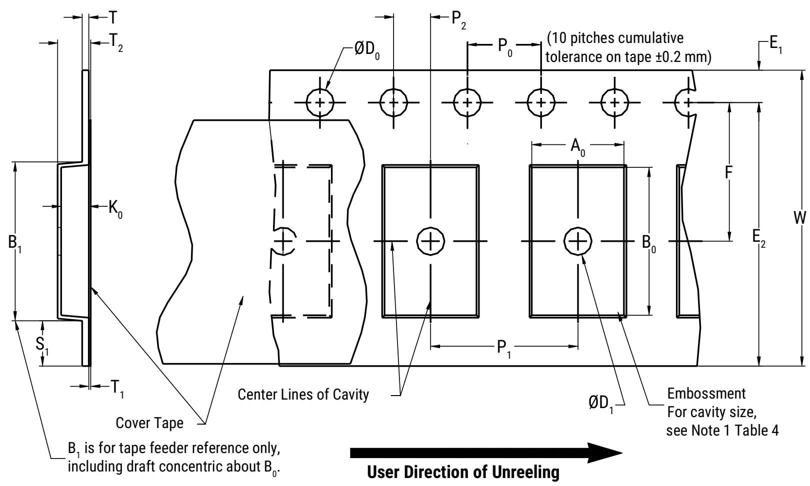


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +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)			
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)	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 S_1 < 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_0, B_0 and K_0 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

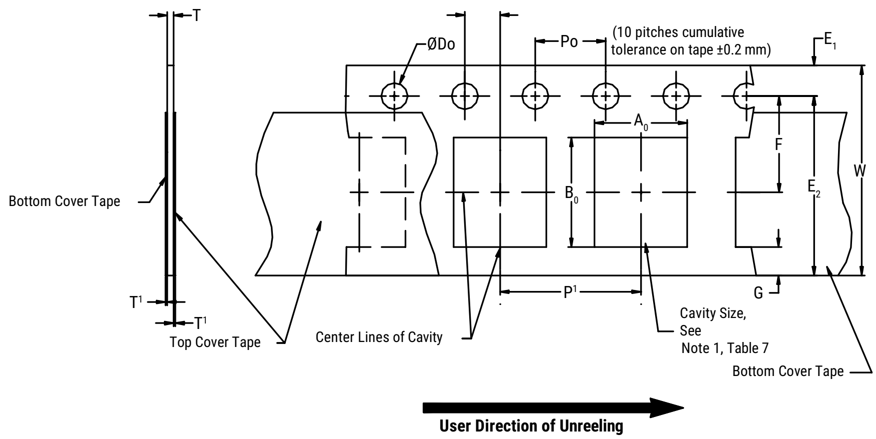


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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

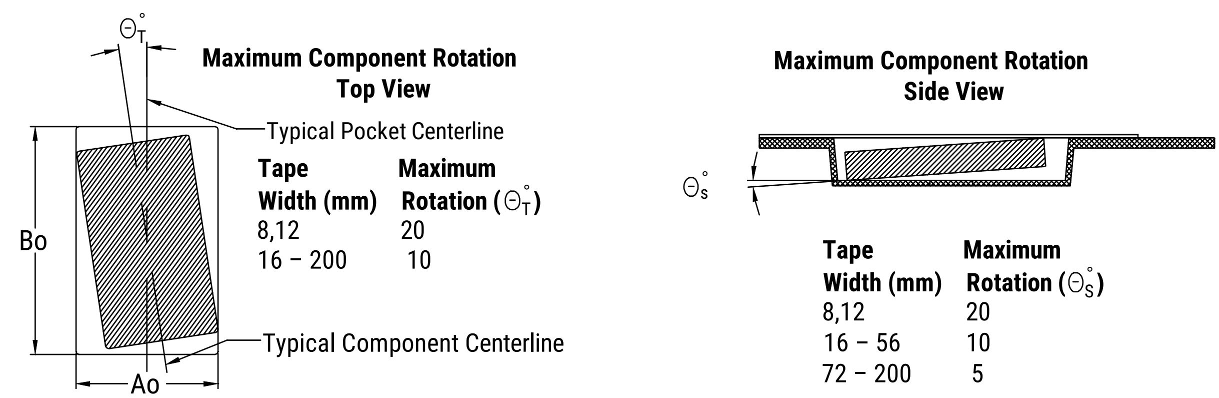


Figure 4 – Maximum Lateral Movement

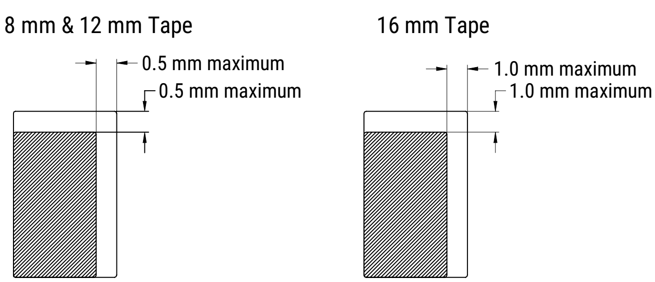


Figure 5 – Bending Radius

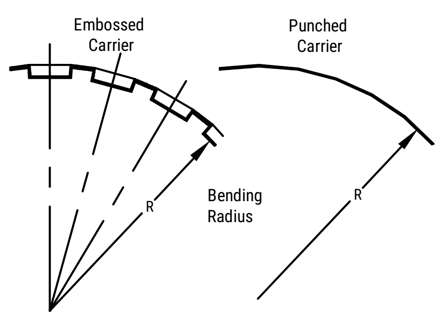
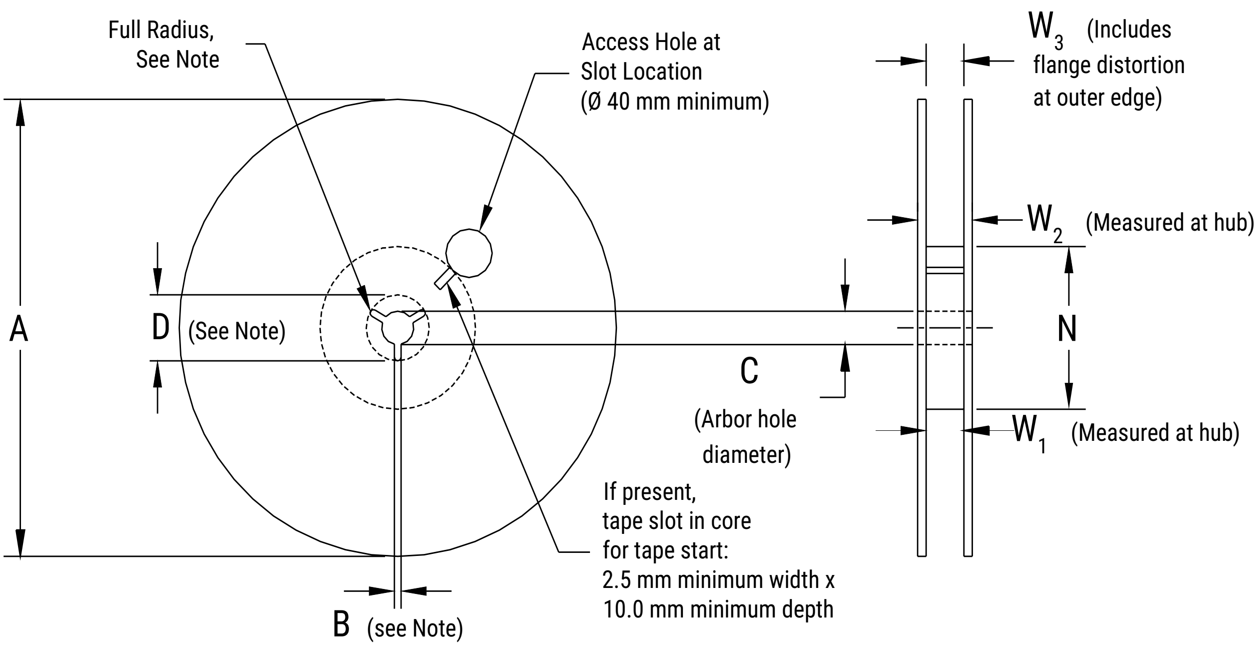


Figure 6 – Reel Dimensions



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	A	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

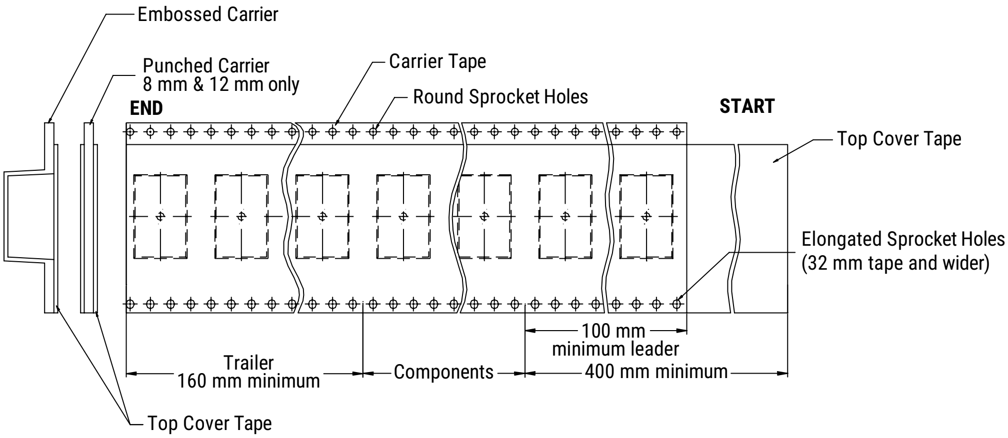
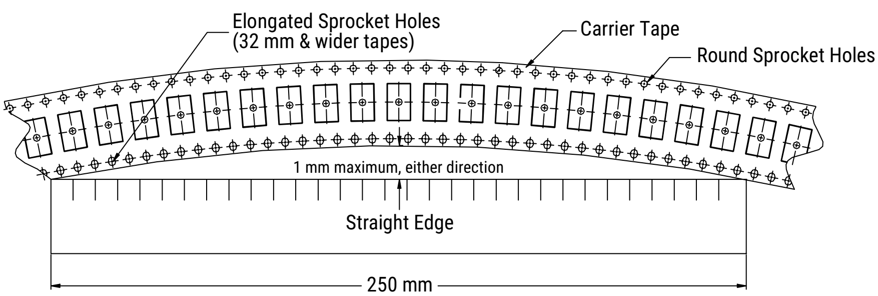


Figure 8 – Maximum Camber



KPS "L" Series, High Voltage, SnPb Termination, X7R Dielectric, 500 – 630 VDC (Commercial Grade)

KEMET a YAGEO company

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

C	2220	C	105	M	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 (±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)
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

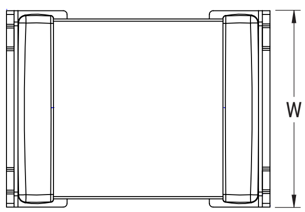
Commercial grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance and Reliability.

Environmental Compliance

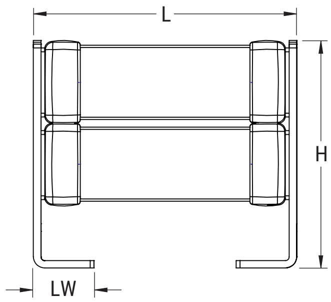
These devices do not meet RoHS criteria due to the concentration of Lead (Pb) in the termination finish.

Dimensions – Inches (Millimeters)

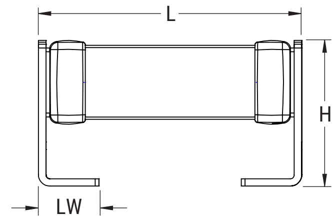
Single or Double Chip Stack



Double Chip Stack



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 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)	150% of rated voltage for voltage rating of < 1000 V 120% of rated voltage for voltage rating of ≥ 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 ≤ 10 µF
120 Hz ±10 Hz and 0.5±0.1 Vrms if capacitance > 10 µF
[4] To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ 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
X7R	> 25	All	3.0	±20%	10% of Initial Limit
	16/25		5.0		
	< 16		7.5		

Table 1 – Capacitance Range/Selection Waterfall (2220 Case Size)

Capacitance	Capacitance Code	Case Size/Series		C2220C	
		Voltage Code		C	B
		Rated Voltage (VDC)		500	630
		Capacitance Tolerance		Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions	
Single Chip Stack					
0.047 µF	473	K	M	JP	JP
0.10 uF	104	K	M	JP	JP
0.15 uF	154	K	M	JP	JP
0.22 uF	224	K	M	JP	JP
0.33 uF	334	K	M	JP	
0.47 uF	474	K	M	JP	
Double Chip Stack					
0.10 uF	104		M	JR	JR
0.22 uF	224		M	JR	JR
0.33 uF	334		M	JR	JR
0.47 uF	474		M	JR	JR
0.68 uF	684		M	JR	
1.0 uF	105		M	JR	
Capacitance	Capacitance Code	Rated Voltage (VDC)		500	630
		Voltage Code		C	B
		Case Size/Series		C2220C	

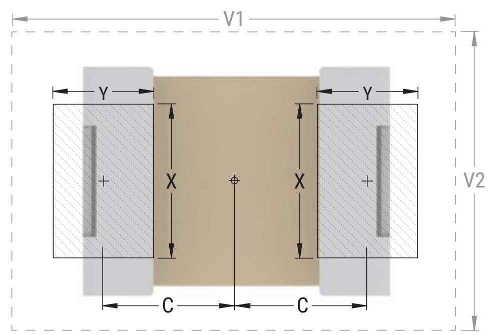
Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			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
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 3 – KPS Land Pattern Design Recommendations (mm)

EIA SIZE CODE	METRIC SIZE CODE	Median (Nominal) Land Protrusion				
		C	Y	X	V1	V2
2220	5650	2.69	2.08	4.78	7.70	6.00



Grid Placement Courtyard

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_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.

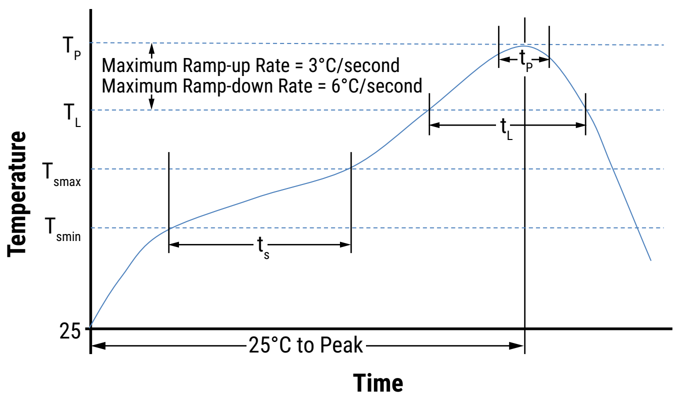


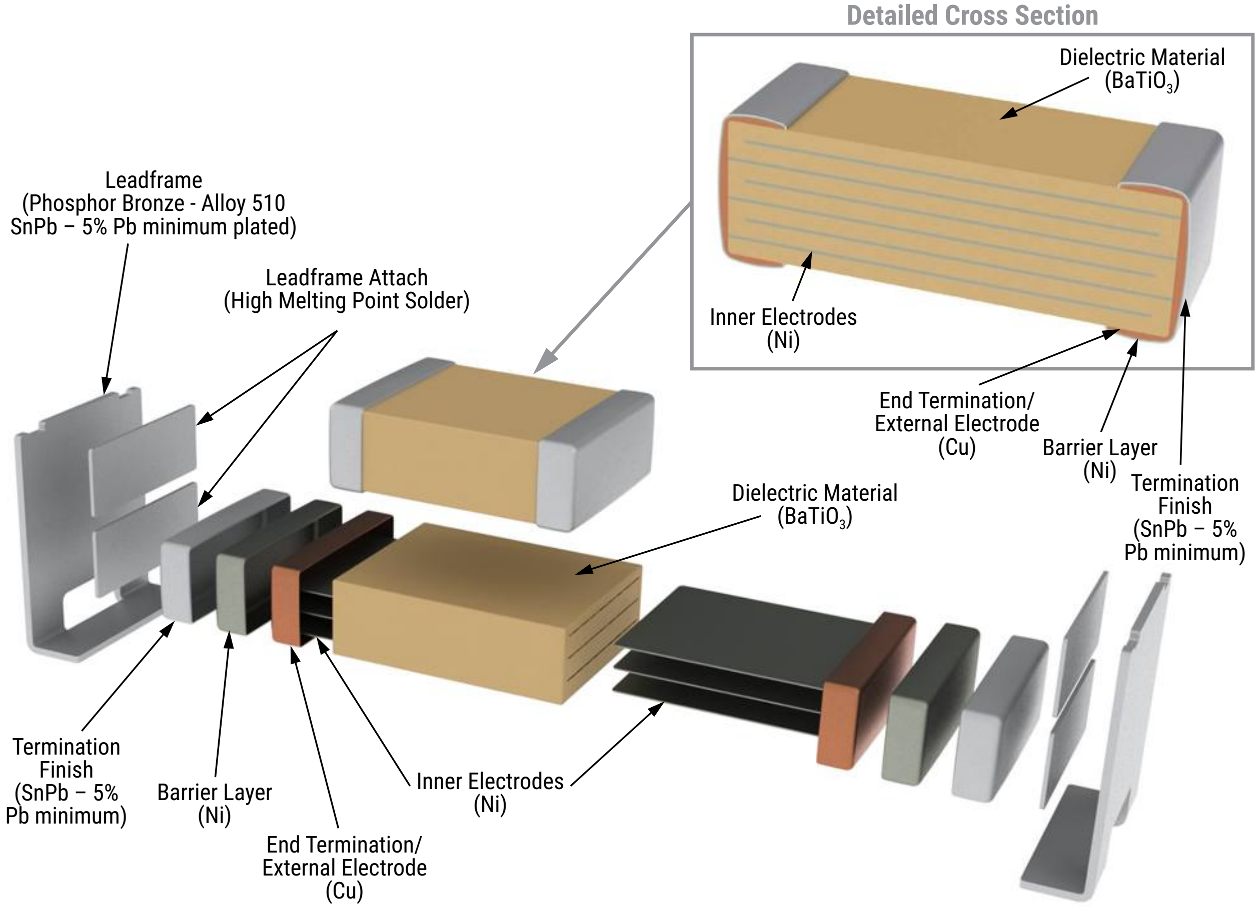
Table 4 – Performance & Reliability: Test Methods and Conditions

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
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 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 200 VDC maximum. Add 100K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion.
		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:

- C0G, 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.

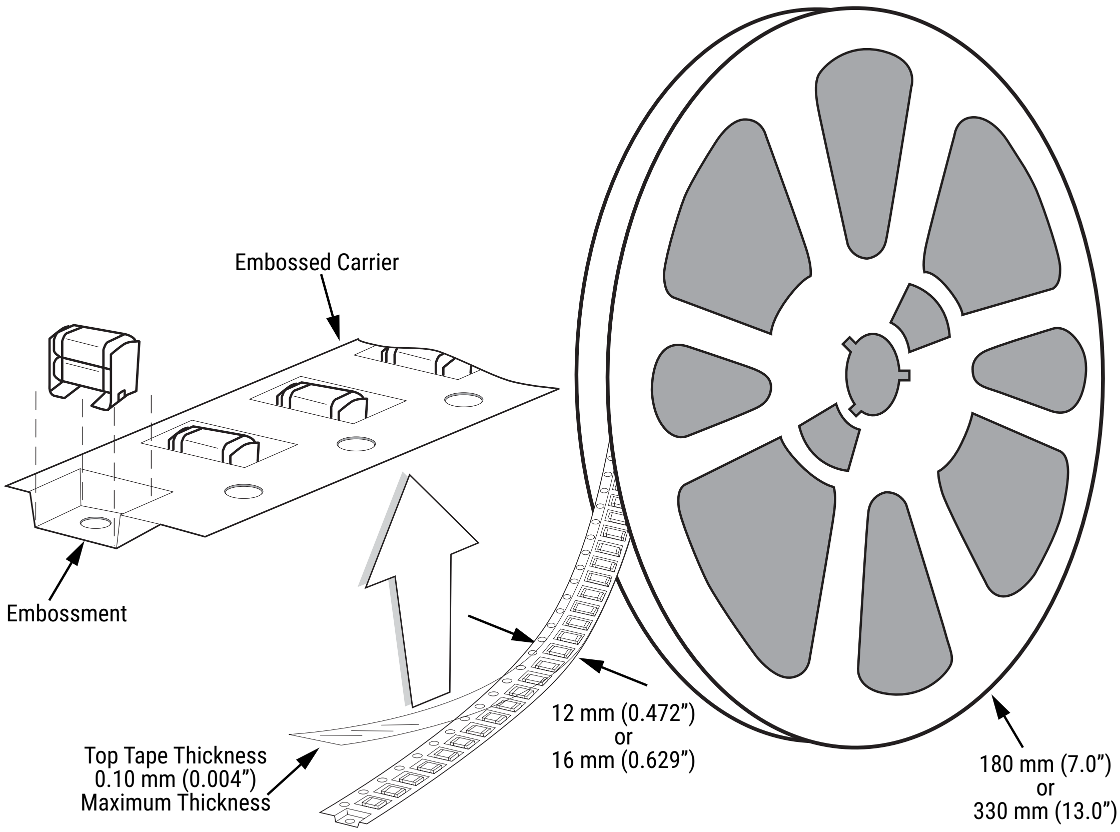


Table 5 – Carrier Tape Configuration – Embossed Plastic (mm)

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_1 carrier tape reference locations.*
**Refer to Table 5 for tolerance specifications.*

Figure 1 – Embossed (Plastic) Carrier Tape Dimensions

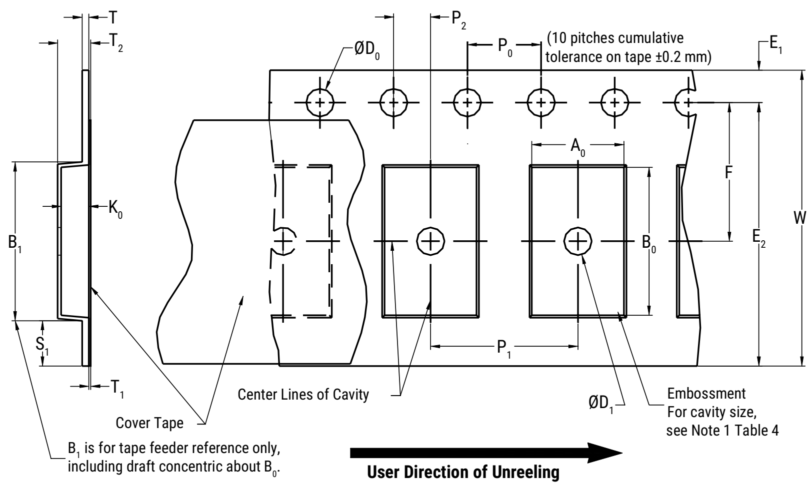


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +0.10/0.0−0.0 (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)			
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)	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 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 < 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_1 dimension is a reference dimension for tape feeder clearance only.*
5. *The cavity defined by A_0, B_0 and K_0 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

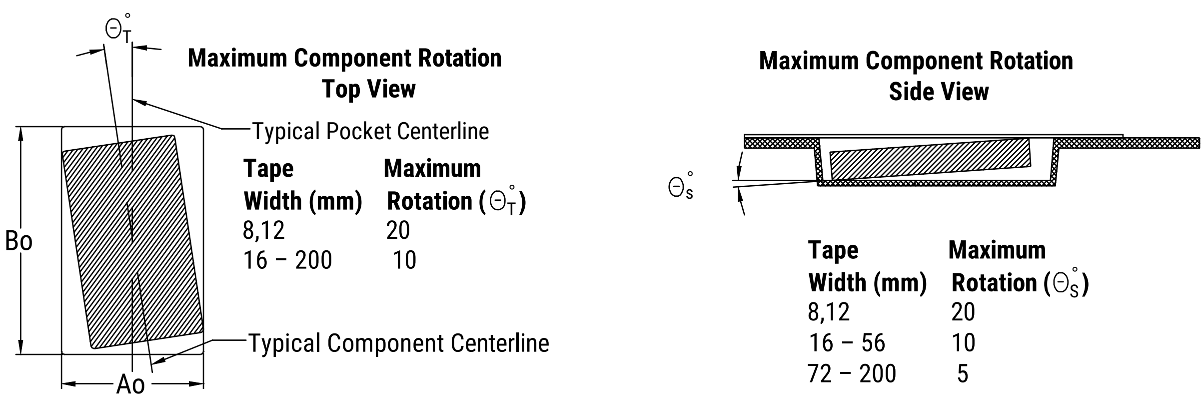


Figure 3 – Maximum Lateral Movement

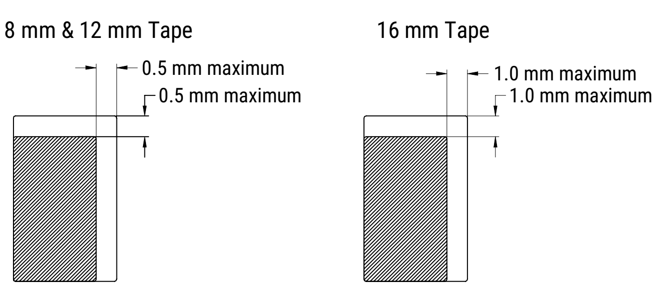


Figure 4 – Bending Radius

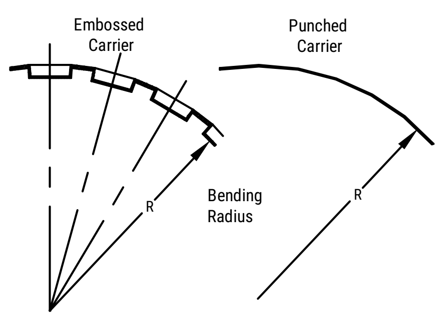
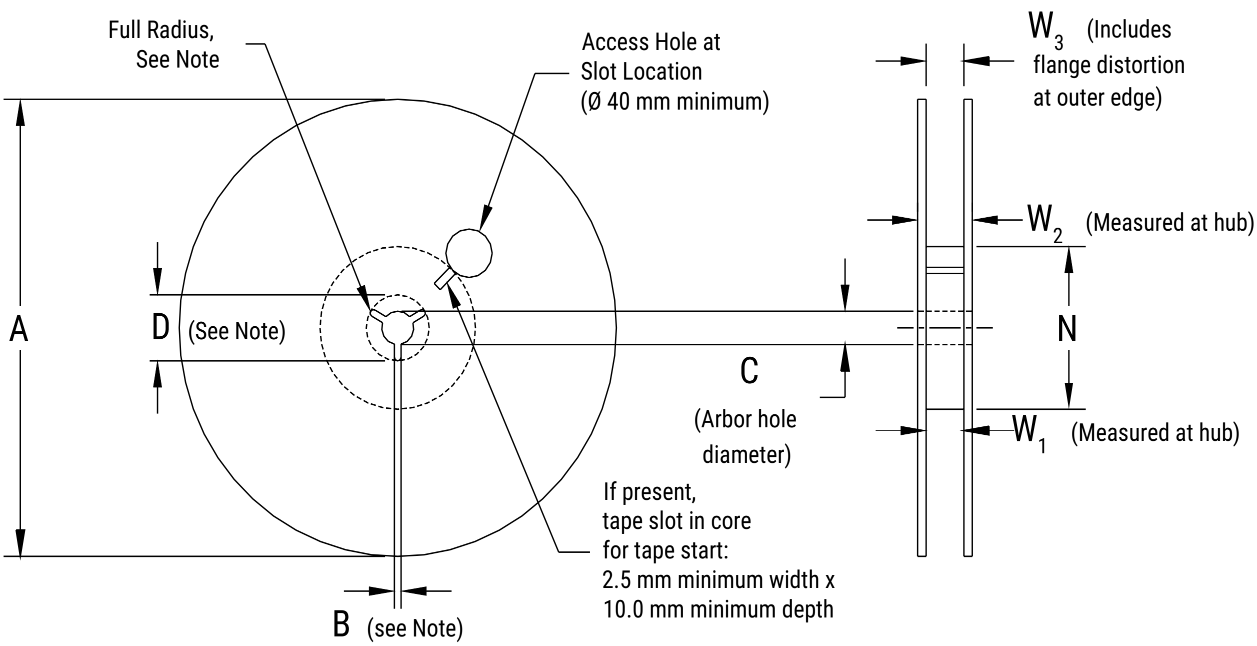


Figure 5 – Reel Dimensions



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

Table 7 – Reel Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)				
Tape Size	A	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 6 – Tape Leader & Trailer Dimensions

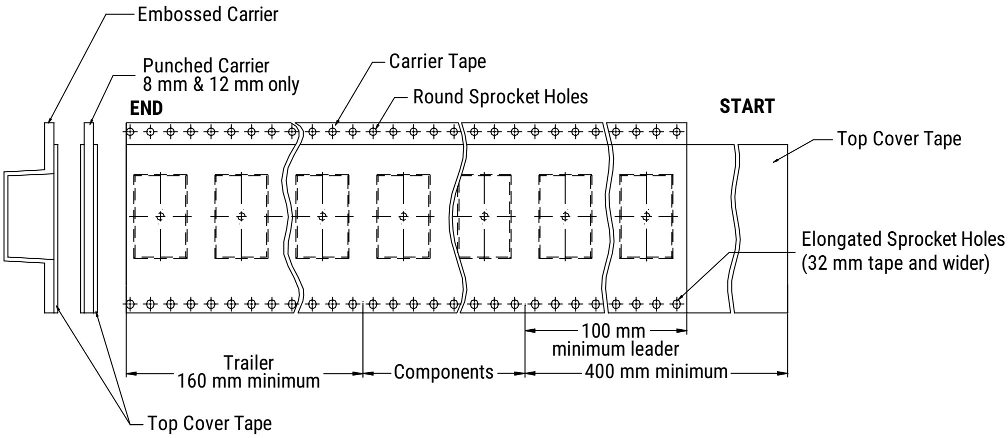
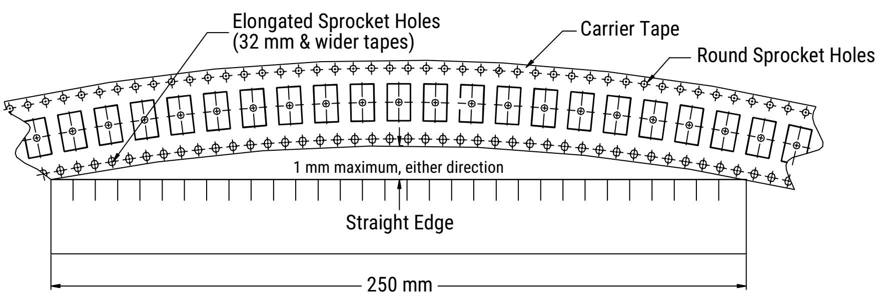


Figure 7 – Maximum Camber



KPS "L", SnPb Termination, X7R Dielectric, 10 – 250 VDC (Commercial Grade)

KEMET a YAGEO company

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 ±15% from −55°C to +125°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
- Capacitance offerings ranging from 0.1 up to 47 μF

Ordering Information

C	2220	C	106	M	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 (±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)
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

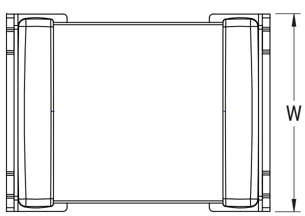
Commercial grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance & Reliability.

Environmental Compliance

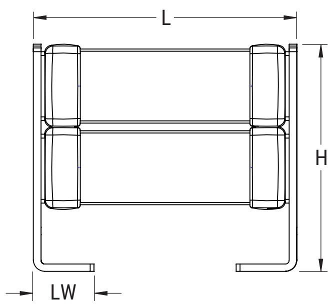
These devices do not meet RoHS criteria due to the concentration of Lead (Pb) in the termination finish.

Dimensions – Inches (Millimeters)

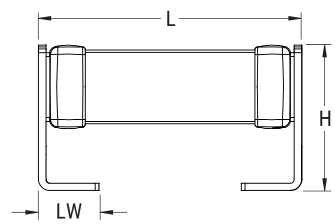
Single or Double Chip Stack



Double Chip Stack



Single Chip Stack



Number of Chips	EIA SIZE CODE	METRIC SIZE CODE	L LENGTH	W WIDTH	H HEIGHT	LW LEAD WIDTH	Mounting Technique
Single	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)	Solder Reflow Only
	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)	
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)	
	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 ≤ 10 µF
120 Hz ±10 Hz and 0.5 ±0.1 V_{rms} if capacitance > 10 µF
[4] To obtain IR limit, divide MΩ - µF value by the capacitance and compare to GΩ 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

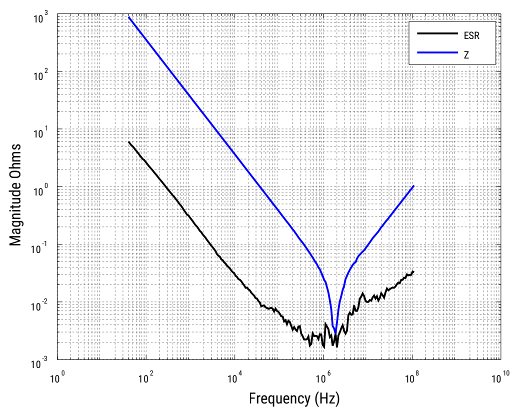
High Temperature Life, Biased Humidity, Moisture Resistance					
Dielectric	Rated DC Voltage	Capacitance Value	Dissipation Factor (Maximum %)	Capacitance Shift	Insulation Resistance
X7R	> 25	All	3.0	±20%	10% of Initial Limit
	16/25		5.0		
	< 16		7.5		

Insulation Resistance Limit Table

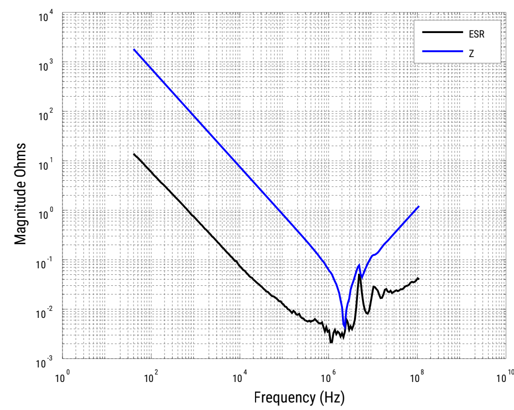
EIA Case Size	1,000 Megohm Microfarads or 100 GΩ	500 Megohm Microfarads or 10 GΩ
1210	< 0.39 µF	≥ 0.39 µF
2220	< 10 µF	≥ 10 µF

Electrical Characteristics

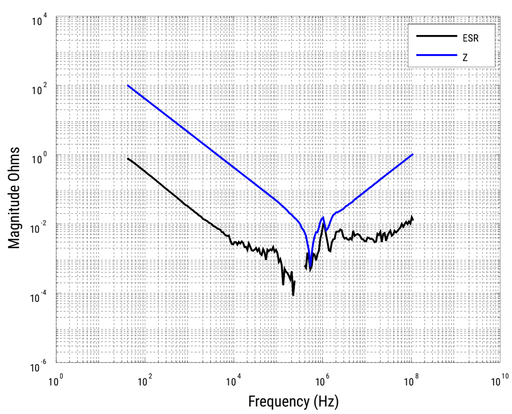
Z and ESR C1210C475M5R1L



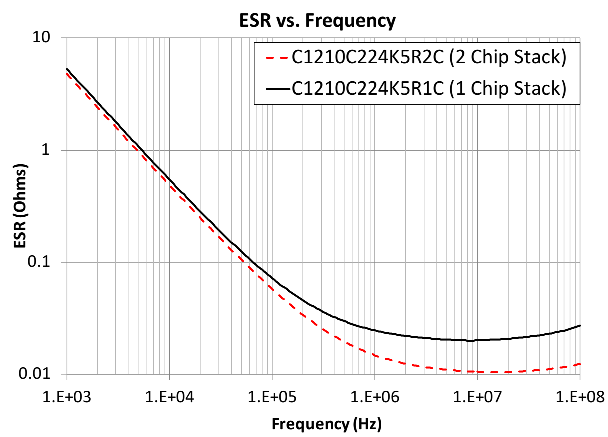
Z and ESR C2220C225MAR2L



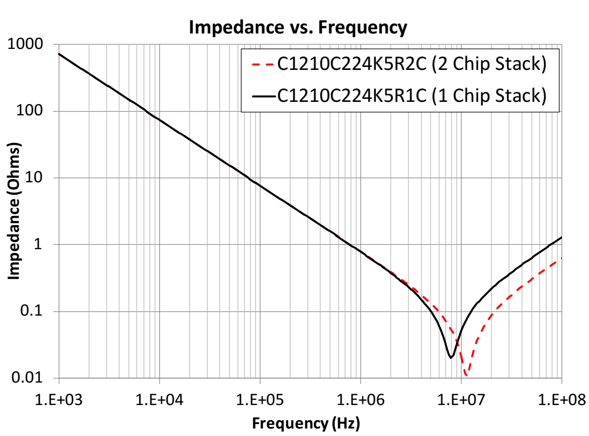
Z and ESR C2220C476M3R2L



ESR – 1210, .22 μF, 50 V X7R

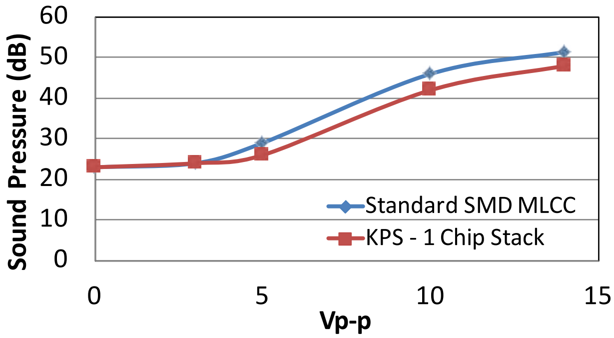


Impedance – 1210, .22 μF, 50 V X7R

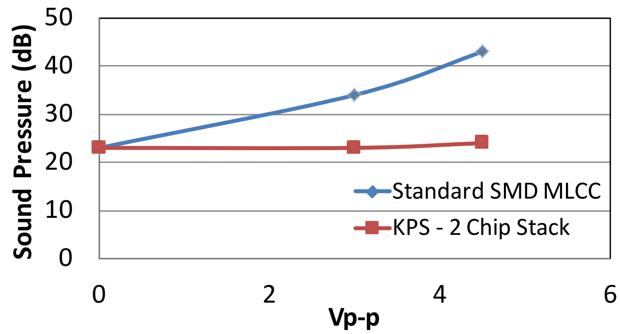


Electrical Characteristics cont.

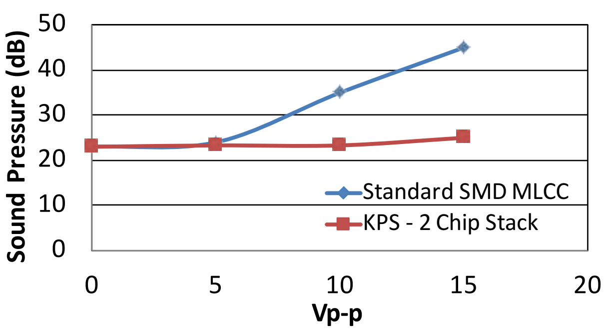
Microphonics – 1210, 4.7 µF, 50 V, X7R



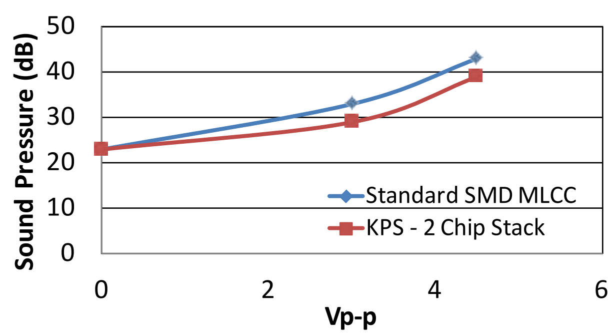
Microphonics – 2220, 22 µF, 50 V, X7R



Microphonics – 2220, 47 µF, 25 V, X7R

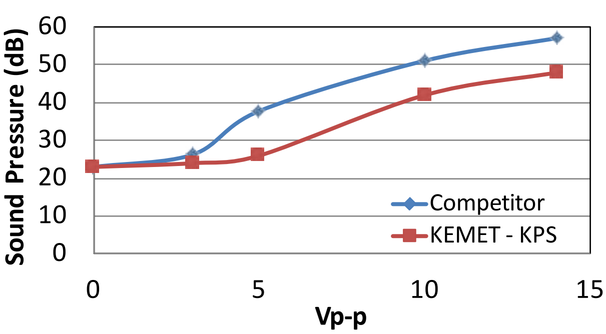


Microphonics – 1210, 22 µF, 25 V, X7R

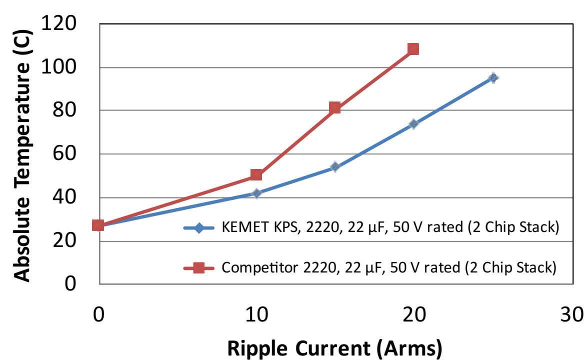


Competitive Comparision

Microphonics – 1210, 4.7 µF, 50 V, X7R



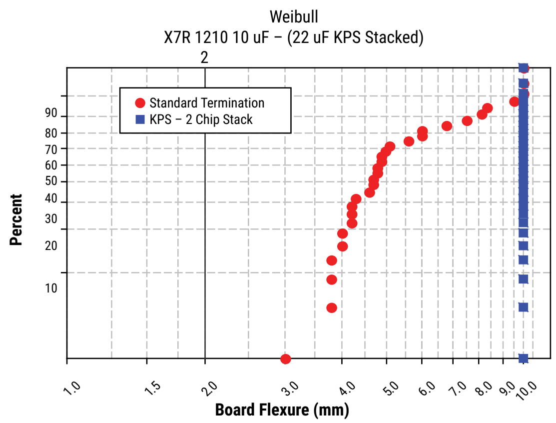
Ripple Current (Arms) 2220, 22 µF, 50 V



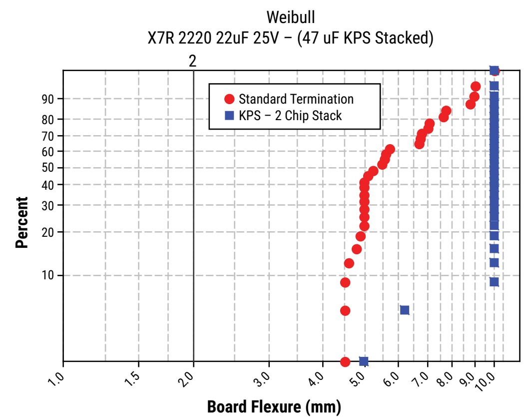
Note: Refer to Table 4 for test method.

Electrical Characteristics cont.

Board Flex vs. Termination Type



Board Flex vs. Termination Type



Board Flexure to 10 mm

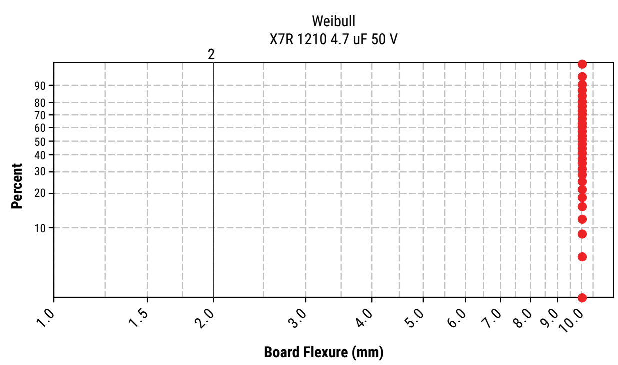


Table 1 – Capacitance Range/Selection Waterfall (1210 & 2220 Case Sizes)

Capacitance	Capacitance Code	Case Size/ Series		C1210C						C2220C					
		Voltage Code		8	4	3	5	1	A	4	3	5	M	1	A
		Rated Voltage (VDC)		10	16	25	50	100	250	16	25	50	63	100	250
		Capacitance Tolerance		Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions											
Single Chip Stack															
0.10 µF	104	K	M	FV	FV	FV	FV	FV	FV	JP	JP	JP	JP	JP	JP
0.22 µF	224	K	M	FV	FV	FV	FV	FV		JP	JP	JP	JP	JP	JP
0.47 µF	474	K	M	FV	FV	FV	FV	FV		JP	JP	JP	JP	JP	JP
1.0 µF	105	K	M	FV	FV	FV	FV	FV		JP	JP	JP	JP	JP	JP
2.2 µF	225	K	M	FV	FV	FV	FV			JP	JP	JP	JP	JP	
3.3 µF	335	K	M	FV	FV	FV	FV			JP	JP	JP	JP	JP	
4.7 µF	475	K	M	FV	FV	FV	FV			JP	JP	JP	JP		
10 µF	106	K	M	FV	FV	FV				JP	JP	JP	JP		
15 µF	156	K	M	FV						JP	JP				
22 µF	226	K	M	FV						JP	JP				
Double Chip Stack															
0.10 µF	104		M	FW	FW	FW	FW	FW	FW	JR	JR	JR	JR	JR	JR
0.22 µF	224		M	FW	FW	FW	FW	FW	FW	JR	JR	JR	JR	JR	JR
0.47 µF	474		M	FW	FW	FW	FW	FW		JR	JR	JR	JR	JR	JR
1.0 µF	105		M	FW	FW	FW	FW	FW		JR	JR	JR	JR	JR	JR
2.2 µF	225		M	FW	FW	FW	FW	FW		JR	JR	JR	JR	JR	JR
3.3 µF	335		M	FW	FW	FW	FW	FW		JR	JR	JR	JR	JR	
4.7 µF	475		M	FW	FW	FW	FW			JR	JR	JR	JR	JR	
10 µF	106		M	FW	FW	FW	FW			JR	JR	JR	JR		
22 µF	226		M	FW	FW	FW				JR	JR	JR	JR		
33 µF	336		M	FW						JR	JR				
47 µF	476		M	FW						JR	JR				
Capacitance	Capacitance Code	Rated Voltage (VDC)		10	16	25	50	100	250	16	25	50	63	100	250
		Voltage Code		8	4	3	5	1	A	4	3	5	M	1	A
		Case Size/Series		C1210C						C2220C					

Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

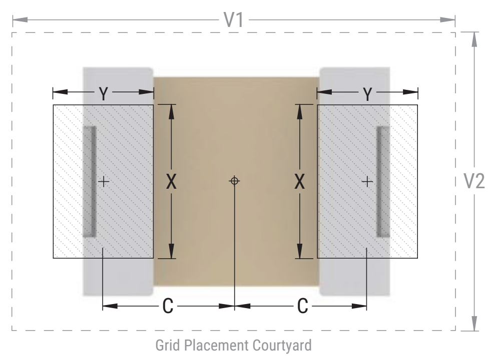
Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
FV	1210	3.35 ±0.10	0	0	600	2,000
FW	1210	6.15 ±0.15	0	0	300	1,000
JP	2220	3.50 ±0.30	0	0	300	1,300
JR	2220	5.00 ±0.50	0	0	200	800
Thickness Code	Case Size	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity		Plastic Quantity	

Package quantity based on finished chip thickness specifications.

Table 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_{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_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.

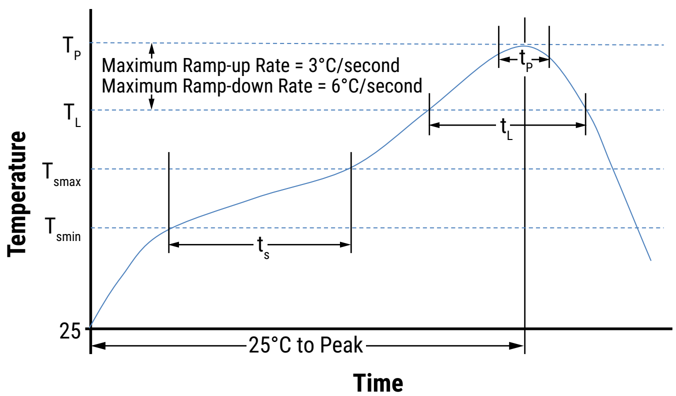


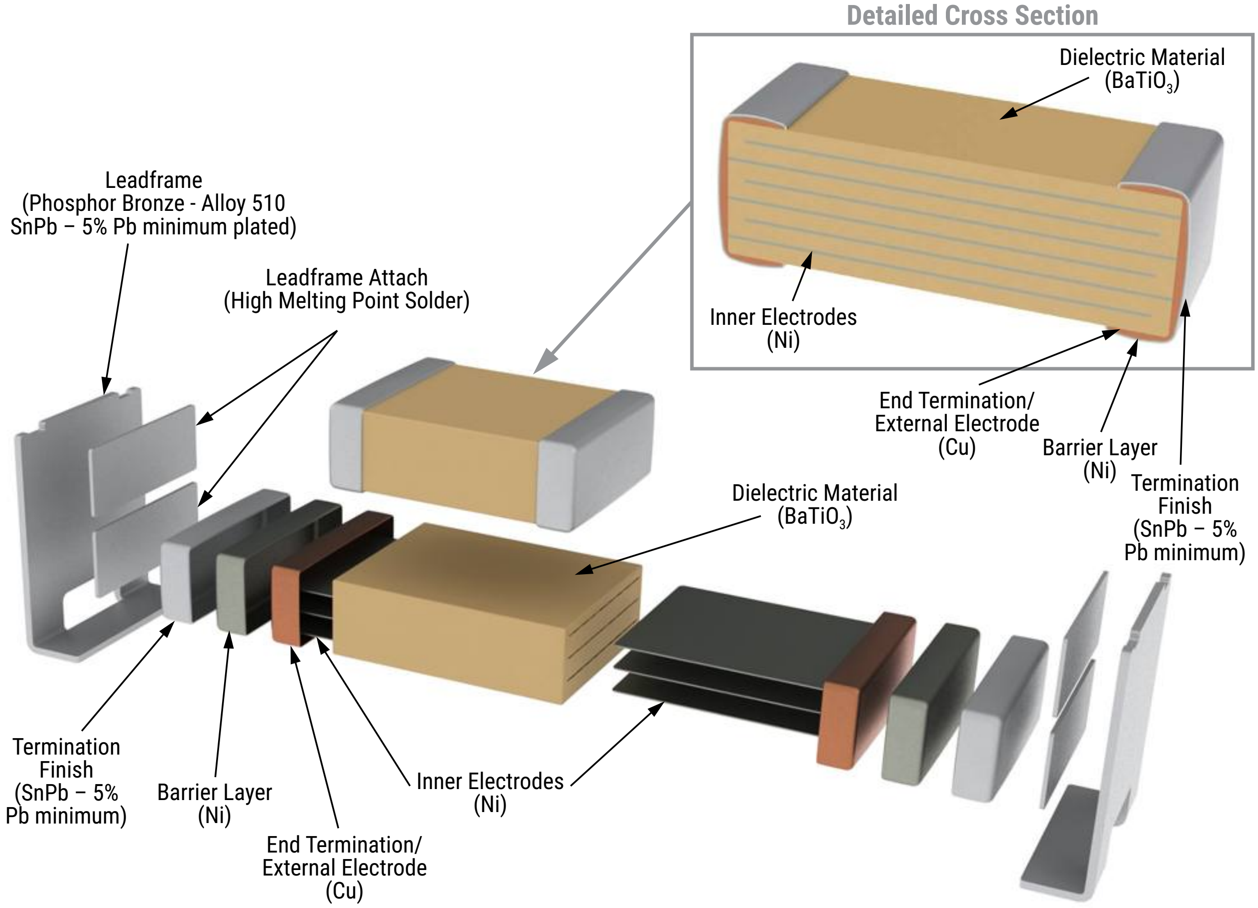
Table 4 – Performance & Reliability: Test Methods & Conditions

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
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 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 100K ohm resistor. Measurement at 24 hours ±4 hours after test conclusion.
		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:

- C0G, 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.

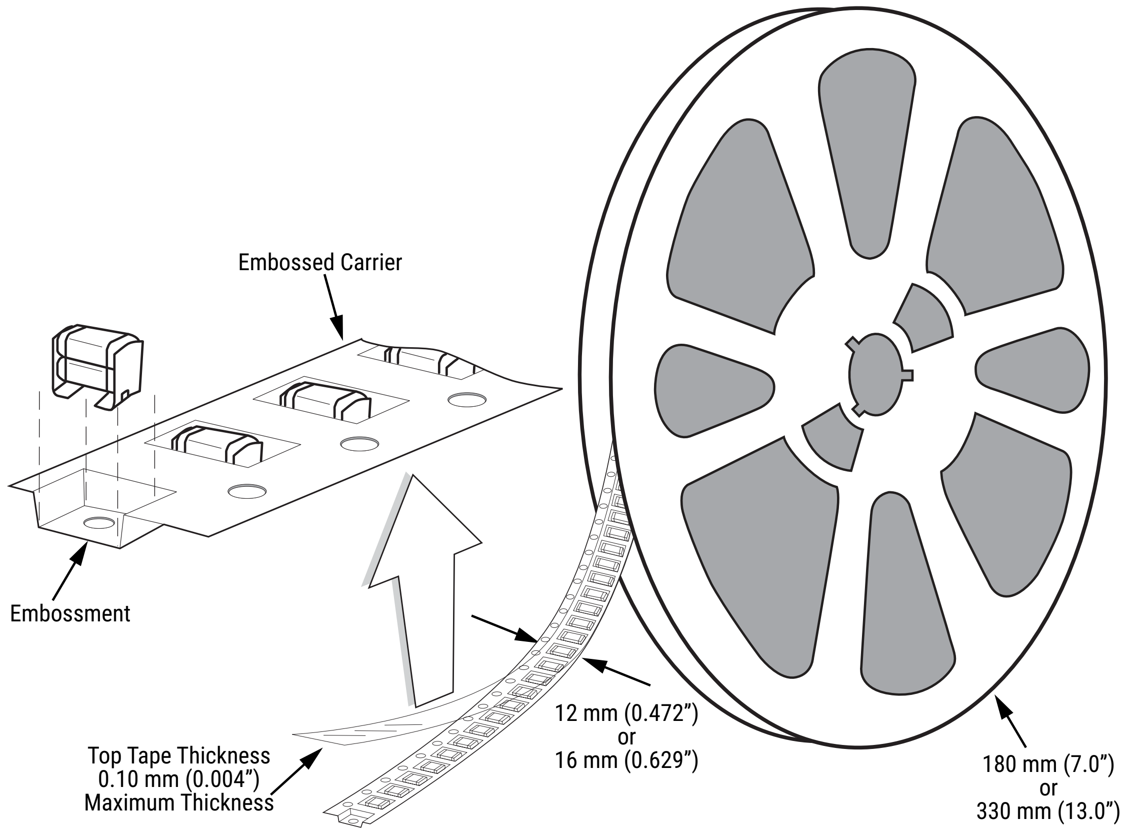


Table 5 – Carrier Tape Configuration – Embossed Plastic (mm)

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_1 carrier tape reference locations.*
**Refer to Table 5 for tolerance specifications.*

Figure 1 – Embossed (Plastic) Carrier Tape Dimensions

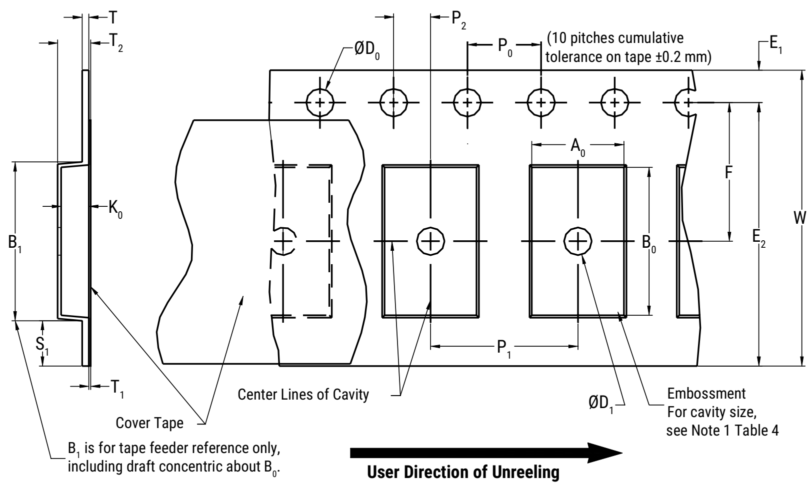


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +0.10/0.0−0.0 (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)			
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)	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 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 < 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_1 dimension is a reference dimension for tape feeder clearance only.*
5. *The cavity defined by A_0, B_0 and K_0 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

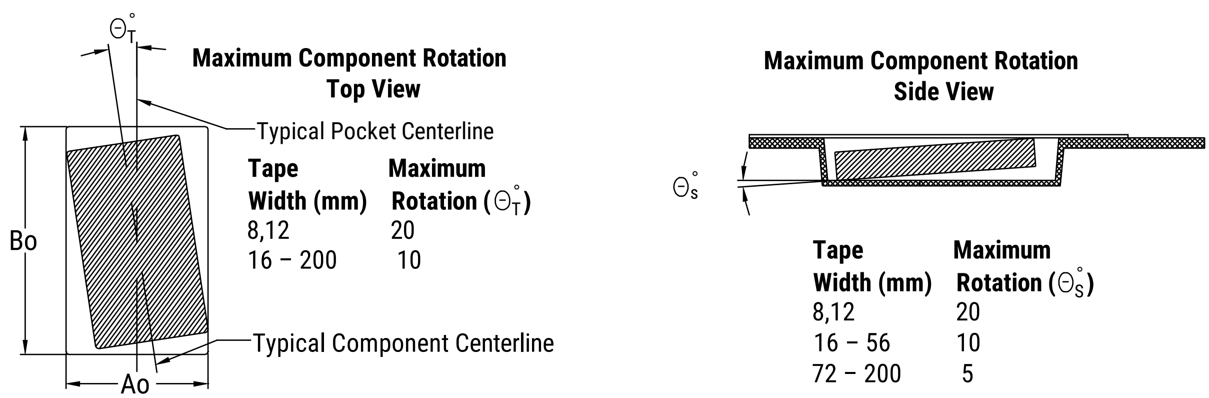


Figure 3 – Maximum Lateral Movement

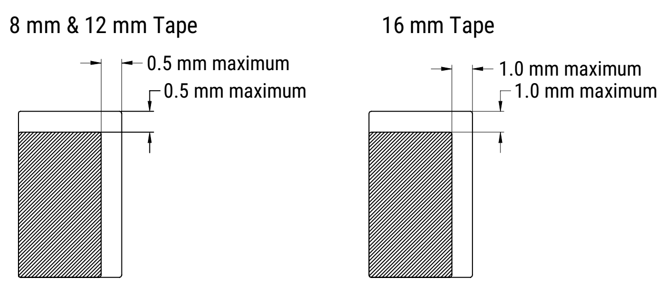


Figure 4 – Bending Radius

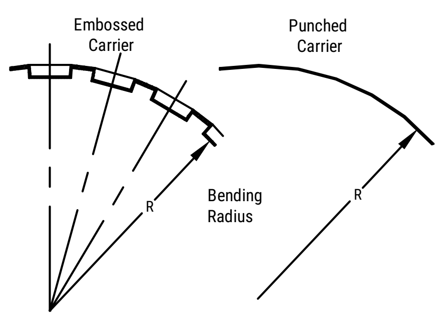
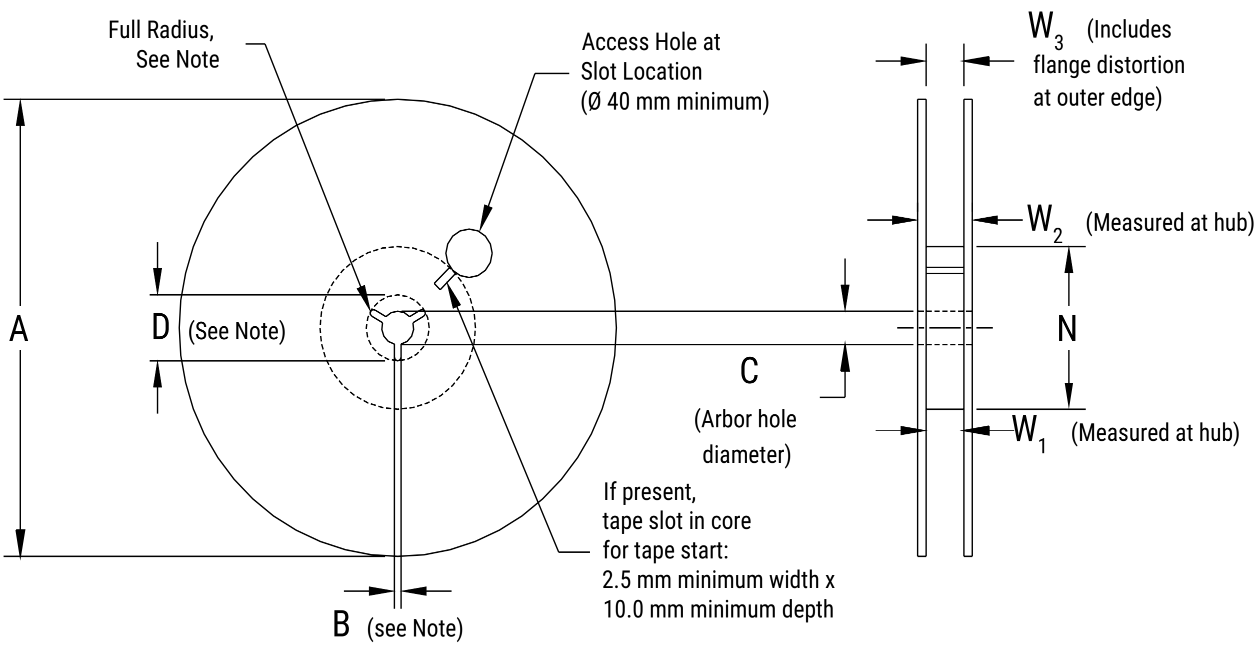


Figure 5 – Reel Dimensions



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

Table 7 – Reel Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)				
Tape Size	A	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 6 – Tape Leader & Trailer Dimensions

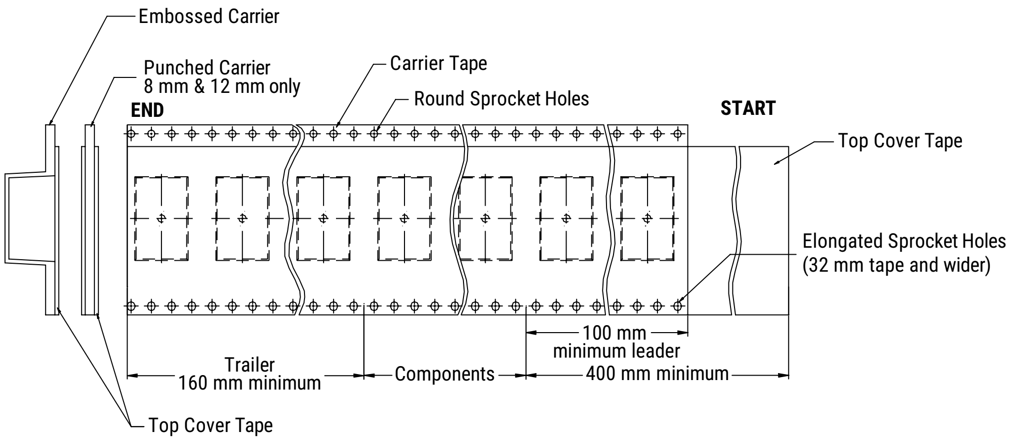
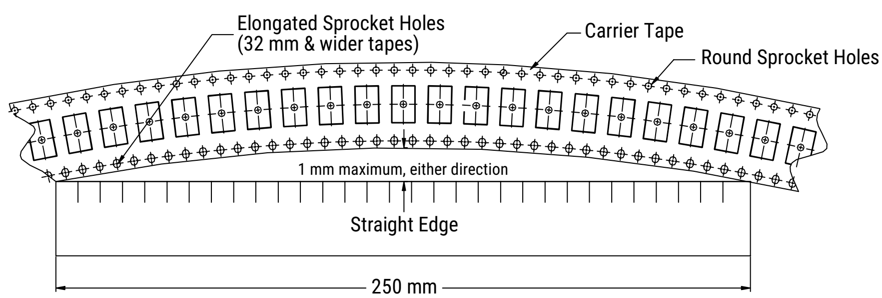


Figure 7 – Maximum Camber



ESD, X7R Dielectric, 16 – 250 VDC (Commercial & Automotive Grade)

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 ±15% from −55°C to +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

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

C	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

Capacitance	Cap Code	Case Size/ Series	C0402C			C0603C					
		Rated Voltage (VDC)	16	25	50	16	25	50	63	100	200
		Voltage Code	4	3	5	4	3	5	M	1	2
		Cap Tolerance	ESD Level per AEC–Q200								
1.0 nF	102	J = ±5% K = ±10% M = ±20%	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		6 kV	6 kV	6 kV	25 kV	25 kV	25 kV	25 kV	25 kV	25 kV
15 nF	153		6 kV	6 kV	6 kV	16 kV	16 kV	16 kV	16 kV	16 kV	
22 nF	223		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 ≤ 8kV
AC (Air Discharched) for Values ≥ 12kV

Table 1A – Capacitance Range/Selection Waterfall (cont.)

Capacitance	Cap Code	Case Size/Series	C0805C							C1206C						
		Rated Voltage (VDC)	16	25	50	63	100	200	250	16	25	50	63	100	200	250
		Voltage Code	4	3	5	M	1	2	A	4	3	5	M	1	2	A
		Cap Tolerance	ESD Level per AEC–Q200													
1.0 nF	102	J = ±5% K = ±10% M = ±20%	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		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		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		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 ≤ 8kV
AC (Air Discharched) for Values ≥ 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	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."

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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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:

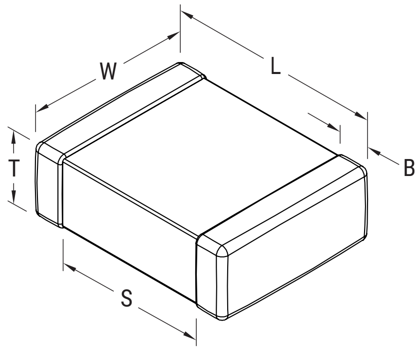
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

[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
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)	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	
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)	Solder wave or Solder reflow
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)	
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*

[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 ≤ 10 µF
120 Hz ± 10 Hz and 0.5 ± 0.1 V_{rms} if capacitance > 10 µF

[4] *To obtain IR limit, divide MΩ – µF value by the capacitance and compare to GΩ 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
All	< 16	All	7.5	±20%	10% of Initial limit
	16/25		5.0		
	> 25		3.0		

Dissipation Factor Limit Table

EIA Case Size	Rated DC Voltage	Capacitance	Dissipation Factor (Maximum %)
All	16/25	All	3.5
	> 25		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

KEMET a YAGEO company

Table 1B – Product Availability and Chip Thickness Waterfall – Standard Termination

Capacitance	Cap Code	Case Size/ Series	C0402C			C0603C					
		Rated Voltage (VDC)	16	25	50	16	25	50	63	100	200
		Voltage Code	4	3	5	4	3	5	M	1	2
		Cap Tolerance	Product Availability and Chip Thickness Codes – See Packaging Specs for Chip Thickness Dimensions								
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% K = ±10% M = ±20%	BB	BB	BB	CF	CF	CF	CF	CF	CF
15 nF	153		BB	BB	BB	CF	CF	CF	CF	CF	
22 nF	223		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				

Capacitance	Cap Code	Case Size/ Series	C0805C							C1206C						
		Rated Voltage (VDC)	16	25	50	63	100	200	250	16	25	50	63	100	200	250
		Voltage Code	4	3	5	M	1	2	A	4	3	5	M	1	2	A
		Cap Tolerance	Product Availability and Chip Thickness Codes – See Packaging Specs for Chip Thickness Dimensions													
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% K = ±10% M = ±20%	DE	DE	DE	DE	DE	DE		EB	EB	EB	EB	EB	EB	EB
47 nF	473		DG	DG	DG	DG	DG	DG		ED	ED	ED	ED	ED	ED	ED
68 nF	683		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

Capacitance	Cap Code	Case Size/ Series	C0603C					
		Rated Voltage (VDC)	16	25	50	63	100	200
		Voltage Code	4	3	5	M	1	2
		Cap Tolerance	Product Availability and Chip Thickness Codes – See Packaging Specs for Chip Thickness Dimensions					
1.0 nF	102	J = ±5% K = ±10% M = ±20%	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		CJ	CJ	CJ	CJ	CJ	CJ
15 nF	153		CJ	CJ	CJ	CJ	CJ	
22 nF	223		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				

Capacitance	Cap Code	Case Size/ Series	C0805C							C1206C						
		Rated Voltage (VDC)	16	25	50	63	100	200	250	16	25	50	63	100	200	250
		Voltage Code	4	3	5	M	1	2	A	4	3	5	M	1	2	A
		Cap Tolerance	Product Availability and Chip Thickness Codes – See Packaging Specs for Chip Thickness Dimensions													
1.0 nF	102	J = ±5% K = ±10% M = ±20%	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		DS	DS	DS	DS	DS	DS		EQ	EQ	EQ	EQ	EQ	EQ	EQ
47 nF	473		DH	DH	DH	DH	DH	DH		ES	ES	ES	ES	ES	ES	ES
68 nF	683		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 Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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

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

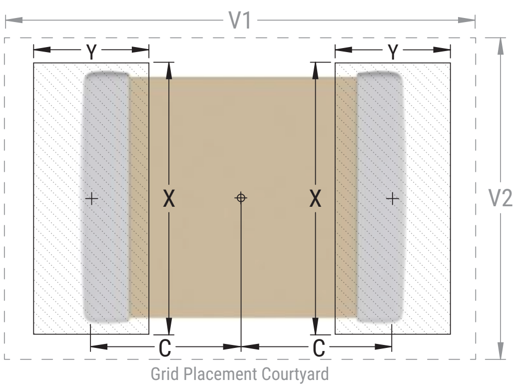
[1] The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial 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 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 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)				
		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
With Flexible Termination																
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
	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.

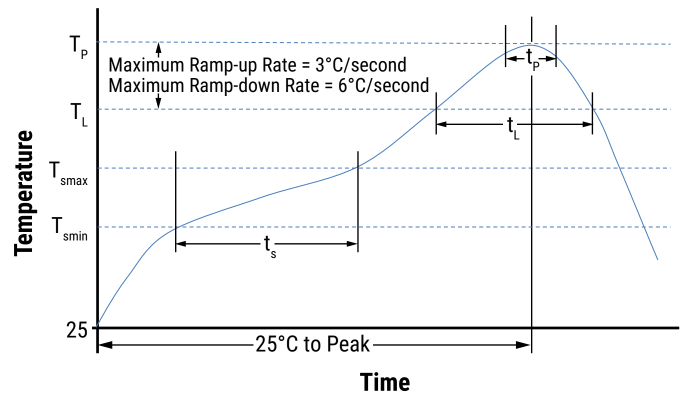


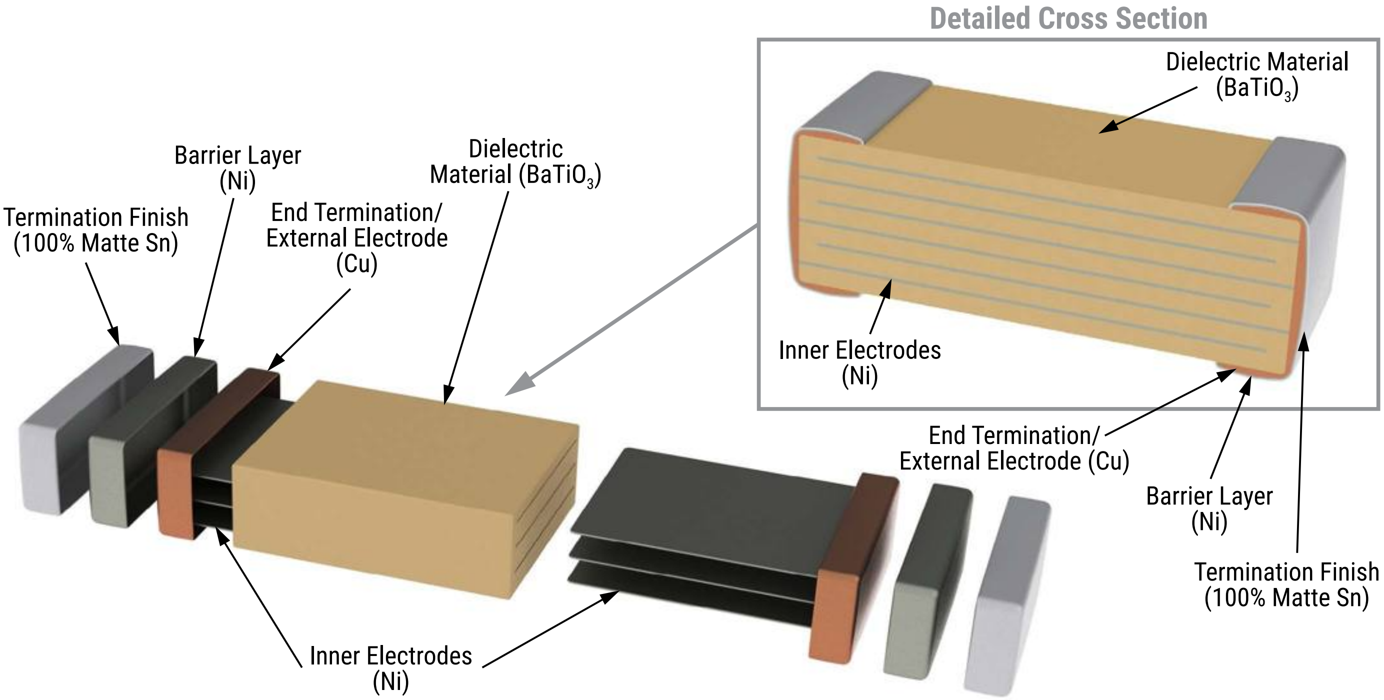
Table 5 – Performance & Reliability: Test Methods and Conditions

<table>
<tr><th>Stress</th><th>Reference</th><th colspan="3">Test or Inspection Method</th></tr>
<tr><td>Terminal Strength</td><td>JIS–C–6429</td><td colspan="3">Appendix 1, Note: Force of 1.8 kg for 60 seconds.</td></tr>
<tr><td>Board Flex</td><td>JIS–C–6429</td><td colspan="3">Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm for C0G. Flexible termination system – 3.0 mm (minimum).</td></tr>
<tr><td rowspan="4">Solderability</td><td rowspan="4">J–STD–002</td><td colspan="3">Magnification 50 X. Conditions:</td></tr>
<tr><td colspan="3">a) Method B, 4 hours at 155°C, dry heat at 235°C</td></tr>
<tr><td colspan="3">b) Method B at 215°C, category 3</td></tr>
<tr><td colspan="3">c) Method D, at 260°C, category 3</td></tr>
<tr><td>Temperature Cycling</td><td>JESD22 Method JA–104</td><td colspan="3">1,000 Cycles (−55°C to +125°C). Measurement at 24 hours ±4 hours after test conclusion.</td></tr>
<tr><td rowspan="2">Biased Humidity</td><td rowspan="2">MIL–STD–202
Method 103</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>Moisture Resistance</td><td>MIL–STD–202
Method 106</td><td colspan="3">t = 24 hours/cycle. Steps 7a and 7b not required.
Measurement at 24 hours ±4 hours after test conclusion.</td></tr>
<tr><td>Thermal Shock</td><td>MIL–STD–202
Method 107</td><td colspan="3">−55°C/+125°C. Note: Number of cycles required – 300. Maximum transfer time – 20 seconds.
Dwell time – 15 minutes. Air – Air.</td></tr>
<tr><td rowspan="4">High Temperature Life</td><td rowspan="4">MIL–STD–202
Method 108/EIA–198</td><td colspan="3">1,000 hours at 125°C with 2 X rated voltage applied excluding the following:</td></tr>
<tr><td>Case Size</td><td>Capacitance</td><td>Applied Voltage</td></tr>
<tr><td>0603 and 0805</td><td>≥ 1.0 µF</td><td rowspan="2">1.5 X</td></tr>
<tr><td>1206 and 1210</td><td>≥ 10 µF</td></tr>
<tr><td>Storage Life</td><td>MIL–STD–202
Method 108</td><td colspan="3">150°C, 0 VDC for 1,000 hours.</td></tr>
<tr><td>Vibration</td><td>MIL–STD–202
Method 204</td><td colspan="3">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</td></tr>
<tr><td>Mechanical Shock</td><td>MIL–STD–202
Method 213</td><td colspan="3">Figure 1 of Method 213, Condition F.</td></tr>
<tr><td>Resistance to Solvents</td><td>MIL–STD–202
Method 215</td><td colspan="3">Add aqueous wash chemical, OKEM Clean or equivalent.</td></tr>
</table>

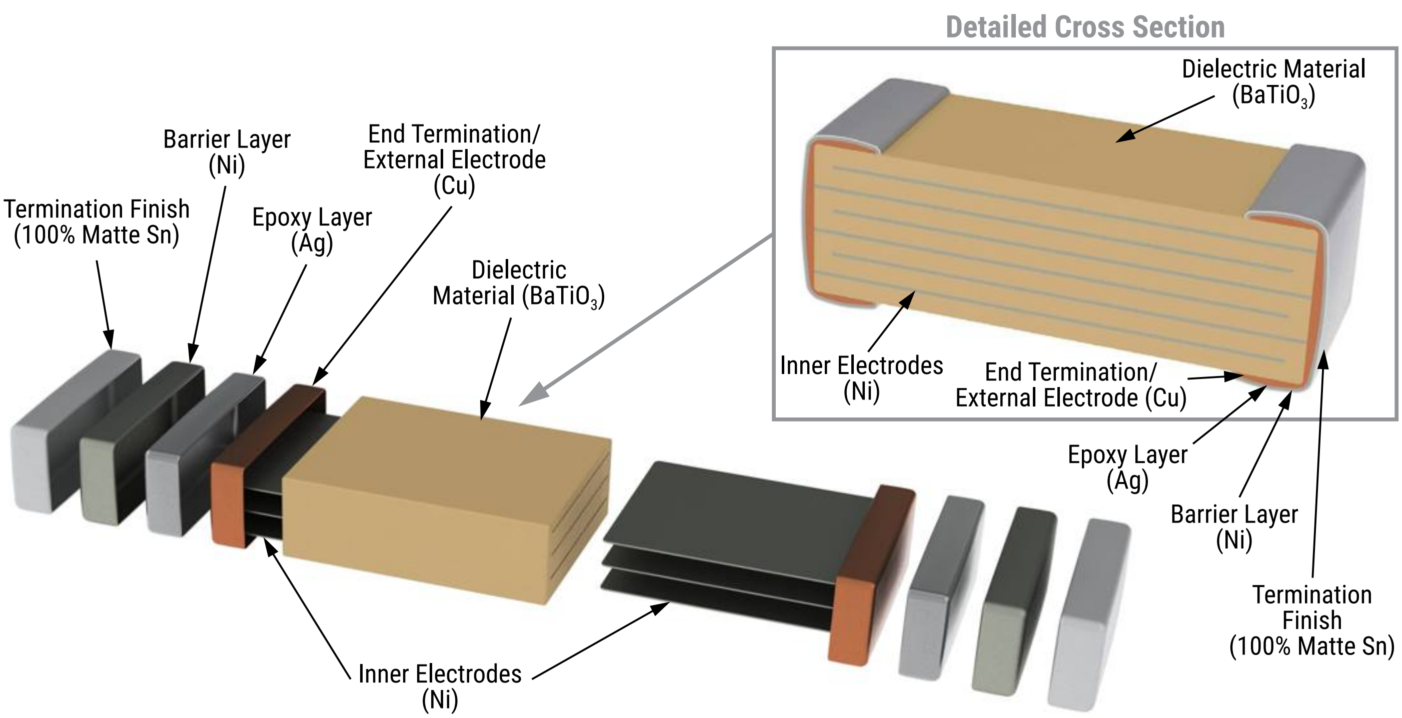
Storage and Handling

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 40ºC 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)

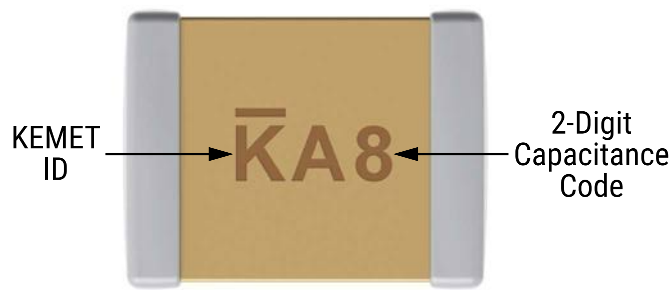
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic 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:

- C0G, 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 µF. Orientation of marking is vendor optional.

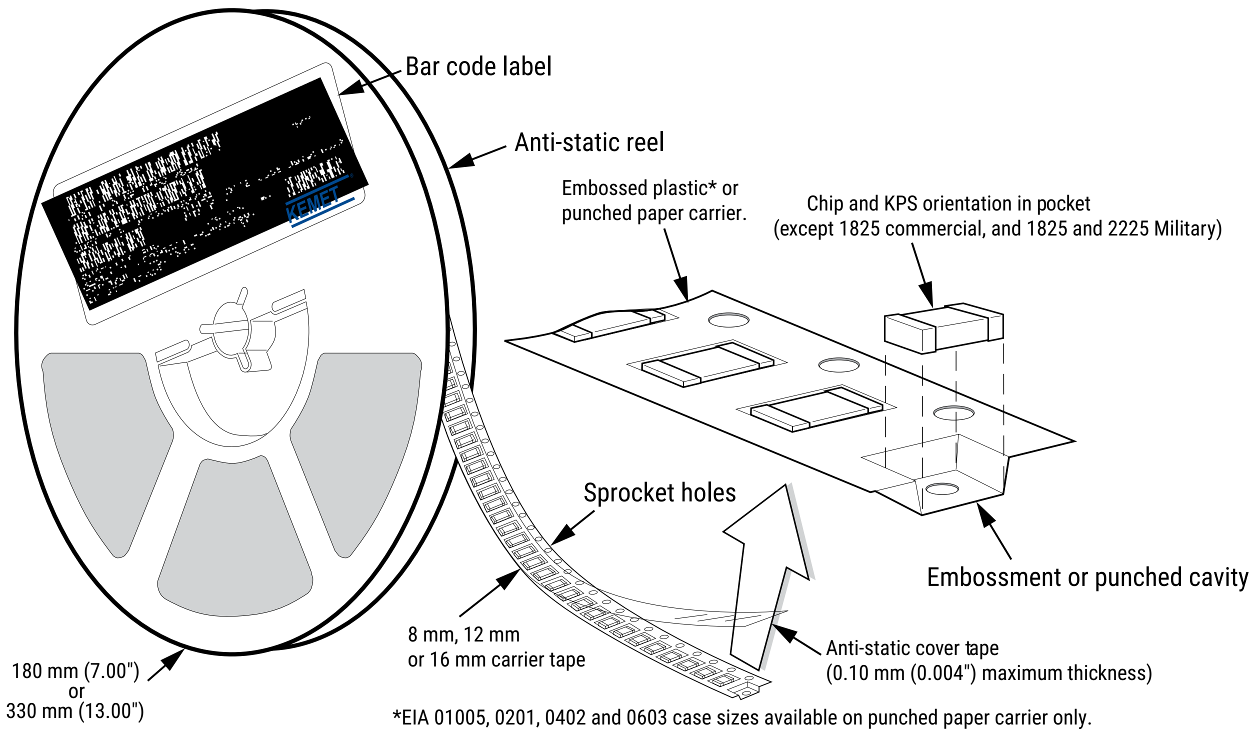


Capacitor Marking (Optional) cont.

Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.10	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

Table 6 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

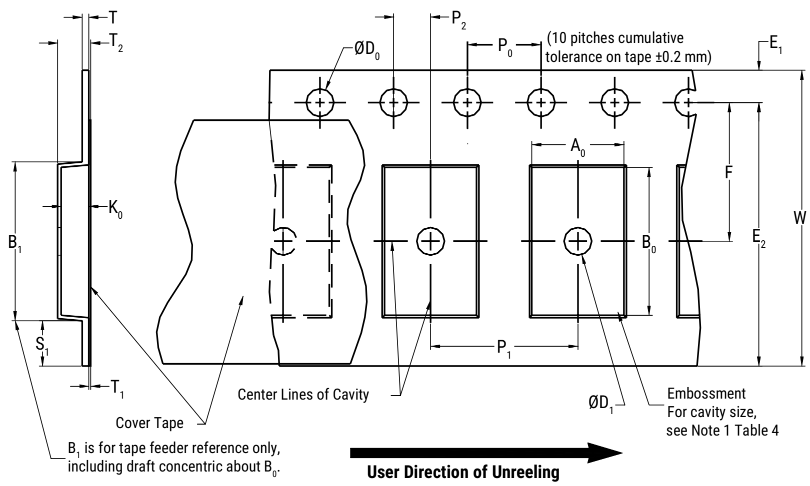


Table 7 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +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)			
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)	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 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 S_1 < 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_1 dimension is a reference dimension for tape feeder clearance only.*
5. *The cavity defined by A_0, B_0 and K_0 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

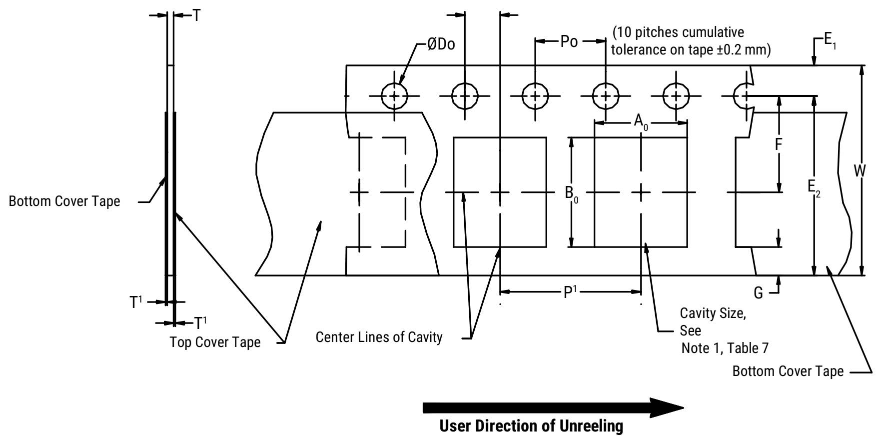


Table 8 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

<table>
<tr><th colspan="8">Constant Dimensions — Millimeters (Inches)</th></tr>
<tr><th>Tape Size</th><th>D_0</th><th>E_1</th><th>P_0</th><th>P_2</th><th>T_1 Maximum</th><th>G Minimum</th><th>R Reference Note 2</th></tr>
<tr><td>8 mm</td><td>1.5 +0.10 -0.0
(0.059 +0.004 -0.0)</td><td>1.75 ±0.10
(0.069 ±0.004)</td><td>4.0 ±0.10
(0.157 ±0.004)</td><td>2.0 ±0.05
(0.079 ±0.002)</td><td>0.10
(0.004)
maximum</td><td>0.75
(0.030)</td><td>25
(0.984)</td></tr>
<tr><th colspan="8">Variable Dimensions — Millimeters (Inches)</th></tr>
<tr><th>Tape Size</th><th>Pitch</th><th>E2 Minimum</th><th>F</th><th>P_1</th><th>T Maximum</th><th>W Maximum</th><th>A_0B_0</th></tr>
<tr><td>8 mm</td><td>Half (2 mm)</td><td rowspan="2">6.25
(0.246)</td><td rowspan="2">3.5 ±0.05
(0.138 ±0.002)</td><td>2.0 ±0.05
(0.079 ±0.002)</td><td rowspan="2">1.1
(0.098)</td><td>8.3
(0.327)</td><td rowspan="2">Note 1</td></tr>
<tr><td>8 mm</td><td>Single (4 mm)</td><td>4.0 ±0.10
(0.157 ±0.004)</td><td>8.3
(0.327)</td></tr>
</table>

1. *The cavity defined by A_0, B_0 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

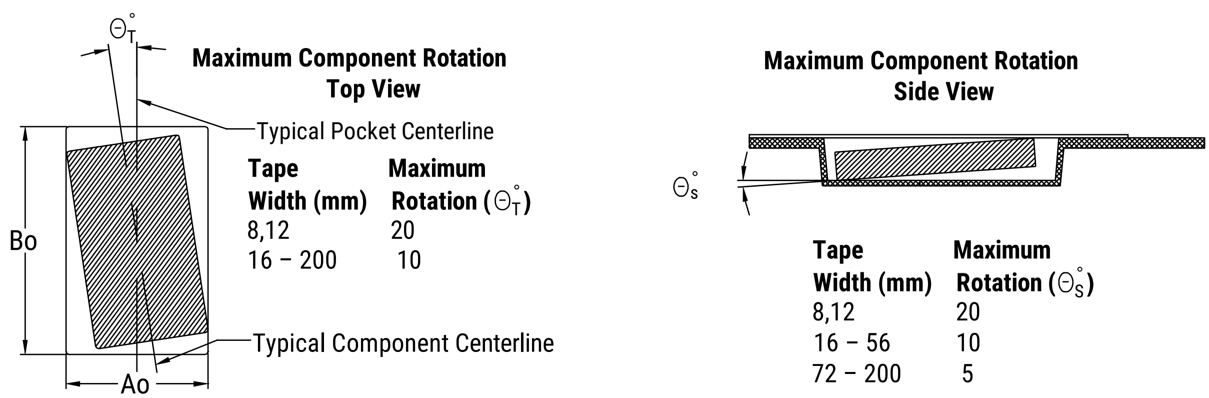


Figure 4 – Maximum Lateral Movement

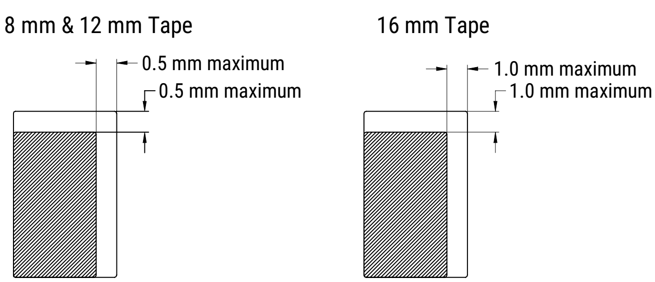


Figure 5 – Bending Radius

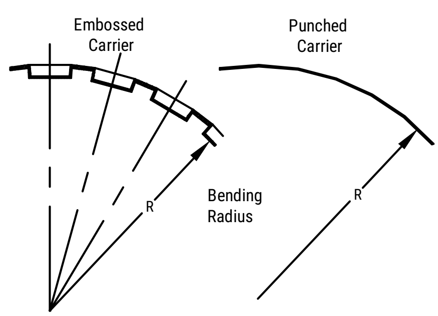
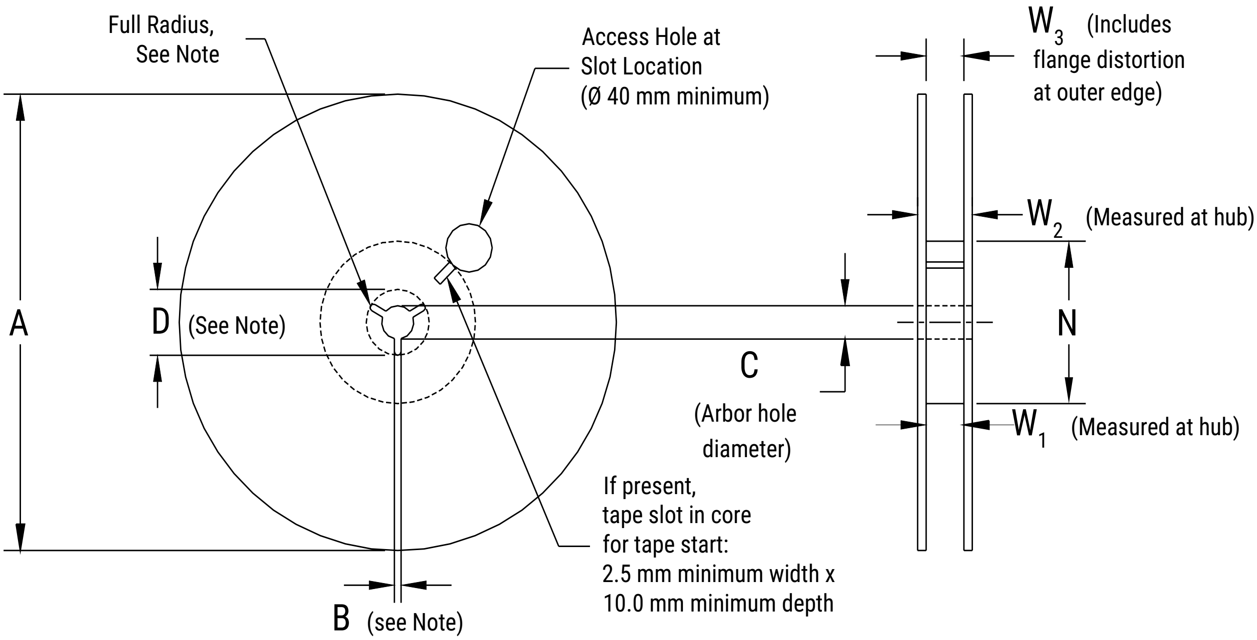


Figure 6 – Reel Dimensions



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

Table 9 – Reel Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)				
Tape Size	A	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

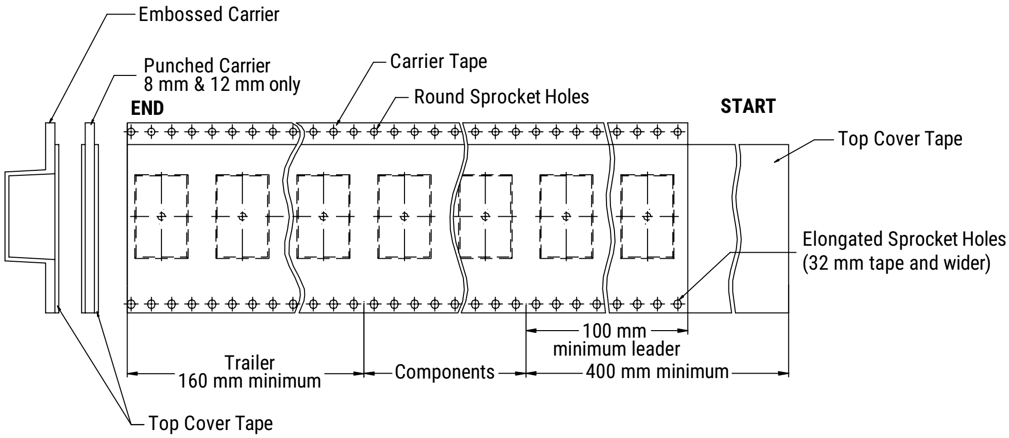
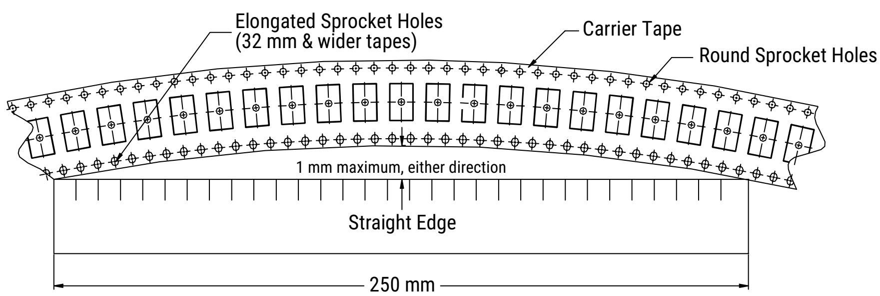


Figure 8 – Maximum Camber



ESD, C0G Dielectric, 25 – 250 VDC (Commercial & Automotive Grade)

Overview

The KEMET electrostatic discharge (ESD) rated commercial and automotive grade surface mount capacitors in C0G 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 C0G dielectric features a 125°C maximum operating temperature and is considered “stable.” The Electronics Industries Alliance (EIA) characterizes C0G 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 C0G 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 +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

C	0603	C	103	J	3	G	E	C	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 = C0G	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.
[2] Additional capacitance tolerance offerings and termination finish options may be available. Contact KEMET for details.Benefits (cont'd)

Table 1A – Capacitance Range/Selection Waterfall

Capacitance	Cap Code	Case Size/ Series	C0402C				C0603C					C0805C						C1206C					
		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	M	1	3	5	M	1	2	3	5	M	1	2	A	3	5	M	1	2	A
		Cap Tolerance	ESD Level per AEC−Q200																				
1.0 nF	102	F = ±1% G = ±2% J = ±5% K = ±10% M = ±20%	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						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						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
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
22 nF	223											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 ≤ 8kV
AC (Air Discharched) for Values ≥ 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	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."*

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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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)

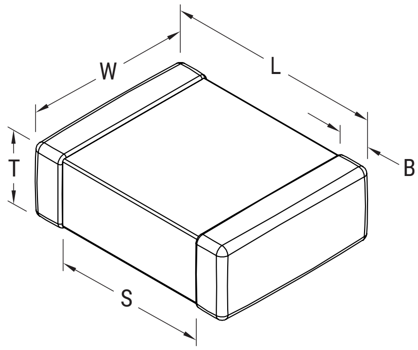
The purpose of the Production Part Approval Process is:
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled 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			○		

[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
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)	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	
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)	Solder wave or Solder reflow
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)	
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 ≤ 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 MΩ-µF value by the capacitance and compare to GΩ 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
C0G	All	All	0.5	0.3% or ±0.25 pf	10% of Initial limit

Table 1B – Product Availability and Chip Thickness Waterfall – Standard Termination

Capacitance	Cap Code	Case Size/ Series	C0402C				C0603C					C0805C						C1206C					
		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	M	1	3	5	M	1	2	3	5	M	1	2	A	3	5	M	1	2	A
		Cap Tolerance	Product Availability and Chip Thickness Codes – See Packaging Specs for Chip Thickness Dimensions																				
1.0 nF	102	F = ±1% G = ±2% J = ±5% K = ±10% M = ±20%	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						CF	CF	CF	CF		DD	DD	DD	DD	DD	DD	EQ	EQ	EQ	EQ	EQ	EQ
6.8 nF	682						CF	CF				DG	DG	DG	DG	DG	DG	EQ	EQ	EQ	EQ	EQ	EQ
10 nF	103						CF					DD	DD	DD	DD			ER	ER	ER	ER	ER	ER
15 nF	153						CF					DG	DG	DG	DG			EF	EF	EF	EF	EF	EF
22 nF	223											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

Capacitance	Cap Code	Case Size/ Series	C0603C					C0805C						C1206C					
		Rated Voltage (VDC)	25	50	63	100	200	25	50	63	100	200	250	25	50	63	100	200	250
		Voltage Code	3	5	M	1	2	3	5	M	1	2	A	3	5	M	1	2	A
		Cap Tolerance	Product Availability and Chip Thickness Codes – See Packaging Specs for Chip Thickness Dimensions																
1.0 nF	102	F = ±1% G = ±2% J = ±5% K = ±10% M = ±20%	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		CJ	CJ	CJ	CJ		DD	DD	DD	DD	DD	DD	EQ	EQ	EQ	EQ	EQ	EQ
6.8 nF	682		CJ	CJ				DG	DG	DG	DG	DG	DG	EQ	EQ	EQ	EQ	EQ	EQ
10 nF	103		CJ					DD	DD	DD	DD			ER	ER	ER	ER	ER	ER
15 nF	153		CJ					DG	DG	DG	DG			EF	EF	EF	EF	EF	EF
22 nF	223							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 2 – Chip Thickness/Tape & Reel Packaging Quantities

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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 3 – Bulk Packaging Quantities

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

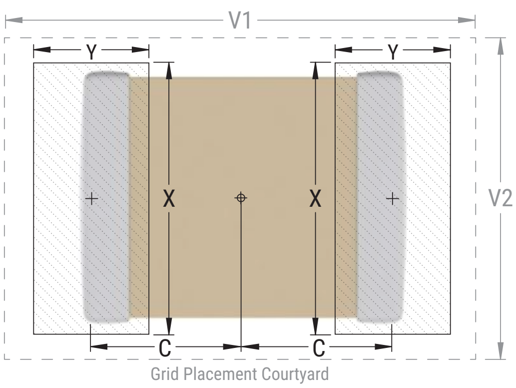
[1] *The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial 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 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 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)				
		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
With Flexible Termination																
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
	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.

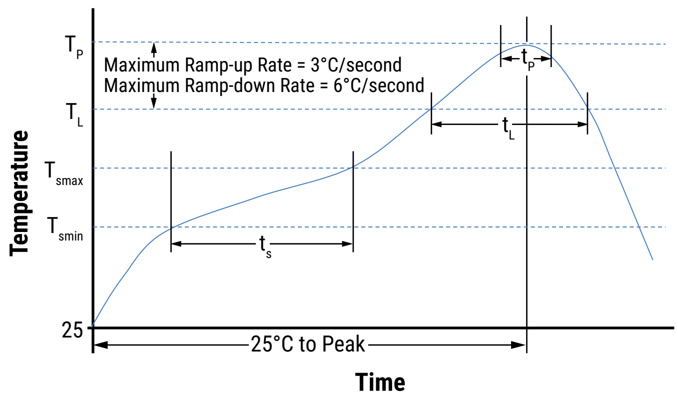


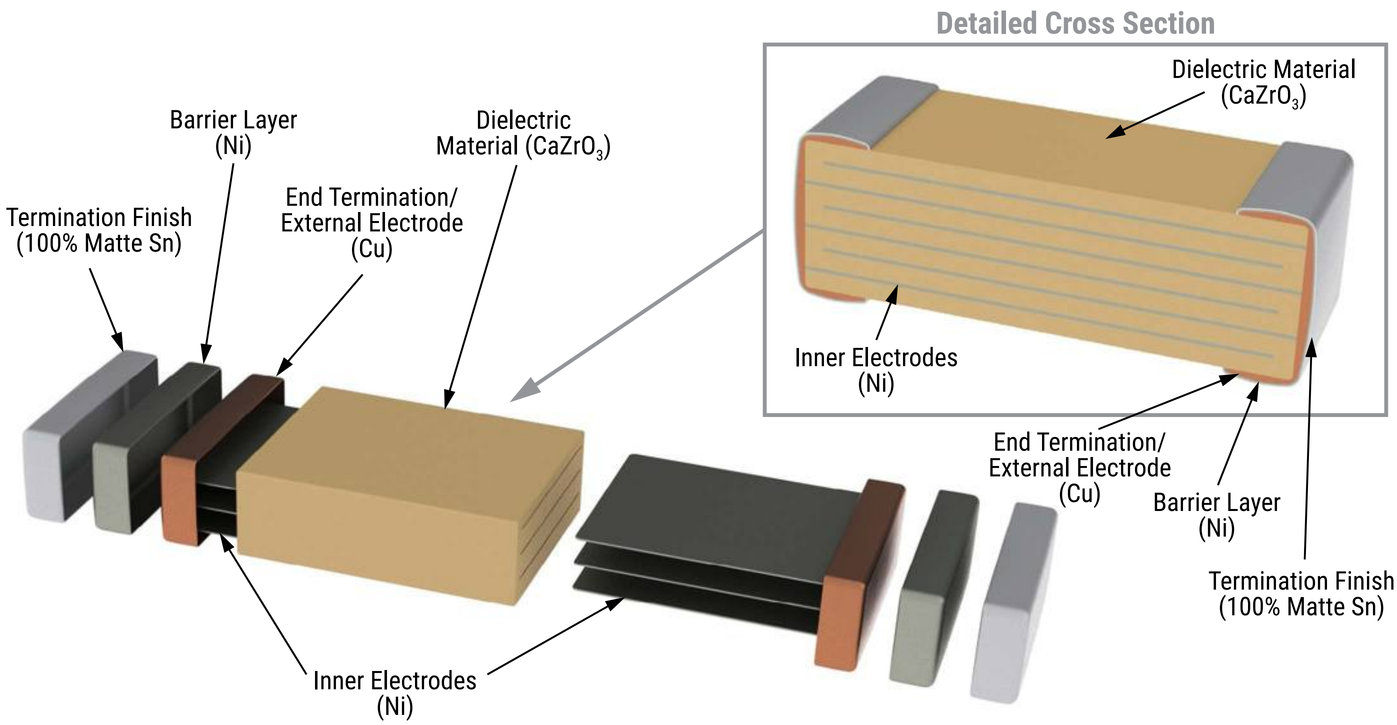
Table 5 – Performance & Reliability: Test Methods and Conditions

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 C0G. 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 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.
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.

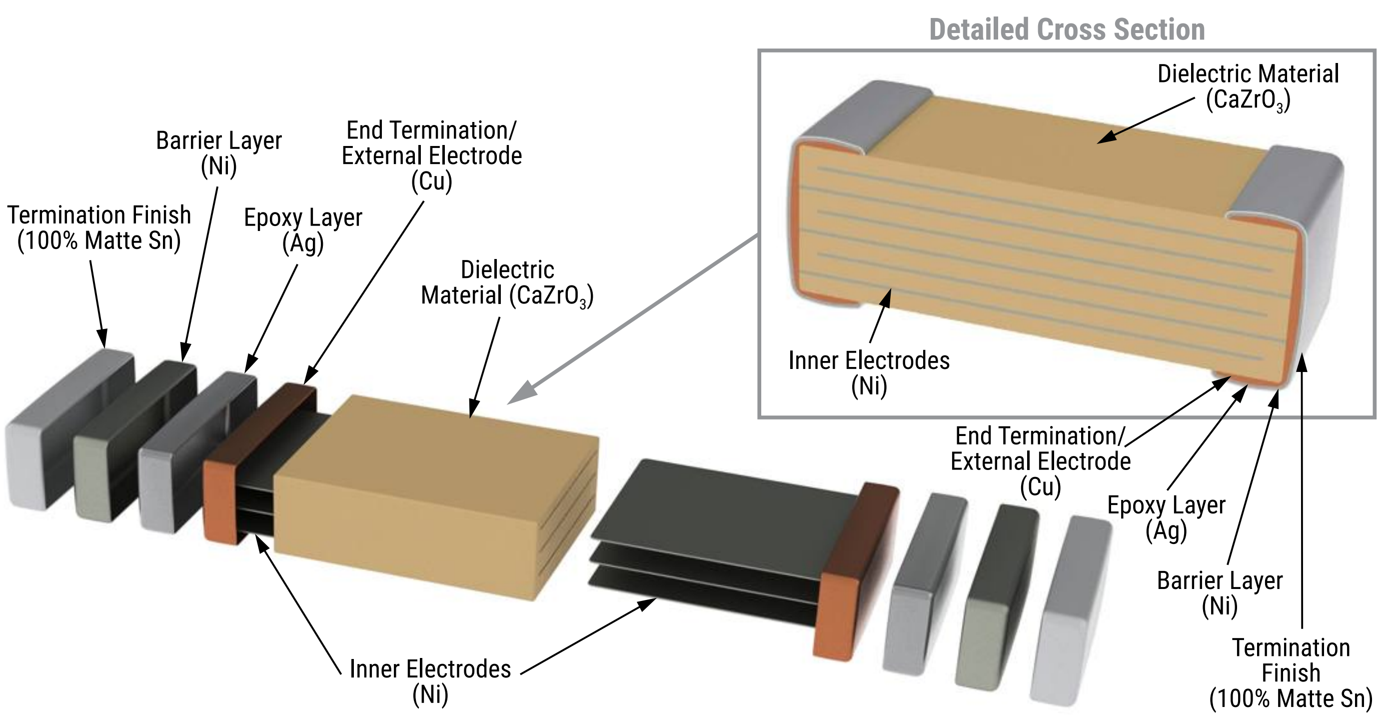
Storage and Handling

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 – Standard Termination



Construction – Flexible Termination



Capacitor Marking (Optional)

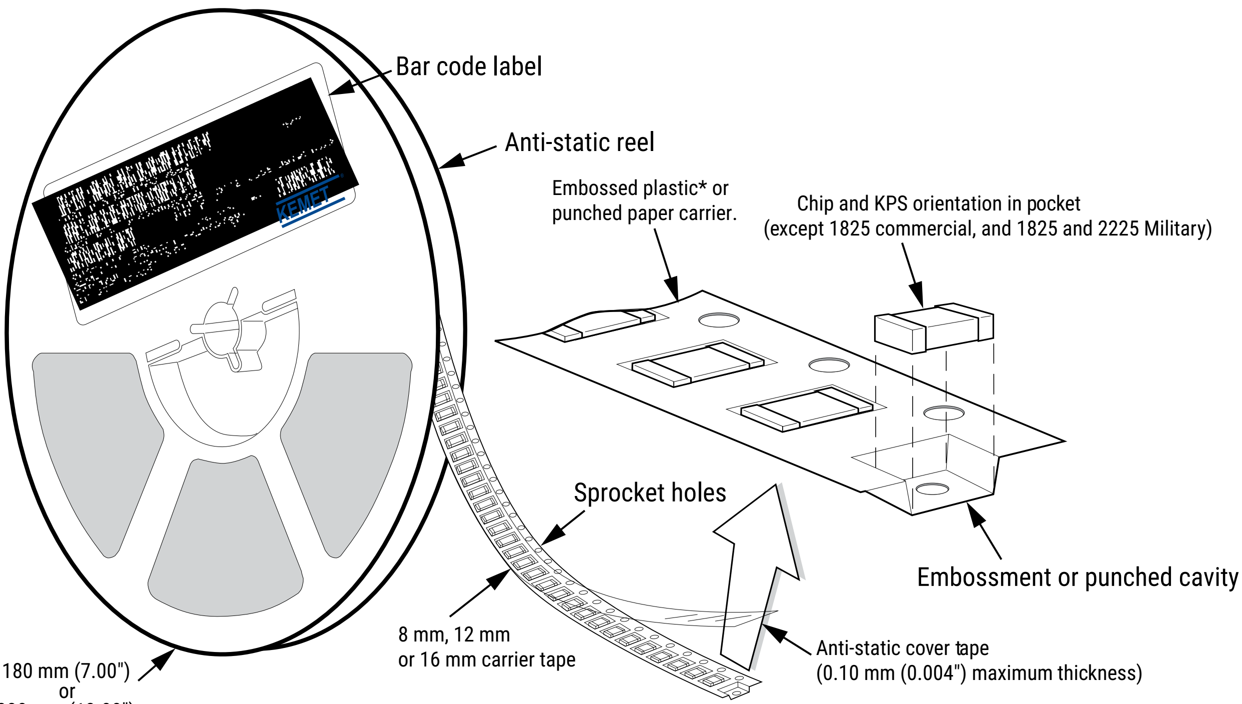
Laser marking option is not available on:

- C0G, 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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

Table 6 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

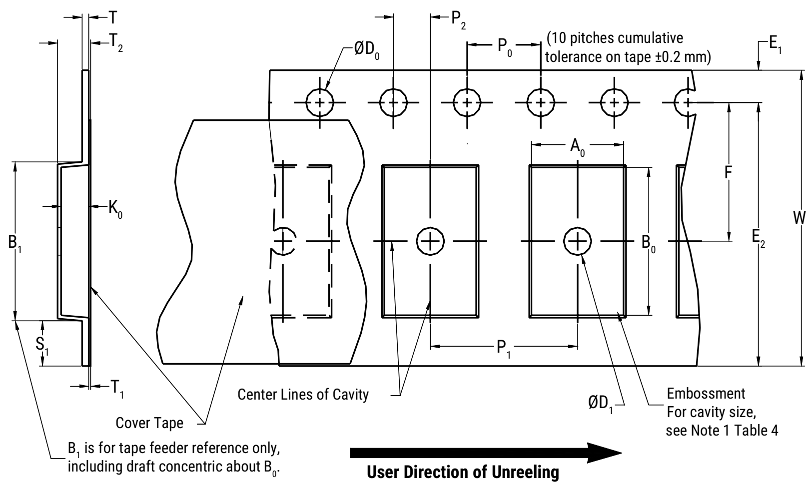


Table 7 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +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)			
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)	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 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 S_1 < 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_1 dimension is a reference dimension for tape feeder clearance only.
5. The cavity defined by A_0, B_0 and K_0 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

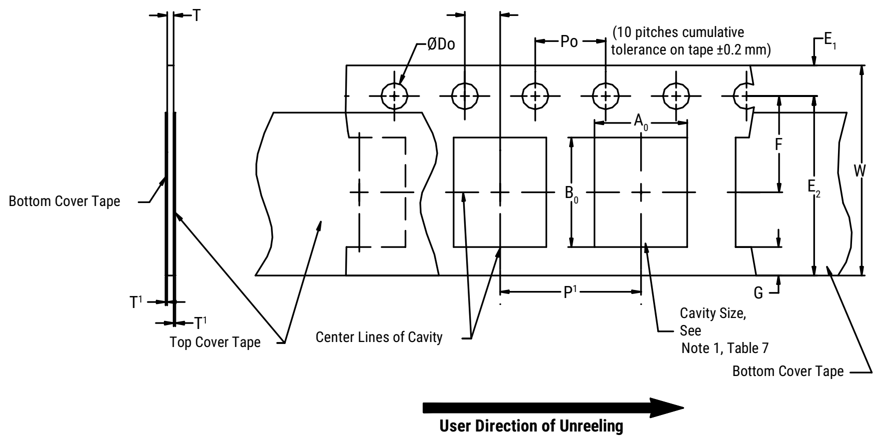


Table 8 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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

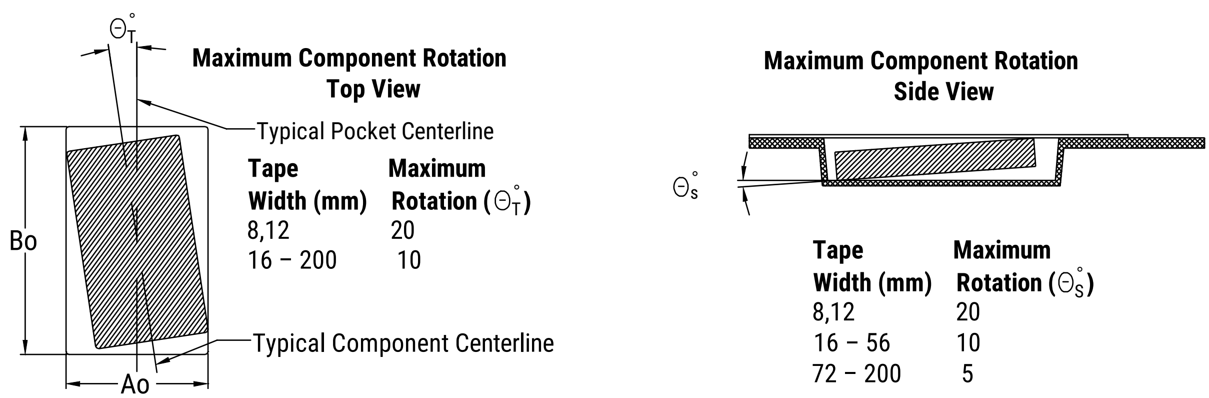


Figure 4 – Maximum Lateral Movement

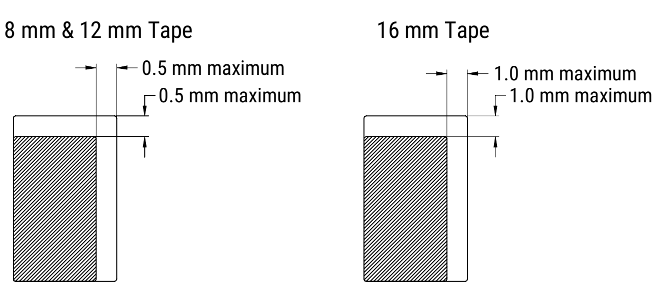


Figure 5 – Bending Radius

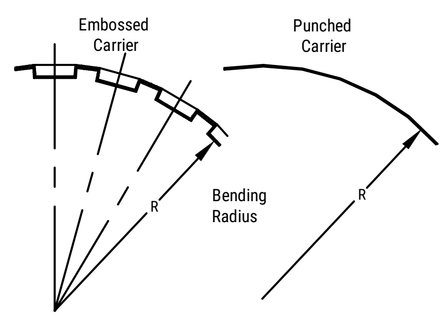
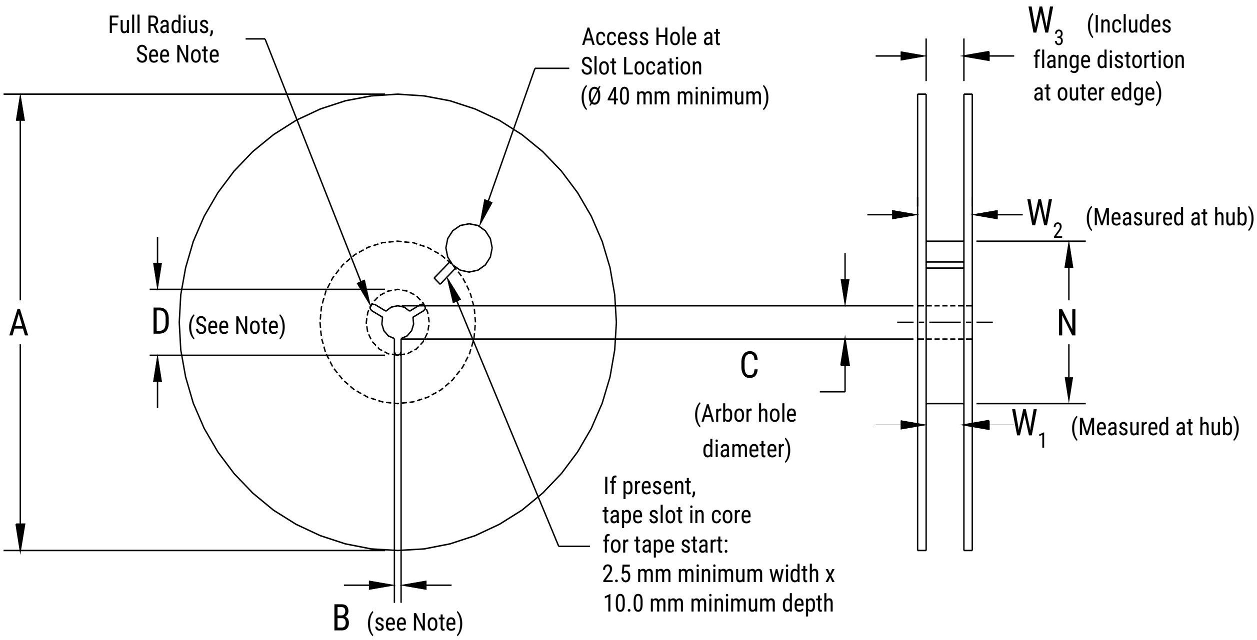


Figure 6 – Reel Dimensions



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

Table 9 – Reel Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)				
Tape Size	A	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

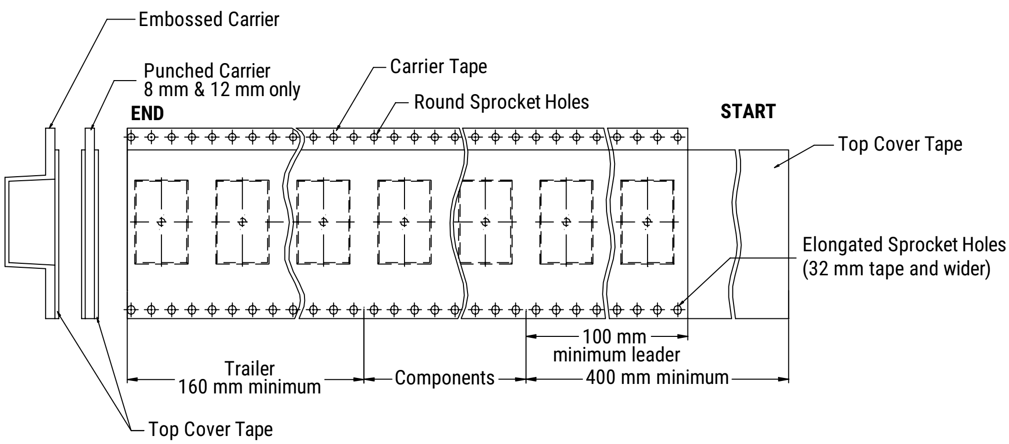
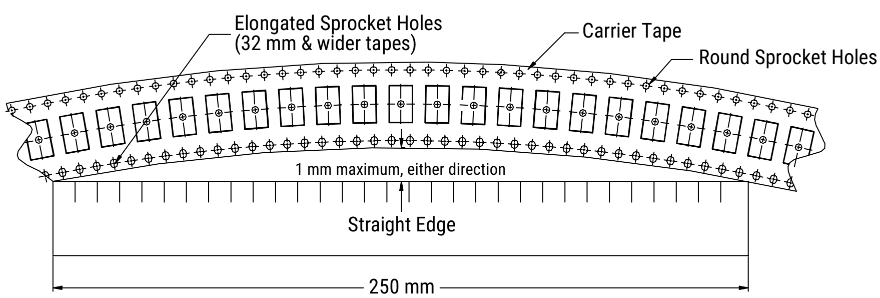


Figure 8 – Maximum Camber



Surface Mount and Through-Hole Multilayer Ceramic Capacitors

KPS-MCC High Temperature 200°C SMPS Stacks 50 – 2,000 VDC (Industrial Grade)

KEMET a YAGEO company

Overview

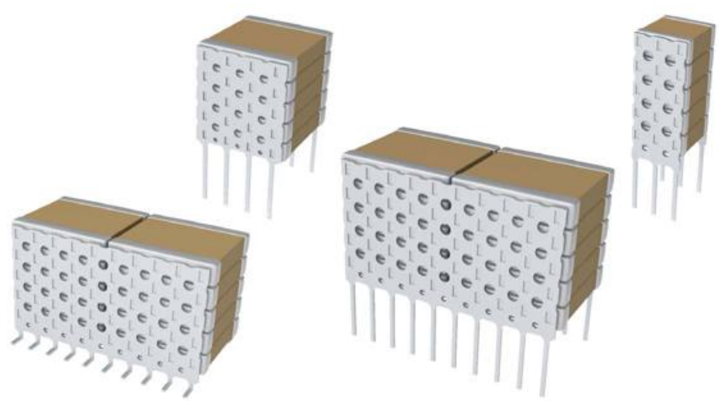
KEMET Power Solutions - Military Case Code (KPS-MCC) High Temperature SMPS Ceramic Stacked Capacitors combine a robust and proprietary C0G/NPO base metal electrode (BME) dielectric system with a durable lead-frame technology for high temperature and high power SMPS applications. These devices are specifically designed to withstand the demands of harsh industrial environments such as down-hole oil exploration and automotive/avionics engine compartment circuitry.

The KPS-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 C0G capacitors are temperature-compensating 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



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	C	106	K	A	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 C0G (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

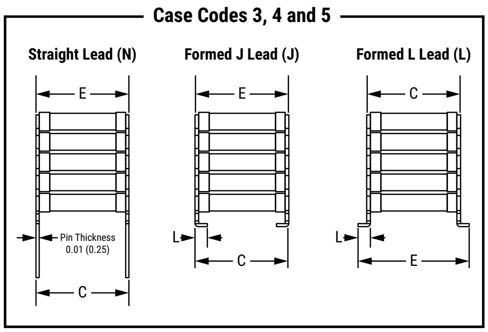
[1] Lead configuration and dimension details are outlined in the "Dimensions" section of this document. Additional lead configurations may be available. Contact KEMET for details.

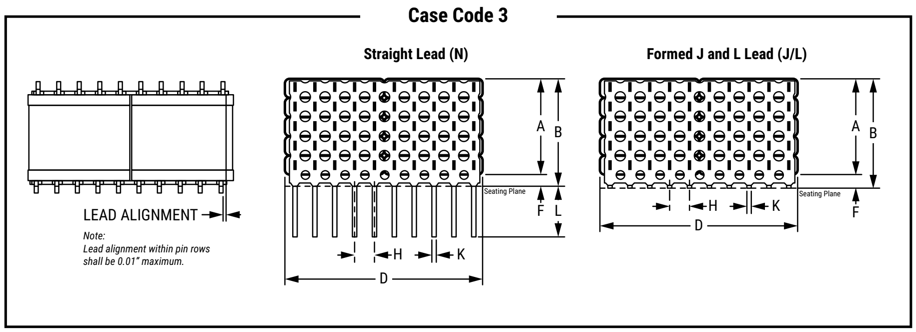
Lead Configurations – Inches (Millimeters)

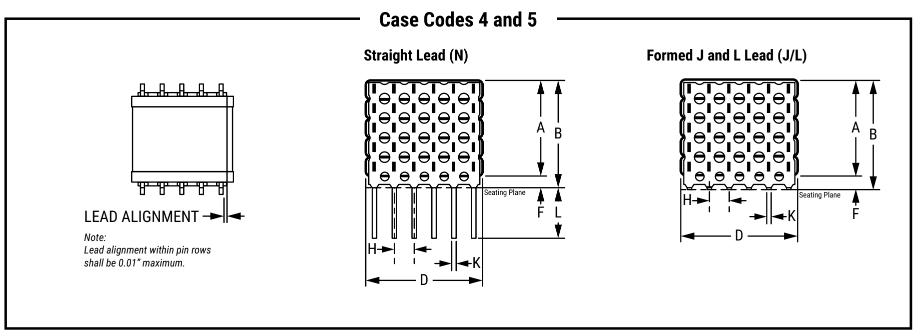
Lead Style Symbol	Lead Style	L Lead Length
N	(N) Straight	0.250 minimum (6.35)
L	(L) Formed	0.055 ±0.005 (1.4 ±0.127)
J	(J) Formed	0.055 ±0.005 (1.4 ±0.127)

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)	Refer to Product Ordering Table 1	For straight lead (N), add 0.07 inch to dimension "A" For (L) and (J) lead add 0.08 inches to dimension "A"	0.1 (2.54)	0.02 (0.5)	For straight lead (N), seating plane is 0.055 For (L) and (J) lead, seating plane is 0.070	10	Solder reflow only
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)						4	
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)						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.

Environmental Compliance

KPS-MCC part types ≥ 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 ≥ 500 to < 1,000 V 120% of rated voltage for voltage rating of ≥ 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 MΩ µF or 100 GΩ (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 ≤ 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 MΩ - µF value by the capacitance and compare to GΩ 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	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	0.9	5	3	0.32 (8.13)	No
L1G(1)505125(2)(3)04	1.2	5	4	0.42 (10.67)	No
L1G(1)505155(2)(3)05	1.5	5	5	0.53 (13.46)	No
100 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
L1G(1)401105(2)(3)03	1.0	4	3	0.32 (8.13)	No
L1G(1)501125(2)(3)04	1.2	5	4	0.42 (10.67)	No
L1G(1)401135(2)(3)04	1.3	4	4	0.42 (10.67)	No
L1G(1)501155(2)(3)05	1.5	5	5	0.53 (13.46)	No
L1G(1)401175(2)(3)05	1.7	4	5	0.53 (13.46)	No
200 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
L1G(1)302804(2)(3)04	0.8	3	4	0.21 (5.3)	No
L1G(1)402105(2)(3)03	1.0	4	3	0.32 (8.13)	No
L1G(1)302125(2)(3)06	1.2	3	6	0.32 (8.13)	No
L1G(1)402135(2)(3)04	1.3	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
500 V					
L1G(1)50C473(2)(3)01	0.047	5	1	0.11 (2.79)	Yes (see note 4)
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)	
L1G(1)40C244(2)(3)02	0.24	4	2	0.21 (5.3)	
L1G(1)50C254(2)(3)05	0.25	5	5	0.53 (13.46)	
L1G(1)40C364(2)(3)03	0.36	4	3	0.32 (8.13)	
L1G(1)30C404(2)(3)02	0.4	3	2	0.11 (2.79)	
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 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-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
630 V					
L1G(1)50B283(2)(3)01	0.028	5	1	0.11 (2.79)	Yes (see note 4)
L1G(1)50B563(2)(3)02	0.056	5	2	0.21 (5.3)	
L1G(1)40B823(2)(3)01	0.082	4	1	0.11 (2.79)	
L1G(1)50B843(2)(3)03	0.084	5	3	0.32 (8.13)	
L1G(1)50B114(2)(3)04	0.11	5	4	0.42 (10.67)	
L1G(1)50B154(2)(3)05	0.15	5	5	0.53 (13.46)	
L1G(1)40B174(2)(3)02	0.17	4	2	0.21 (5.3)	
L1G(1)40B254(2)(3)03	0.25	4	3	0.32 (8.13)	
L1G(1)30B254(2)(3)02	0.25	3	2	0.11 (2.79)	
L1G(1)40B334(2)(3)04	0.33	4	4	0.42 (10.67)	
L1G(1)40B424(2)(3)05	0.42	4	5	0.53 (13.46)	
L1G(1)30B504(2)(3)04	0.5	3	4	0.21 (5.3)	
L1G(1)30B754(2)(3)06	0.75	3	6	0.32 (8.13)	
L1G(1)30B105(2)(3)08	1.0	3	8	0.42 (10.67)	
L1G(1)30B125(2)(3)10	1.2	3	10	0.53 (13.46)	
1,000 V					
L1G(1)50D183(2)(3)01	0.018	5	1	0.11 (2.79)	Yes (see note 4)
L1G(1)50D363(2)(3)02	0.036	5	2	0.21 (5.3)	
L1G(1)50D543(2)(3)03	0.054	5	3	0.32 (8.13)	
L1G(1)40D563(2)(3)01	0.056	4	1	0.11 (2.79)	
L1G(1)50D723(2)(3)04	0.072	5	4	0.42 (10.67)	
L1G(1)50D923(2)(3)05	0.092	5	5	0.53 (13.46)	
L1G(1)40D124(2)(3)02	0.12	4	2	0.21 (5.3)	
L1G(1)30D164(2)(3)02	0.16	3	2	0.11 (2.79)	
L1G(1)40D174(2)(3)03	0.17	4	3	0.32 (8.13)	
L1G(1)40D224(2)(3)04	0.22	4	4	0.42 (10.67)	
L1G(1)40D274(2)(3)05	0.27	4	5	0.53 (13.46)	
L1G(1)30D334(2)(3)04	0.33	3	4	0.21 (5.3)	
L1G(1)30D474(2)(3)06	0.47	3	6	0.32 (8.13)	
L1G(1)30D634(2)(3)08	0.63	3	8	0.42 (10.67)	
L1G(1)30D824(2)(3)10	0.82	3	10	0.53 (13.46)	
1,500 V					
L1G(1)50F682(2)(3)01	0.0068	5	1	0.11 (2.79)	Yes (see note 4)
L1G(1)50F133(2)(3)02	0.013	5	2	0.21 (5.3)	
L1G(1)50F203(2)(3)03	0.02	5	3	0.32 (8.13)	
L1G(1)40F223(2)(3)01	0.022	4	1	0.11 (2.79)	
L1G(1)50F273(2)(3)04	0.027	5	4	0.42 (10.67)	
L1G(1)50F333(2)(3)05	0.033	5	5	0.53 (13.46)	
L1G(1)40F443(2)(3)02	0.044	4	2	0.21 (5.3)	
L1G(1)40F663(2)(3)03	0.066	4	3	0.32 (8.13)	
L1G(1)30F663(2)(3)02	0.066	3	2	0.11 (2.79)	
L1G(1)40F883(2)(3)04	0.088	4	4	0.42 (10.67)	
L1G(1)40F114(2)(3)05	0.11	4	5	0.53 (13.46)	
L1G(1)30F134(2)(3)04	0.13	3	4	0.21 (5.3)	
L1G(1)30F204(2)(3)06	0.2	3	6	0.32 (8.13)	
L1G(1)30F274(2)(3)08	0.27	3	8	0.42 (10.67)	
L1G(1)30F334(2)(3)10	0.33	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 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)	Yes (see note 4)
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)	
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 value.*
[4] *KPS-MCC Stacked Capacitors ≥ 500 V with Ag plating are RoHS compliant by exemption 7a.*

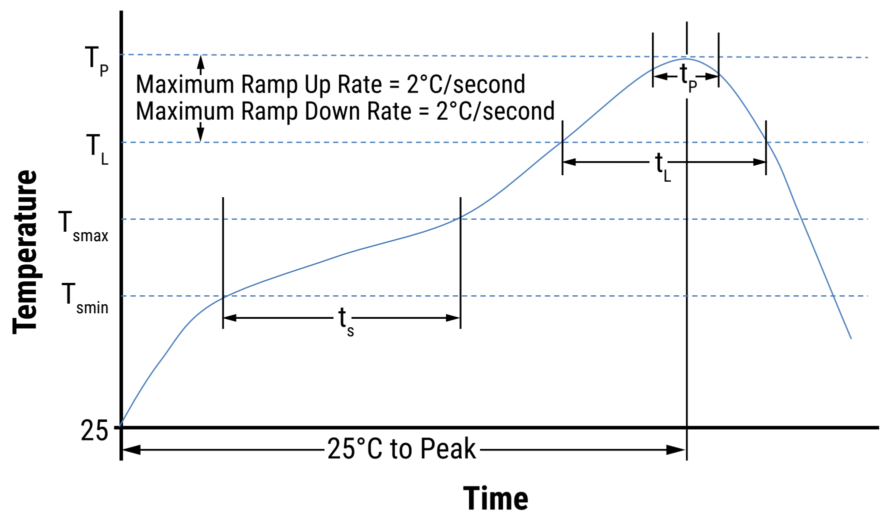
Soldering Process

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:



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_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.

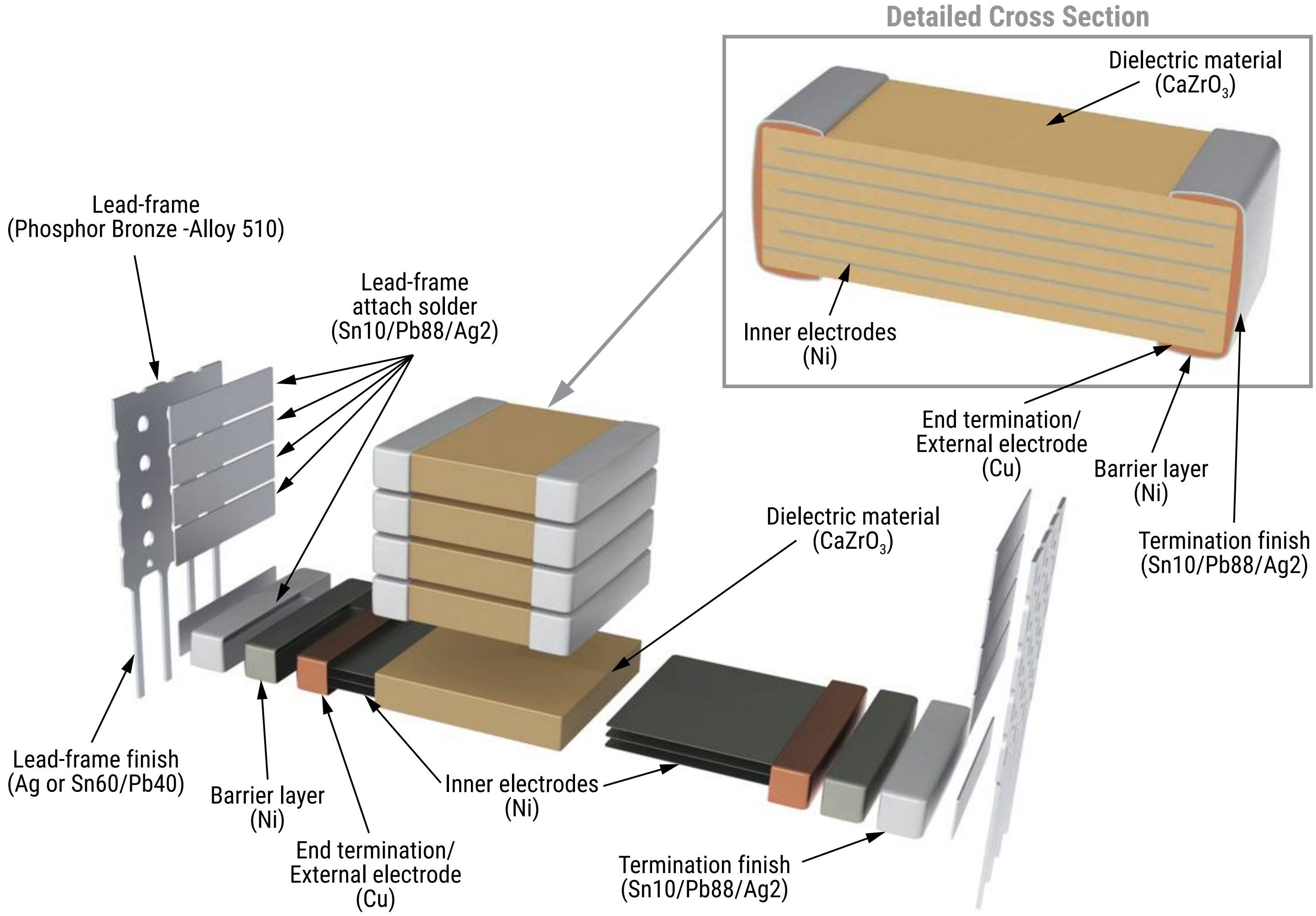
Storage & Handling

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

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	L/N	1, 2, 3	50
		4, 5	25
	J	1, 2, 3, 4, 5	50
5	N	1, 2, 3	50
		4, 5	25
	L/J	1, 2, 3, 4, 5	50

[1] *Minimum order value applies. Contact KEMET for details.*

Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs)

High Reliability Surface Mount Capacitors, MIL-PRF-32535, 4 – 200 VDC (C0G and BP Dielectrics)

KEMET a YAGEO company

Overview

The KEMET MIL-PRF-32535 C0G 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 C0G 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 C0G 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, ±1%, ±2%, ±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	M	B
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 = C0G 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 = ±0.1 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.)

C	0805	K	104	J	3	G	M	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 = ±0.1 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 = C0G 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"

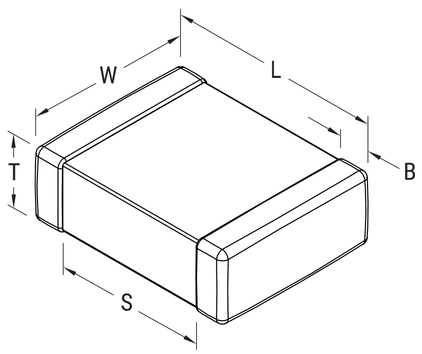
Packaging C-Spec Ordering Options Table

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 (1.02±0.10)	0.020±0.004 (0.51±0.10)	0.024 (0.61)	0.004 (0.100) minimum	1.6	Solder reflow only
0603	1608	0.063±0.006 (1.60±0.15)	0.032±0.006 (0.81±0.15)	0.039 (0.99)	0.016±0.008 (0.41±0.20)	6.3	Solder wave or solder reflow
0805[1]	2012	0.079±0.010 (2.01±0.25)	0.050±0.010 (1.27±0.25)	0.060 (1.52)	0.020±0.010 (0.51±0.25)	20	
1206[2]	3216	0.126±0.010 (3.20±0.25)	0.063±0.010 (1.60±0.25)	0.070 (1.78)	0.020±0.014 (0.51±0.36)	57	
1210[2]	3225	0.126±0.010 (3.20±0.25)	0.098±0.010 (2.49±0.25)	0.110 (2.79)	0.020±0.014 (0.51±0.36)	108	Solder reflow only
1812[2]	4532	0.178±0.012 (4.52±0.30)	0.126±0.012 (3.20±0.30)	0.110 (2.79)	0.024±0.018 (0.61±0.46)	216	
2220[2]	5650	0.224±0.016 (5.69±0.41)	0.197±0.016 (5.00±0.41)	0.110 (2.79)	0.025±0.018 (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 MΩ µFs or 100 GΩ, whichever is less Rated voltage ≥ 25 V 1,000 MΩ µF or 100 GΩ, 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 ±50 Hz and 1.0 V_{rms} ±0.2 V if capacitance > 1,000 pF

[3] *To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ 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)

Capacitance	Cap Code (MIL-PRF-32535 Part Number)	Cap Code (KEMET Part Number)	Case Size							0402							0603								0805							
			Voltage Code (MIL)							V	W	X	Y	Z	A	B	V	W	X	Y	Z	A	B	C	V	W	X	Y	Z	A	B	C
			Voltage Code (KEMET)							7	9	8	4	3	5	1	7	9	8	4	3	5	1	2	7	9	8	4	3	5	1	2
			Rated Voltage (VDC)							4	6.3	10	16	25	50	100	4	6.3	10	16	25	50	100	200	4	6.3	10	16	25	50	100	200
			Capacitance Tolerance							Product Availability																						
1 pF	1R0	109	B	C	D												•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
1.5 pF	1R5	159	B	C	D												•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
2.2 pF	2R2	229	B	C	D												•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
2.7 pF	2R7	279	B	C	D												•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
3.3 pF	3R3	339	B	C	D												•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
3.9 pF	3R9	399	B	C	D												•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
4.7 pF	4R7	479	B	C	D												•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
5.6 pF	5R6	569	B	C	D												•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
6.8 pF	6R8	689	B	C	D												•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
8.2 pF	8R2	829	B	C	D												•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
10 pF	100	100				F	G	J	K	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
12 pF	120	120				F	G	J	K	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
15 pF	150	150				F	G	J	K	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
18 pF	180	180				F	G	J	K	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
20 pF	200	200				F	G	J	K								•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
22 pF	220	220				F	G	J	K	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
27 pF	270	270				F	G	J	K	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
33 pF	330	330				F	G	J	K	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
39 pF	390	390				F	G	J	K	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
47 pF	470	470				F	G	J	K	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
56 pF	560	560				F	G	J	K	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
68 pF	680	680				F	G	J	K	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
82 pF	820	820				F	G	J	K	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
100 pF	101	101				F	G	J	K	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•
120 pF	121	121				F	G	J	K	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•
150 pF	151	151				F	G	J	K	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•
180 pF	181	181				F	G	J	K	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•
220 pF	221	221				F	G	J	K	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•
270 pF	271	271				F	G	J	K	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•
330 pF	331	331				F	G	J	K	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•
390 pF	391	391				F	G	J	K	•	•	•	•	•	•		•	•	•	•	•	•	•		•	•	•	•	•	•	•	•
470 pF	471	471				F	G	J	K	•	•	•	•	•	•		•	•	•	•	•	•	•		•	•	•	•	•	•	•	•
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																•	•	•	•	•	•	•	
8,200 pF	822	822				F	G	J	K																•	•	•	•	•	•	•	
10,000 pF	103	103				F	G	J	K																•	•	•	•	•			
Capacitance	Cap Code (MIL-PRF-32535 Part Number)	Cap Code (KEMET Part Number)	Rated Voltage (VDC)							4	6.3	10	16	25	50	100	4	6.3	10	16	25	50	100	200	4	6.3	10	16	25	50	100	200
			Voltage Code							7	9	8	4	3	5	1	7	9	8	4	3	5	1	2	7	9	8	4	3	5	1	2
			Case Size/Series							0402							0603								0805							

Table 1B – Capacitance Range/Selection Waterfall (1206 – 1210 Case Sizes)

Capacitance	Cap Code (MIL-PRF-32535 Part Number)	Cap Code (KEMET Part Number)	Case Size				1206								1210							
			Voltage Code (MIL)				V	W	X	Y	Z	A	B	C	V	W	X	Y	Z	A	B	C
			Voltage Code (KEMET)				7	9	8	4	3	5	1	2	7	9	8	4	3	5	1	2
			Rated Voltage (VDC)				4	6.3	10	16	25	50	100	200	4	6.3	10	16	25	50	100	200
							Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions															
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	•	•	•	•	•	•	•		•	•	•	•	•	•	•	
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									•	•	•	•	•			
Capacitance	Cap Code (MIL-PRF-32535 Part Number)	Cap Code (KEMET Part Number)	Rated Voltage (VDC)				4	6.3	10	16	25	50	100	200	4	6.3	10	16	25	50	100	200
			Voltage Code				7	9	8	4	3	5	1	2	7	9	8	4	3	5	1	2
			Case Size/Series				1206								1210							

Table 1C – Capacitance Range/Selection Waterfall (1812 – 2220 Case Sizes)

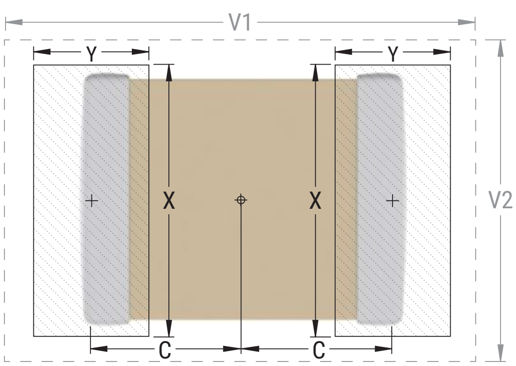
Capacitance	Cap Code (MIL-PRF-32535 Part Number)	Cap Code (KEMET Part Number)	Case Size				1812								2220							
			Voltage Code (MIL)				V	W	X	Y	Z	A	B	C	V	W	X	Y	Z	A	B	C
			Voltage Code (KEMET)				7	9	8	4	3	5	1	2	7	9	8	4	3	5	1	2
			Rated Voltage (VDC)				4	6.3	10	16	25	50	100	200	4	6.3	10	16	25	50	100	200
			Capacitance Tolerance				Product Availability															
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	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
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	•	•	•	•	•	•	•		•	•	•	•	•	•	•	
56,000 pF	563	563	F	G	J	K	•	•	•	•	•	•	•		•	•	•	•	•	•	•	
68,000 pF	683	683	F	G	J	K	•	•	•	•	•	•			•	•	•	•	•	•	•	
82,000 pF	823	823	F	G	J	K	•	•	•	•	•				•	•	•	•	•	•	•	
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									•	•	•	•	•			
Capacitance	Cap Code (MIL-PRF-32535 Part Number)	Cap Code (KEMET Part Number)	Rated Voltage (VDC)				4	6.3	10	16	25	50	100	200	4	6.3	10	16	25	50	100	200
			Voltage Code				7	9	8	4	3	5	1	2	7	9	8	4	3	5	1	2
			Case Size/Series				1812								2220							

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)					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
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
	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.

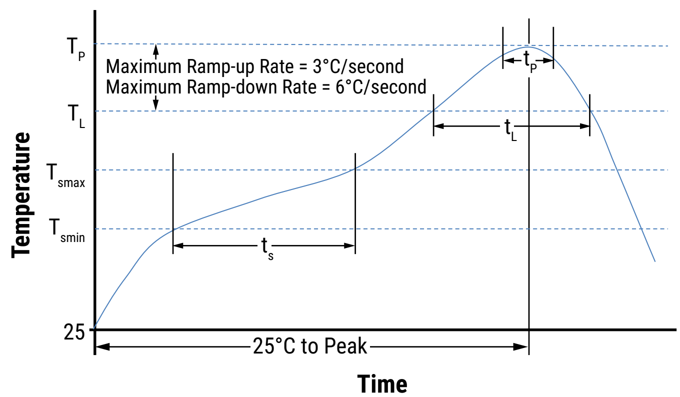


Table 3 – Performance & Reliability: Test Methods and Conditions

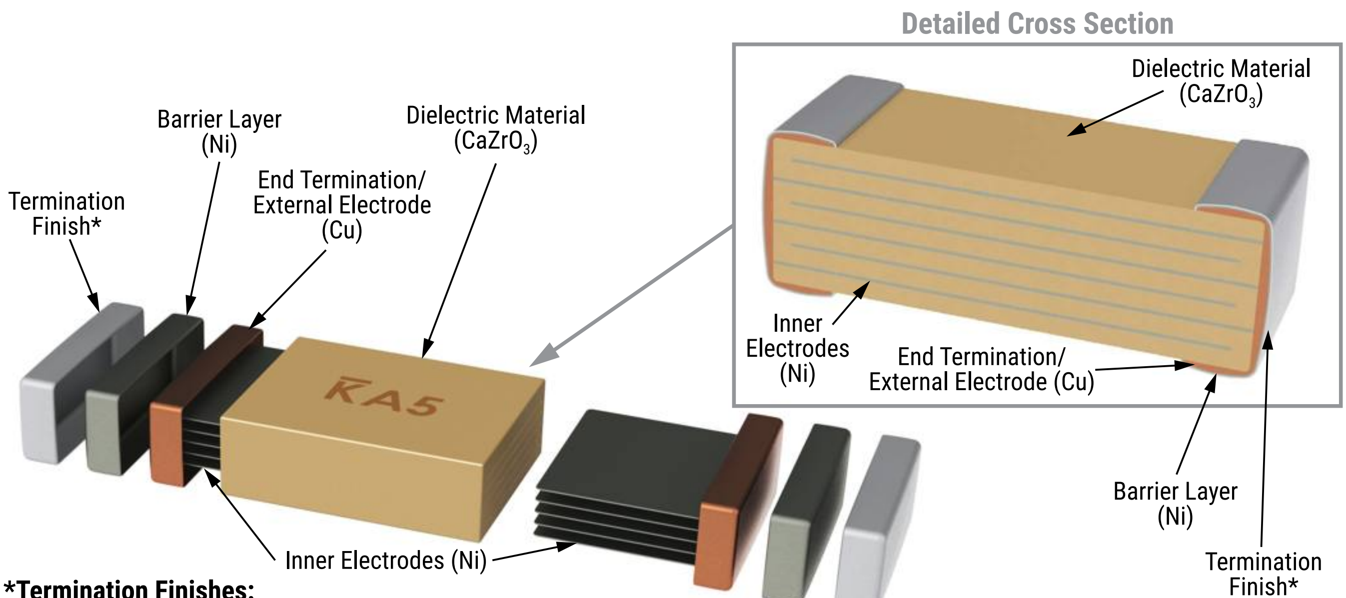
Inspection	Test Method	MIL-PRF-32535 M-Level	MIL-PRF-32535 T-Level
In-Process Inspection			
Nondestructive internal examination (pre-termination)	MIL-PRF-32535 Method 4.6.1	Not required	Yes (100%)
Visual examination (post-termination)	MIL-PRF-32535 Method 4.6.2	Not required	Yes (100%)
Group A Inspection			
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 Inspection			
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 Inspection			
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

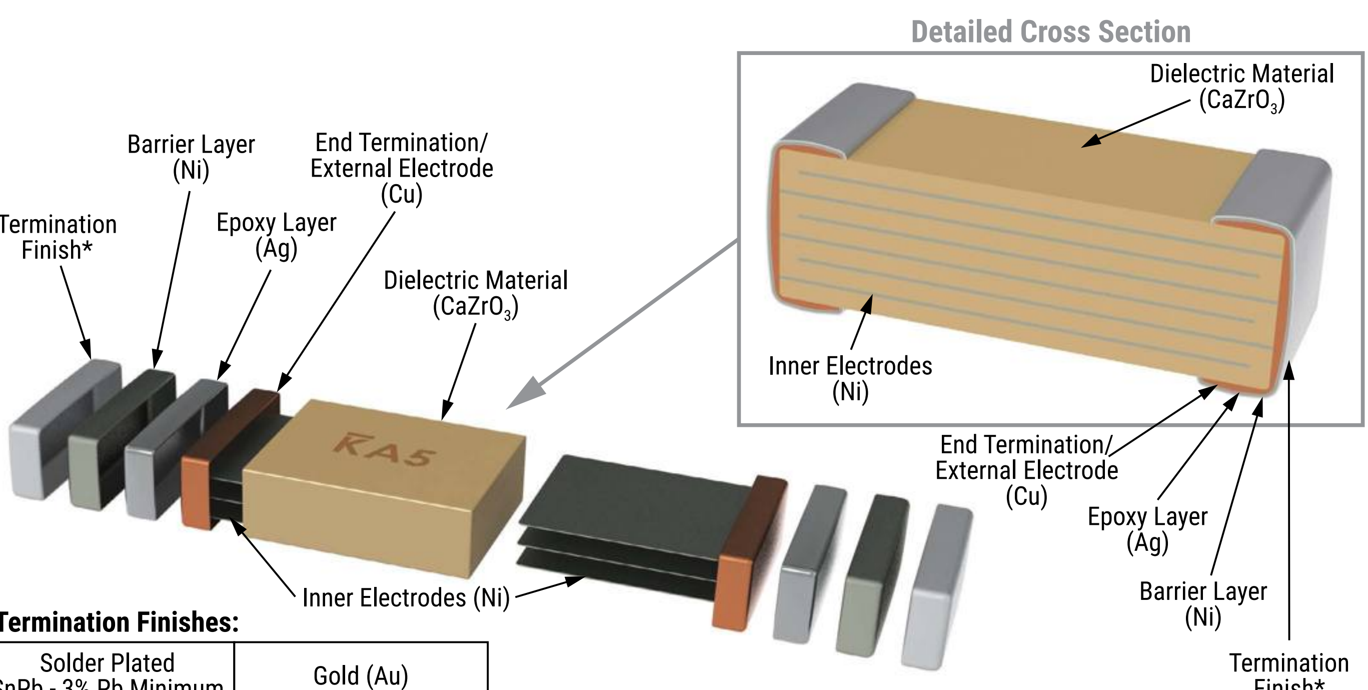
Standard Termination



***Termination Finishes:**

Solder Dipped SnPb - 3% Pb Minimum	Solder Plated SnPb - 3% Pb Minimum	Gold (Au)

Flexible Termination



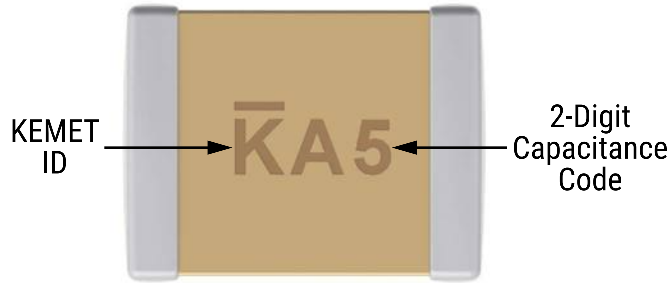
***Termination Finishes:**

Solder Plated SnPb - 3% Pb Minimum	Gold (Au)

Capacitor Marking:

KEMET MIL-PRF-32535 ceramic capacitors will be marked in accordance with the military specification on case sizes ≥ 0805. Case sizes below 0805 will not be marked. Two sides of the ceramic body will be laser marked with a "K̄" to identify KEMET, followed by two characters to identify the capacitance value.

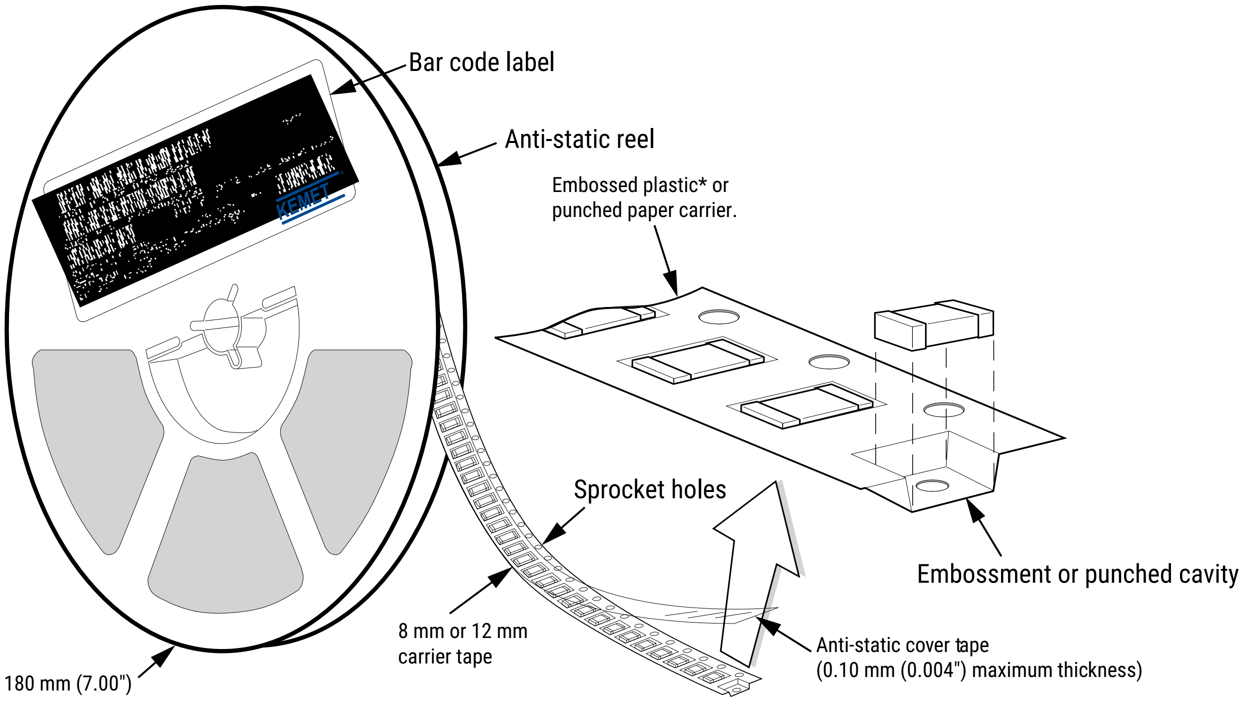
The marking appears in legible contrast. Illustrated below is an example of an MLCC with laser the marking of "K̄A5", which designates a KEMET device with the rated capacitance of 100 nF.



Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.1	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 0402 and 0603 case sizes available on punched paper carrier only.

Table 4 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

EIA Case Size	Tape size (W)*	Embossed Plastic	Punched Paper
		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

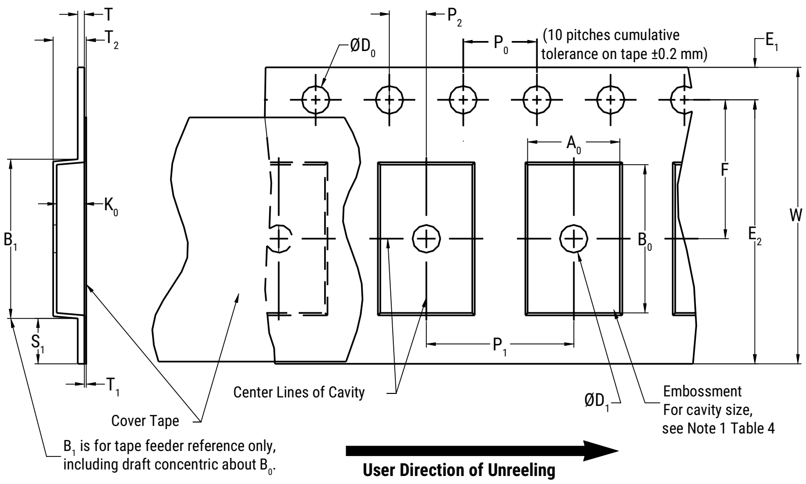


Table 5 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)									
Tape Size	D_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)	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_0, B_0 and K_0 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

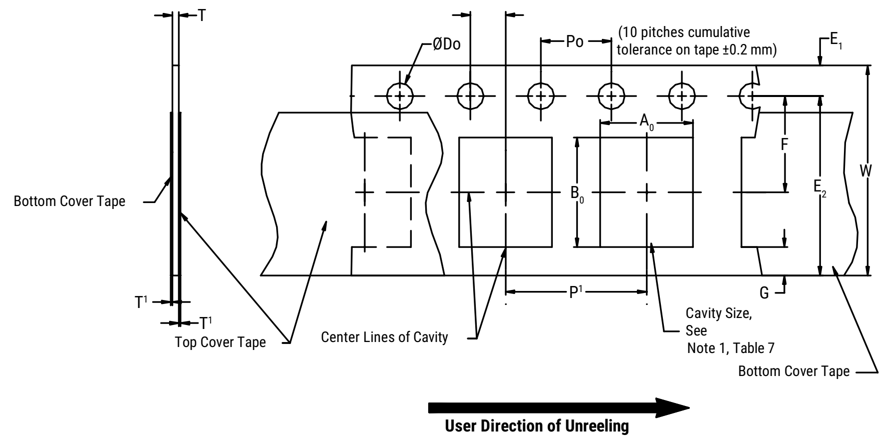


Table 6 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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

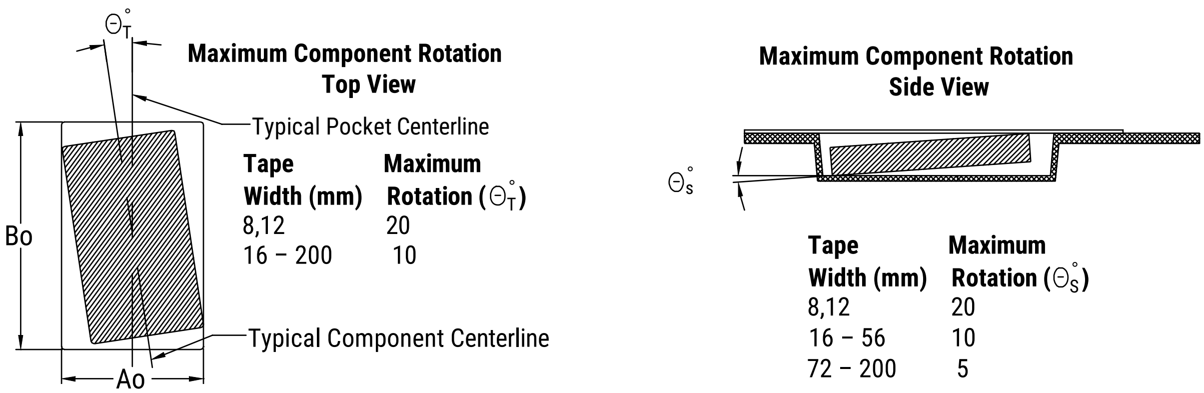


Figure 4 – Maximum Lateral Movement

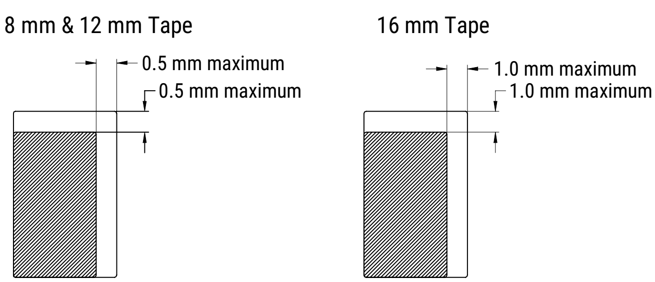


Figure 5 – Bending Radius

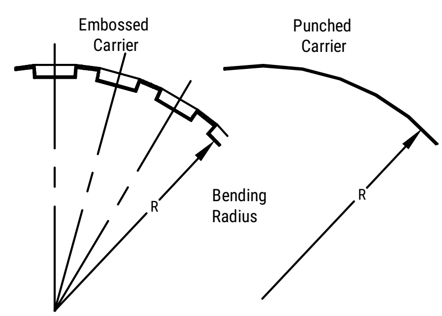
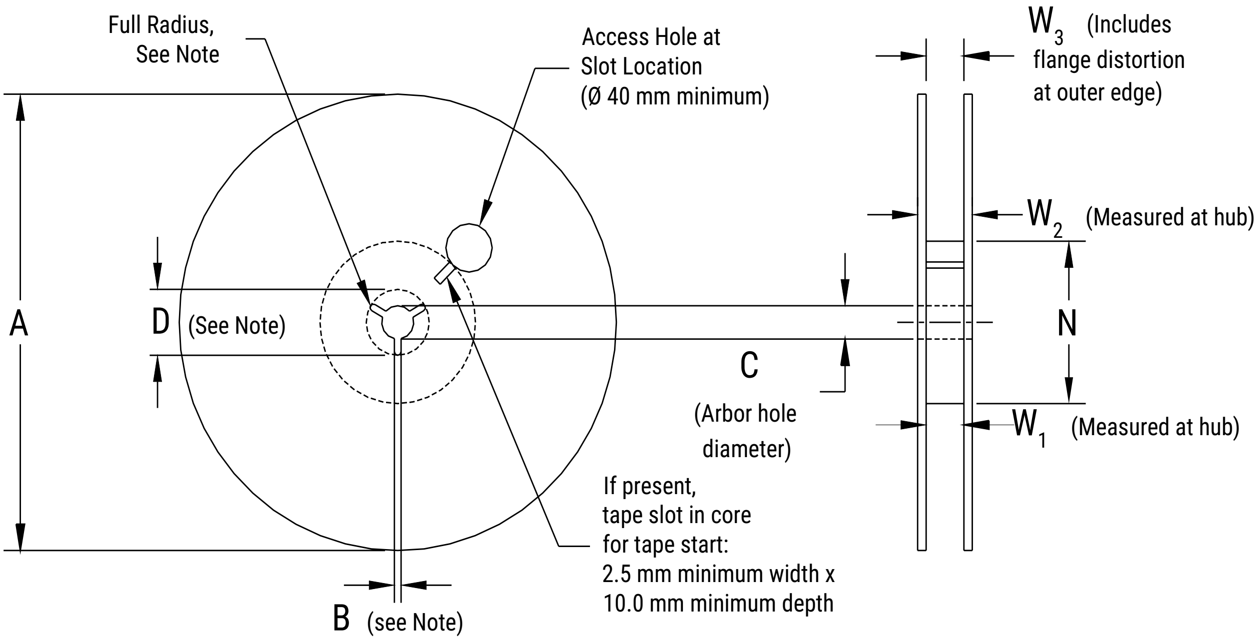


Figure 6 – Reel Dimensions



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

Table 7 – Reel Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)				
Tape Size	A	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				
Variable Dimensions — Millimeters (Inches)				
Tape Size	N Minimum See Note 2, Tables 2–3	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 accomadate tape width without interference
12 mm		12.4 + 2.0/−0.0 (0.488 + 0.078/−0.0)	18.4 (0.724)	

Figure 7 – Tape Leader & Trailer Dimensions

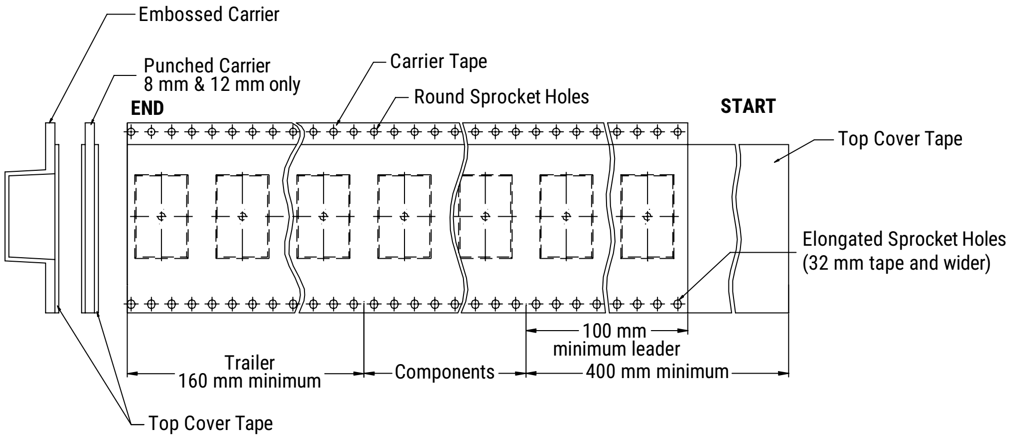
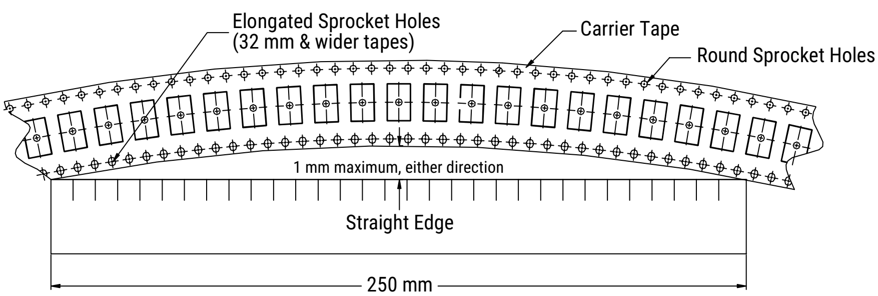


Figure 8 – Maximum Camber



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

Figure 9 – Waffle Tray Dimensions – Inches (Millimeters)

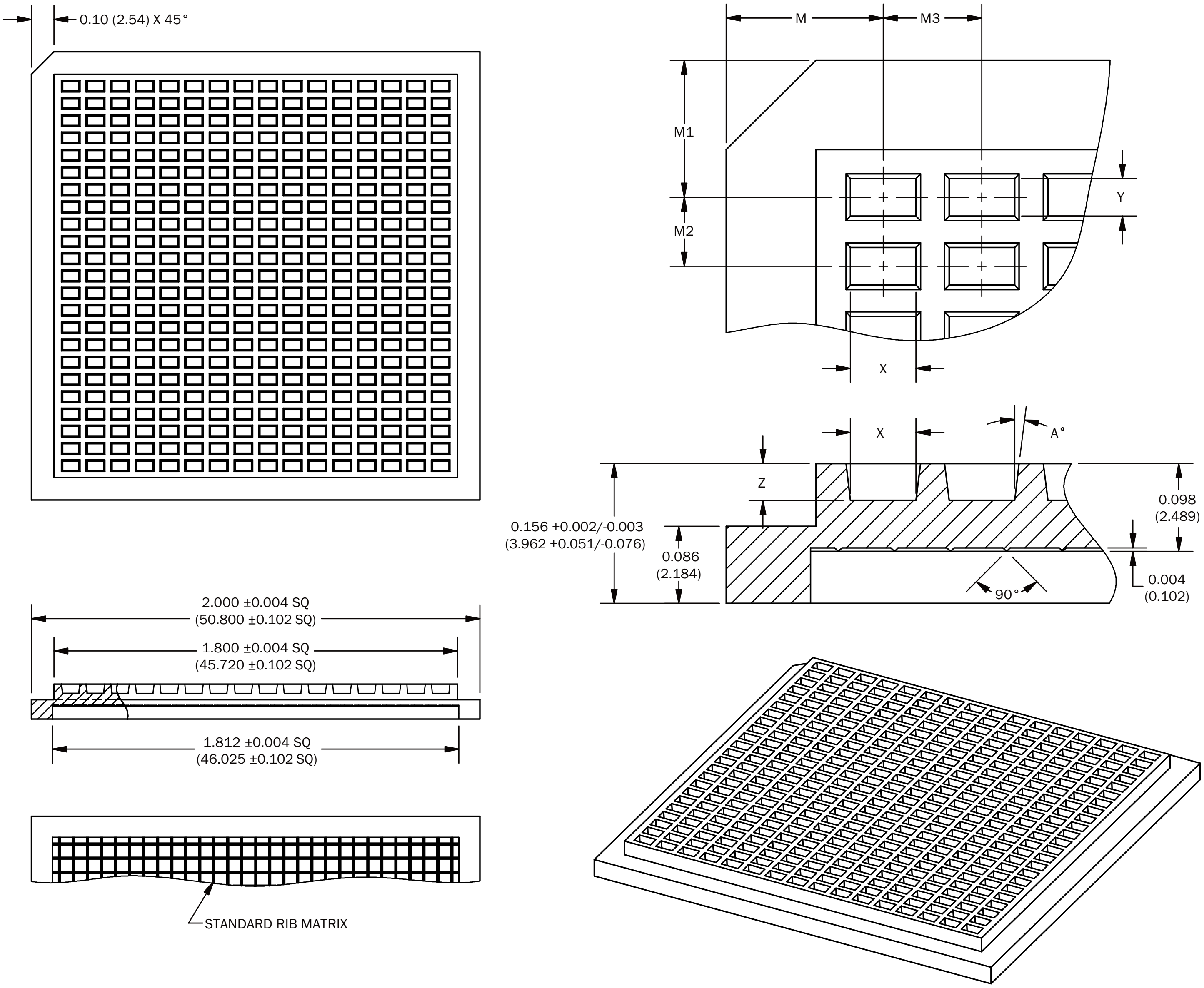


Table 8A – Waffle Tray Dimensions – Inches

Case Size		2" x 2" Waffle Tray Dimensions – Inches									Packaging Quantity (pcs/unit packaging)
		M	M1	M2	M3	X	Y	Z	A°	MATRIX	
EIA (in)	Metric (mm)	±0.003	±0.003	±0.002	±0.002	±0.002	±0.002	±0.003	±1/2°	(X x Y)	
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 ≤ 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									Packaging Quantity (pcs/unit packaging)
		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)	
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 ≤ 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).

High Reliability Surface Mount Capacitors, MIL-PRF-32535, 4 – 100 VDC (X7R Dielectric)

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	M	B
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.
[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.)

C	0805	K	104	J	3	R	M	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"

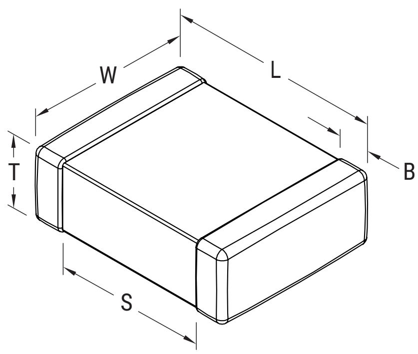
Packaging C-Spec Ordering Options Table

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 (1.02+0.15/−0.10)	0.020+0.005/−0.004 (0.51+0.13/−0.10)	0.025 (0.64)	0.004 (0.100) Minimum	1.6	Solder reflow only
0603	1608	0.063+0.008/−0.006 (1.60+0.2/−0.15)	0.032+0.008/−0.006 (0.81+0.2/−0.15)	0.040 (1.02)	0.016 ±0.008 (0.41±0.20)	6.3	Solder wave or solder reflow
0805[1]	2012	0.079+0.012/−0.01 (2.01+0.3/−0.25)	0.050+0.012/−0.01 (1.27+0.3/−0.25)	0.062 (1.57)	0.020±0.010 (0.51±0.25)	20	
1206[2]	3216	0.126+0.012/−0.01 (3.20+0.3/−0.25)	0.063+0.012/−0.01 (1.60+0.3/−0.25)	0.071 (1.8)	0.020±0.014 (0.51±0.36)	57	
1210[2]	3225	0.126+0.012/−0.01 (3.20+0.3/−0.25)	0.098+0.012/−0.010 (2.49+0.3/−0.25)	0.110 (2.79)	0.020±0.014 (0.51±0.36)	108	Solder reflow only
1812[2]	4532	0.178±0.012 (4.52±0.30)	0.126±0.012 (3.20±0.30)	0.110 (2.79)	0.024±0.018 (0.61±0.46)	216	
2220[2]	5650	0.224±0.016 (5.69±0.41)	0.197±0.016 (5.00±0.41)	0.110 (2.79)	0.025±0.018 (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 → 7.5; 6.3 → 7.5; 10 → 5.0; 16 → 3.5; 25 → 3.5; ≥ 50 → 2.5
[3]Insulation Resistance (IR) minimum limit at 25°C	Rated voltage < 25 V 500 MΩ µF or 100 GΩ, whichever is less Rated voltage ≥ 25 V 1,000 MΩ µF or 100 GΩ, whichever is less (Rated voltage applied for 120 seconds maximum at 25°C)

Maximum Allowable DF (%)

Rated Voltage (VDC)	4	6.3	10	16	25	≥ 50
DF (%)	7.5	7.5	5.0	3.5	3.5	2.5

[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 ±50 Hz and 1.0 V_{rms} ±0.2 V if capacitance > 1,000 pF
[3] To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ 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)

Capacitance	Cap Code	Case Size			0402						0603						0805						
		Voltage Code (MIL)			V	W	X	Y	Z	A	V	W	X	Y	Z	A	V	W	X	Y	Z	A	B
		Voltage Code (KEMET)			7	9	8	4	3	5	7	9	8	4	3	5	7	9	8	4	3	5	1
		Rated Voltage (VDC)			4	6.3	10	16	25	50	4	6.3	10	16	25	50	4	6.3	10	16	25	50	100
		Capacitance Tolerance			Product Availability																		
39 pF	390	J	K	M	•	•	•	•	•	•													
47 pF	470	J	K	M	•	•	•	•	•	•													
56 pF	560	J	K	M	•	•	•	•	•	•													
68 pF	680	J	K	M	•	•	•	•	•	•													
82 pF	820	J	K	M	•	•	•	•	•	•													
100 pF	101	J	K	M	•	•	•	•	•	•													
120 pF	121	J	K	M	•	•	•	•	•	•													
150 pF	151	J	K	M	•	•	•	•	•	•													
180 pF	181	J	K	M	•	•	•	•	•	•													
220 pF	221	J	K	M	•	•	•	•	•	•													
270 pF	271	J	K	M	•	•	•	•	•	•													
330 pF	331	J	K	M	•	•	•	•	•	•													
390 pF	391	J	K	M	•	•	•	•	•	•													
470 pF	471	J	K	M	•	•	•	•	•	•													
560 pF	561	J	K	M	•	•	•	•	•	•													
680 pF	681	J	K	M	•	•	•	•	•	•													
820 pF	821	J	K	M	•	•	•	•	•	•													
1,000 pF	102	J	K	M	•	•	•	•	•	•	•	•	•	•	•	•							
1,200 pF	122	J	K	M	•	•	•	•	•	•	•	•	•	•	•	•							
1,500 pF	152	J	K	M	•	•	•	•	•	•	•	•	•	•	•	•							
1,800 pF	182	J	K	M	•	•	•	•	•	•	•	•	•	•	•	•							
2,200 pF	222	J	K	M	•	•	•	•	•	•	•	•	•	•	•	•							
2,700 pF	272	J	K	M	•	•	•	•	•	•	•	•	•	•	•	•							
3,300 pF	332	J	K	M	•	•	•	•	•	•	•	•	•	•	•	•							
3,900 pF	392	J	K	M	•	•	•	•	•	•	•	•	•	•	•	•							
4,700 pF	472	J	K	M	•	•	•	•	•	•	•	•	•	•	•	•							
5,600 pF	562	J	K	M	•	•	•	•	•	•	•	•	•	•	•	•							
6,800 pF	682	J	K	M	•	•	•	•	•	•	•	•	•	•	•	•							
8,200 pF	822	J	K	M	•	•	•	•	•		•	•	•	•	•	•							
10,000 pF	103	J	K	M	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•[1]
12,000 pF	123	J	K	M	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•[1]
15,000 pF	153	J	K	M	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•[1]
18,000 pF	183	J	K	M	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•[1]
22,000 pF	223	J	K	M	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•[1]
27,000 pF	273	J	K	M	•	•	•				•	•	•	•	•	•	•	•	•	•	•	•	•[1]
33000 pF	333	J	K	M	•	•	•				•	•	•	•	•	•	•	•	•	•	•	•	•[1]
39,000 pF	393	J	K	M	•	•	•				•	•	•	•	•	•	•	•	•	•	•	•	•[1]
47,000 pF	473	J	K	M	•	•	•				•	•	•	•	•	•	•	•	•	•	•	•	•[1]
51,000 pF	513	J	K	M							•	•	•	•	•								
56,000 pF	563	J	K	M							•	•	•	•	•		•	•	•	•	•	•	•[1]
68,000 pF	683	J	K	M							•	•	•	•	•		•	•	•	•	•	•	
82,000 pF	823	J	K	M							•	•	•	•	•		•	•	•	•	•	•	
100,000 pF	104	J	K	M							•	•	•	•	•		•	•	•	•	•	•	
120,000 pF	124	J	K	M							•	•	•	•	•		•	•	•	•	•	•	
150,000 pF	154	J	K	M							•	•	•	•	•		•	•	•	•	•	•	
180,000 pF	184	J	K	M							•	•	•				•	•	•	•	•		
220,000 pF	224	J	K	M							•	•	•				•	•	•	•	•		
270,000 pF	274	J	K	M													•	•	•	•	•		
330,000 pF	334	J	K	M													•	•	•	•	•		
390,000 pF	394	J	K	M													•	•	•	•	•		
470,000 pF	474	J	K	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	K	M													•	•	•				
Capacitance	Cap Code	Rated Voltage			4	6.3	10	16	25	50	4	6.3	10	16	25	50	4	6.3	10	16	25	50	100
		Voltage Code			7	9	8	4	3	5	7	9	8	4	3	5	7	9	8	4	3	5	1
		Case Size			0402						0603						0805						

[1] *Only available with flexible termination.*

Table 1B – Capacitance Range/Selection Waterfall (1206 – 1210 Case Sizes)

Capacitance	Cap Code	Case Size			1206							1210						
		Voltage Code (MIL)			V	W	X	Y	Z	A	B	V	W	X	Y	Z	A	B
		Voltage Code (KEMET)			7	9	8	4	3	5	1	7	9	8	4	3	5	1
		Rated Voltage (VDC)			4	6.3	10	16	25	50	100	4	6.3	10	16	25	50	100
		Capacitance Tolerance			Product Availability													
82,000 pF	823	J	K	M								•	•	•	•	•	•	•[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	K	M	•	•	•	•	•	•		•	•	•	•	•	•	•[1]
330,000 pF	334	J	K	M	•	•	•	•	•	•		•	•	•	•	•	•	•[1]
390,000 pF	394	J	K	M	•	•	•	•	•			•	•	•	•	•	•	
470,000 pF	474	J	K	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	K	M	•	•	•	•	•			•	•	•	•	•		
1,200,000 pF	125	J	K	M	•	•	•	•	•			•	•	•	•	•		
1,500,000 pF	155	J	K	M	•	•	•	•	•			•	•	•	•	•		
1,800,000 pF	185	J	K	M	•	•	•					•	•	•	•	•		
2,200,000 pF	225	J	K	M	•	•	•					•	•	•	•	•		
2,700,000 pF	275	J	K	M														
3,300,000 pF	335	J	K	M								•	•	•				
Capacitance	Cap Code	Rated Voltage			4	6.3	10	16	25	50	100	4	6.3	10	16	25	50	100
		Voltage Code			7	9	8	4	3	5	1	7	9	8	4	3	5	1
		Case Size			1206							1210						

[1] *Only available with flexible termination.*

Table 1C – Capacitance Range/Selection Waterfall (1812 – 2220 Case Sizes)

Capacitance	Cap Code	Case Size			1812							2220					
		Voltage Code (MIL)			V	W	X	Y	Z	A	B	V	W	X	Y	Z	A
		Voltage Code (KEMET)			7	9	8	4	3	5	1	7	9	8	4	3	5
		Rated Voltage (VDC)			4	6.3	10	16	25	50	100	4	6.3	10	16	25	50
		Capacitance Tolerance			Product Availability												
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	M	•[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	K	M	•[1]	•[1]	•[1]	•[1]	•[1]	•[1]		•	•	•	•	•	•[1]
1,500,000 pF	155	J	K	M	•[1]	•[1]	•[1]	•[1]	•[1]	•[1]		•	•	•	•	•	•[1]
1,800,000 pF	185	J	K	M	•[1]	•[1]	•[1]	•[1]	•[1]	•[1]		•	•	•	•	•	
2,200,000 pF	225	J	K	M	•[1]	•[1]	•[1]	•[1]	•[1]			•	•	•	•	•	
2,700,000 pF	275	J	K	M	•[1]	•[1]	•[1]	•[1]	•[1]			•	•	•	•	•	
3,300,000 pF	335	J	K	M	•[1]	•[1]	•[1]	•[1]	•[1]			•	•	•	•	•	
3,900,000 pF	395	J	K	M	•[1]	•[1]	•[1]	•[1]	•[1]			•	•	•	•		
4,700,000 pF	475	J	K	M	•[1]	•[1]	•[1]					•	•	•	•		
5,600,000 pF	565	J	K	M								•	•				
6,800,000 pF	685	J	K	M								•	•				
8,200,000 pF	825	J	K	M								•	•				
10,000,000 pF	106	J	K	M								•	•				
Capacitance	Cap Code	Rated Voltage			4	6.3	10	16	25	50	100	4	6.3	10	16	25	50
		Voltage Code			7	9	8	4	3	5	1	7	9	8	4	3	5
		Case Size			1812							2220					

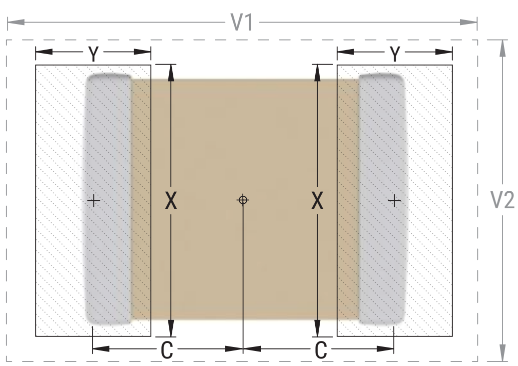
[1] *Only available with flexible termination.*

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)					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
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.



Grid Placement Courtyard

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
	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.

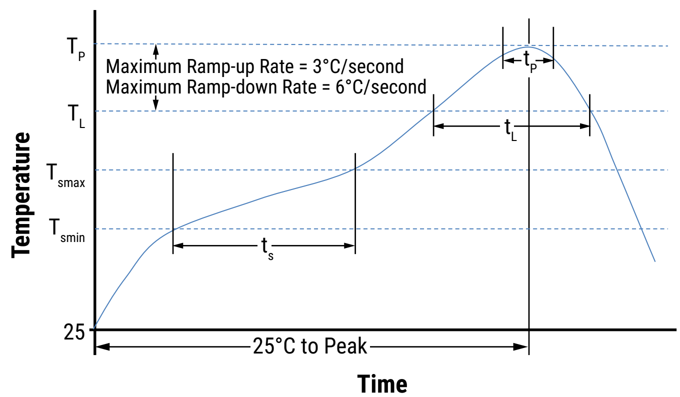


Table 3 – Performance & Reliability: Test Methods and Conditions

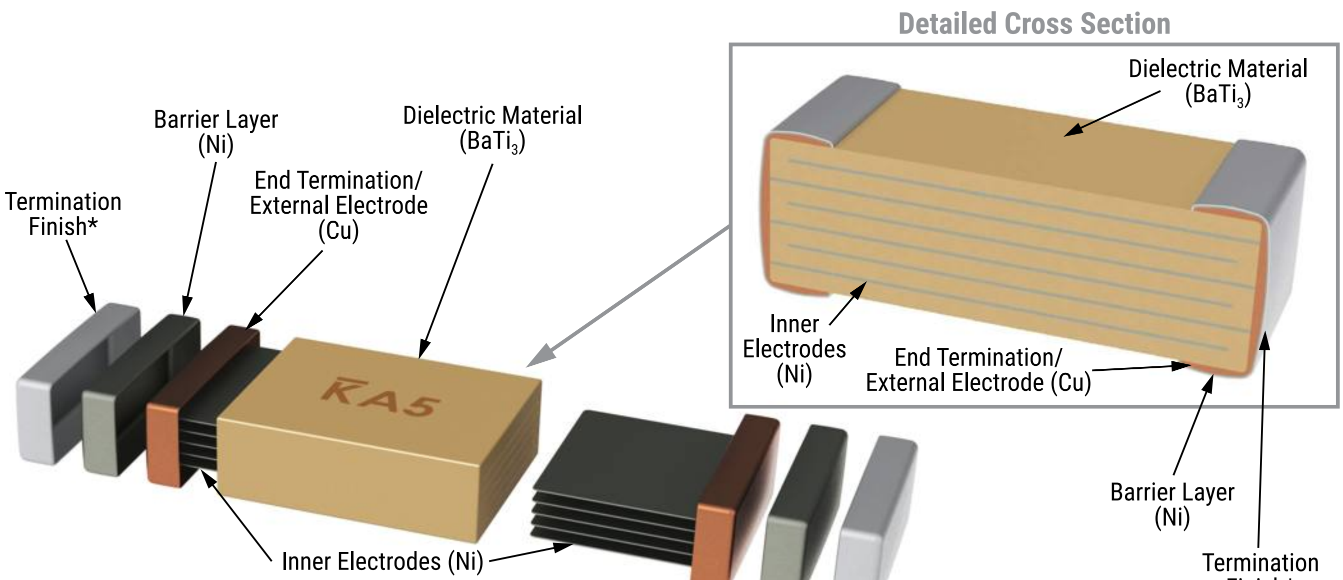
Inspection	Test Method	MIL-PRF-32535 M-Level	MIL-PRF-32535 T-Level
In-Process Inspection			
Nondestructive internal examination (pre-termination)	MIL-PRF-32535 Method 4.6.1	Not required	Yes (100%)
Visual examination (post-termination)	MIL-PRF-32535 Method 4.6.2	Not required	Yes (100%)
Group A Inspection			
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 Inspection			
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 Inspection			
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

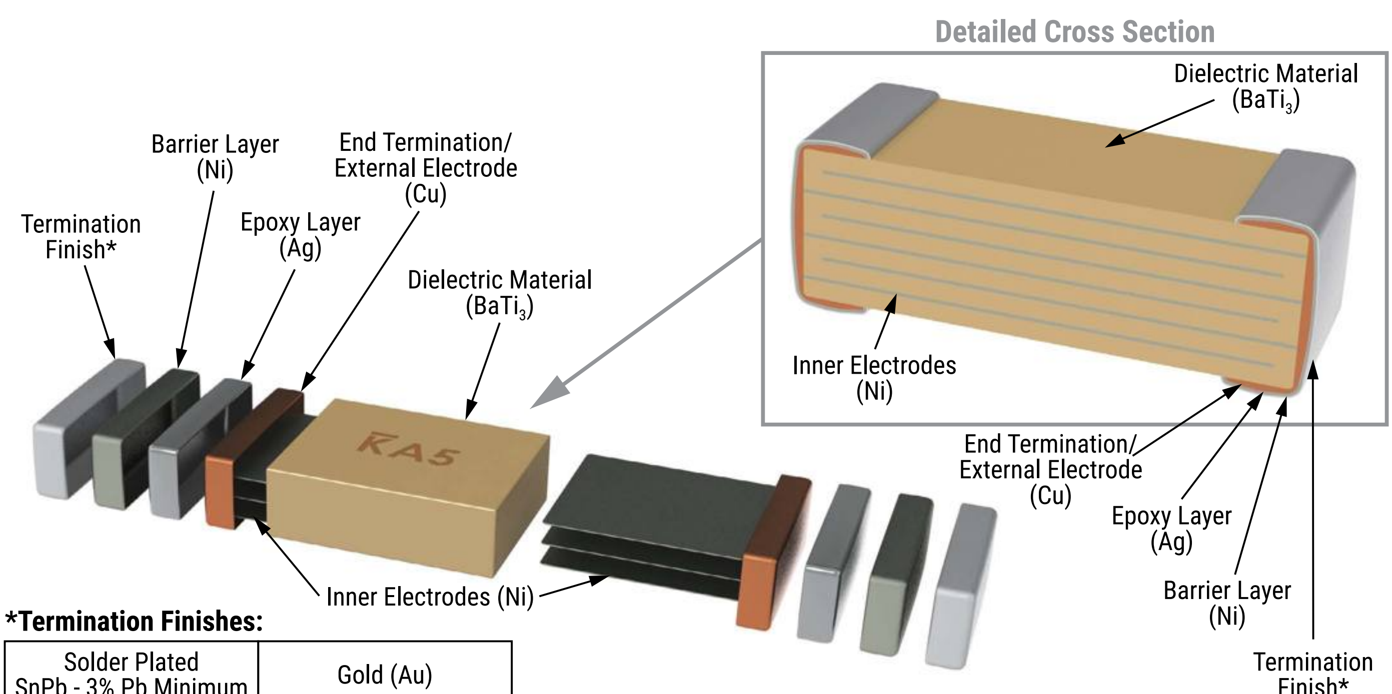
Standard Termination



***Termination Finishes:**

Solder Dipped SnPb - 3% Pb Minimum	Solder Plated SnPb - 3% Pb Minimum	Gold (Au)

Flexible Termination



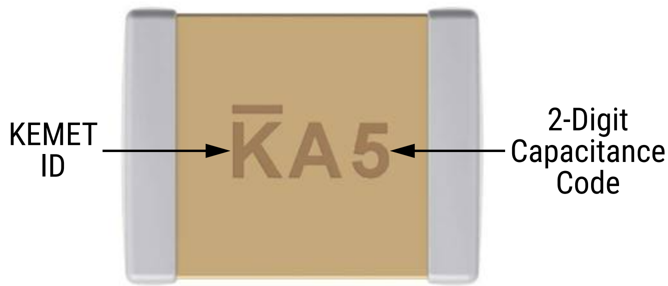
***Termination Finishes:**

Solder Plated SnPb - 3% Pb Minimum	Gold (Au)

Capacitor Marking:

KEMET MIL-PRF-32535 ceramic capacitors will be marked in accordance with the military specification on case sizes ≥ 0805. Case sizes below 0805 will not be marked. Two sides of the ceramic body will be laser marked with a “K̄” to identify KEMET, followed by two characters to identify the capacitance value.

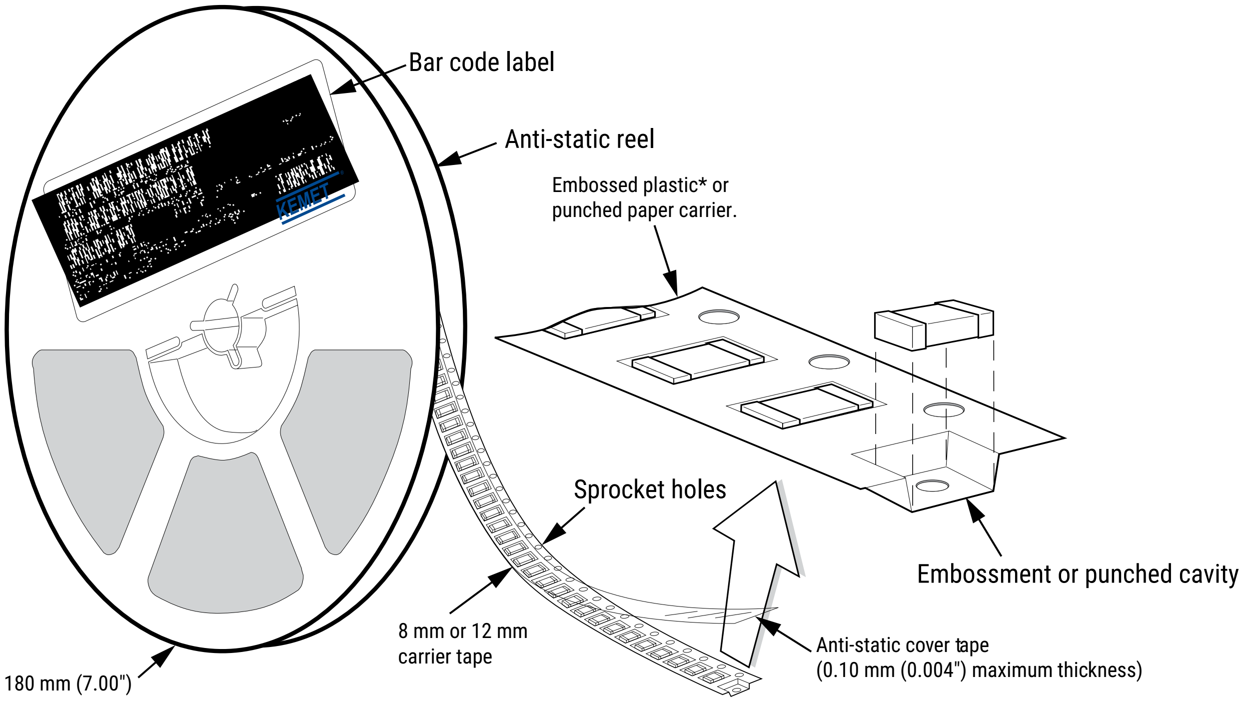
The marking appears in legible contrast. Illustrated below is an example of an MLCC with laser the marking of “K̄A5”, which designates a KEMET device with the rated capacitance of 100 nF.



Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.1	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 0402 and 0603 case sizes available on punched paper carrier only.

Table 4 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

EIA Case Size	Tape size (W)*	Embossed Plastic	Punched Paper
		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

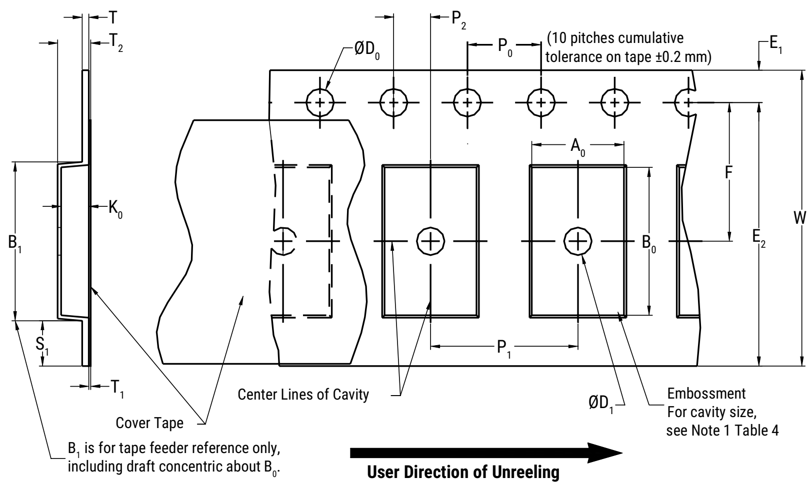


Table 5 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)									
Tape Size	D_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)	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_0, B_0 and K_0 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

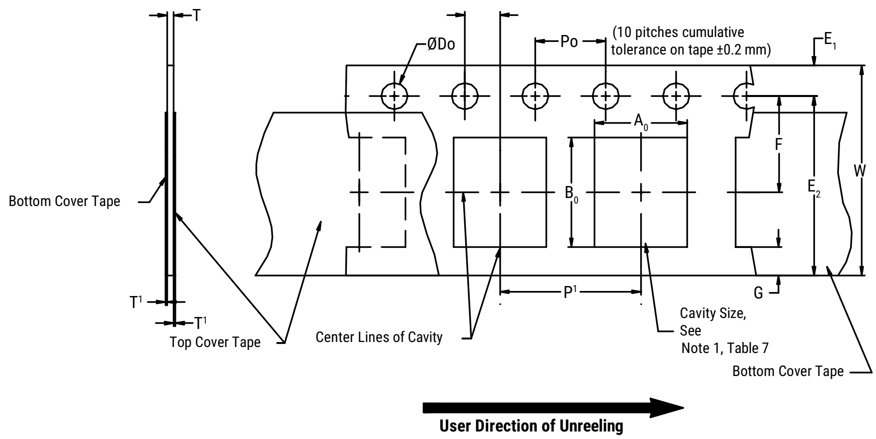


Table 6 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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

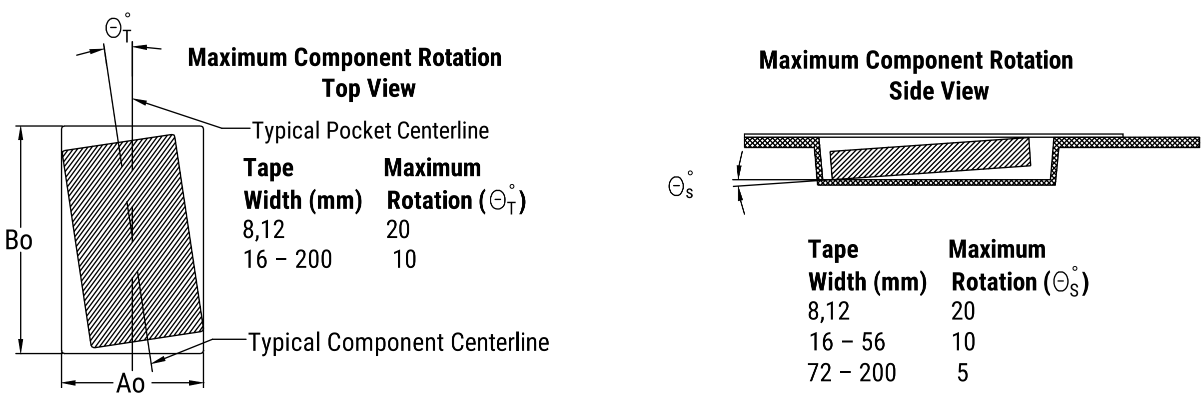


Figure 4 – Maximum Lateral Movement

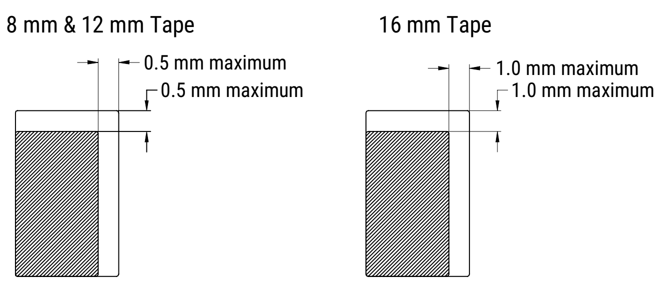


Figure 5 – Bending Radius

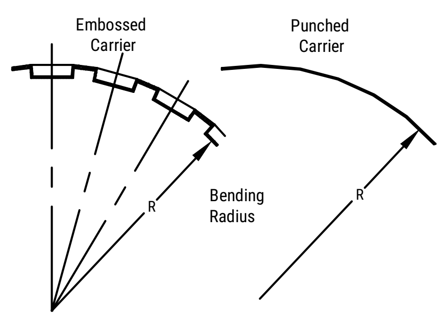
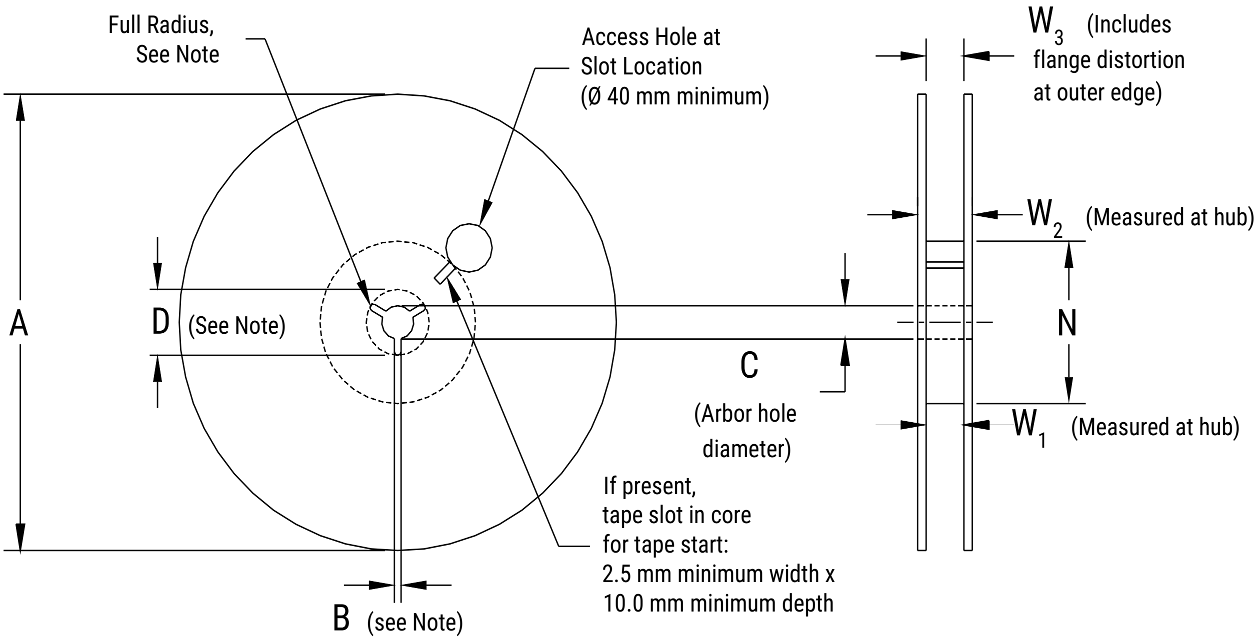


Figure 6 – Reel Dimensions



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

Table 7 – Reel Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)				
Tape Size	A	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				
Variable Dimensions — Millimeters (Inches)				
Tape Size	N Minimum See Note 2, Tables 2–3	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 accomadate tape width without interference
12 mm		12.4 + 2.0/−0.0 (0.488 + 0.078/−0.0)	18.4 (0.724)	

Figure 7 – Tape Leader & Trailer Dimensions

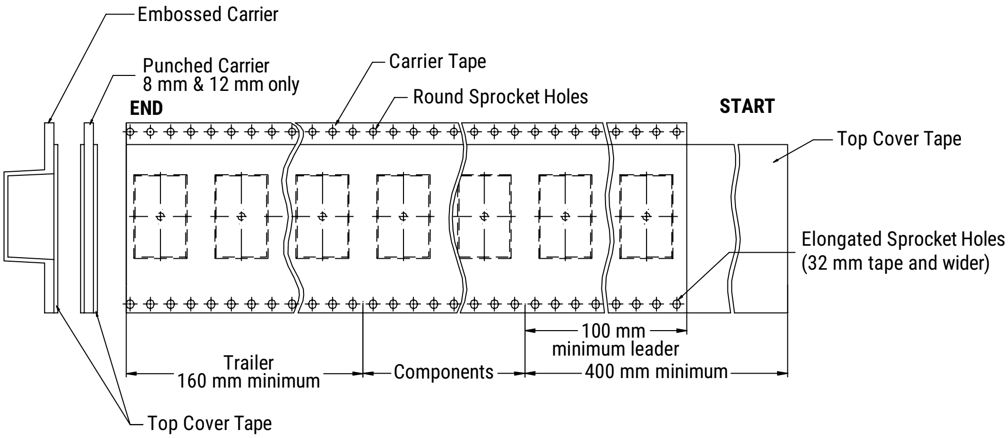
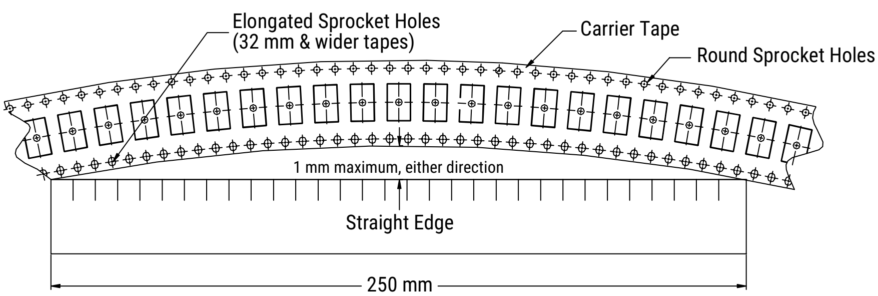


Figure 8 – Maximum Camber



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

Figure 9 – Waffle Tray Dimensions – Inches (Millimeters)

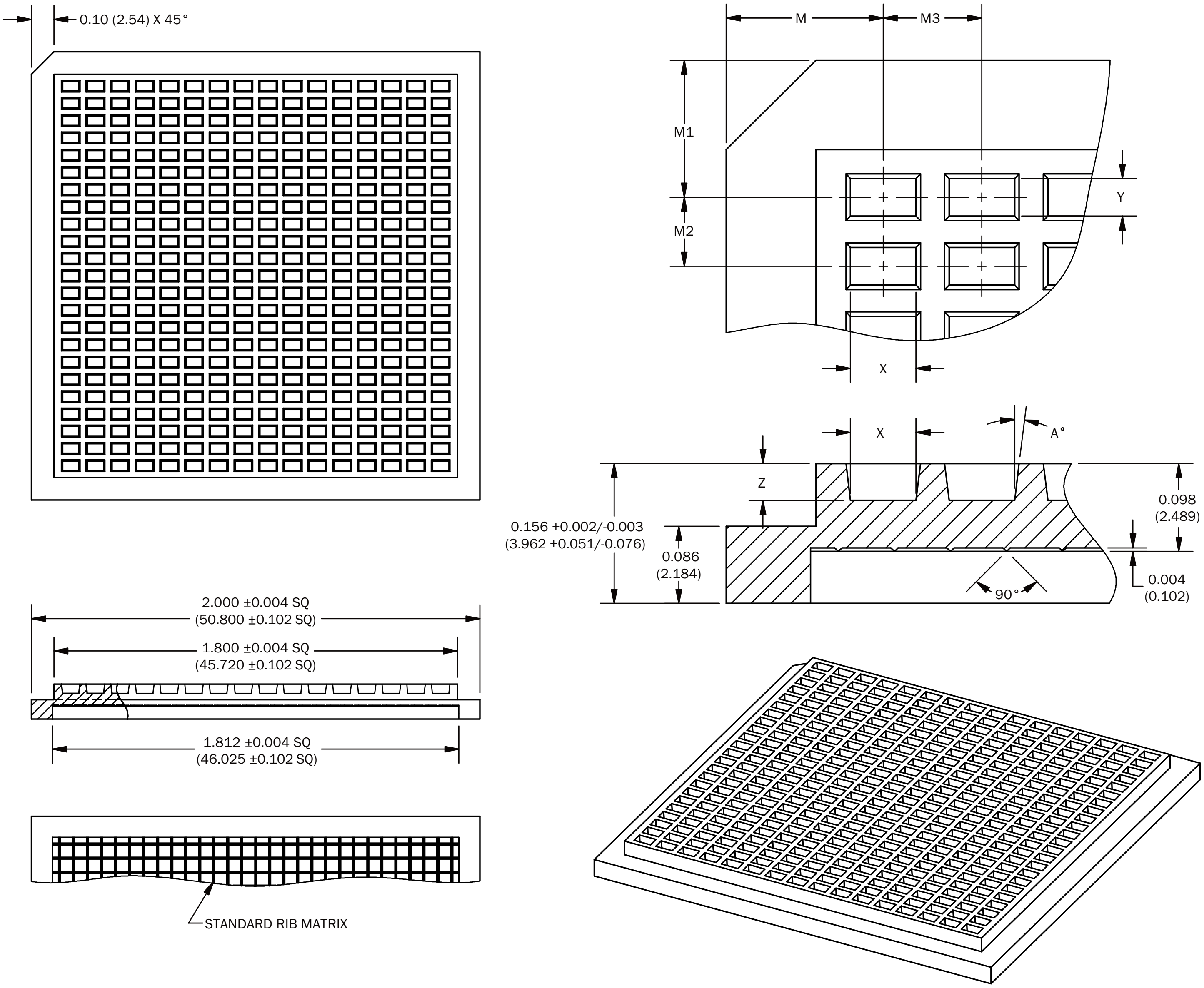


Table 8A – Waffle Tray Dimensions – Inches

Case Size		2" x 2" Waffle Tray Dimensions – Inches									Packaging Quantity (pcs/unit packaging)
		M	M1	M2	M3	X	Y	Z	A°	MATRIX	
EIA (in)	Metric (mm)	±0.003	±0.003	±0.002	±0.002	±0.002	±0.002	±0.003	±1/2°	(X x Y)	
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 ≤ 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									Packaging Quantity (pcs/unit packaging)
		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)	
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 ≤ 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)

KONNEKT™ High Density Packaging

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

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

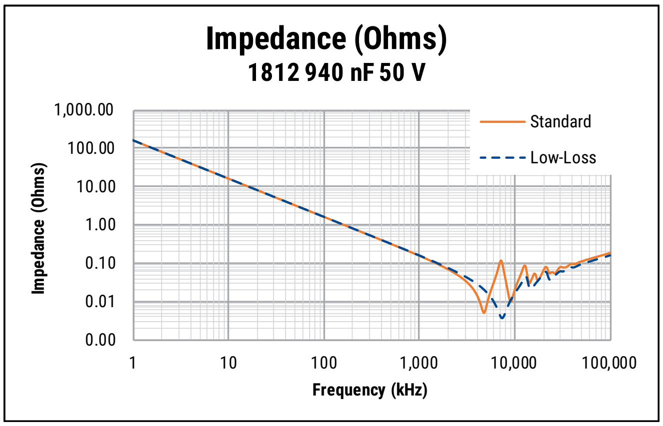
Standard

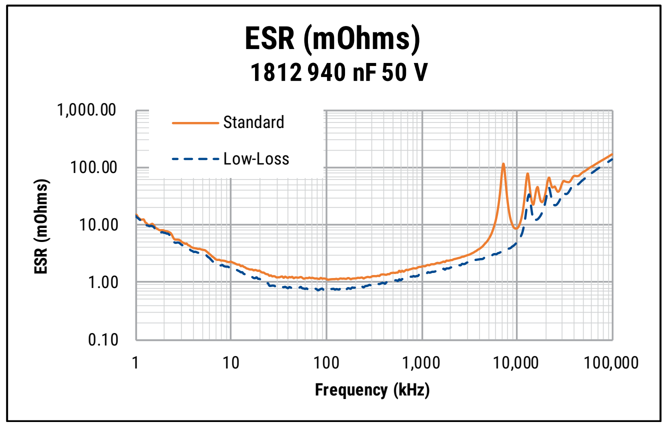
Low Loss

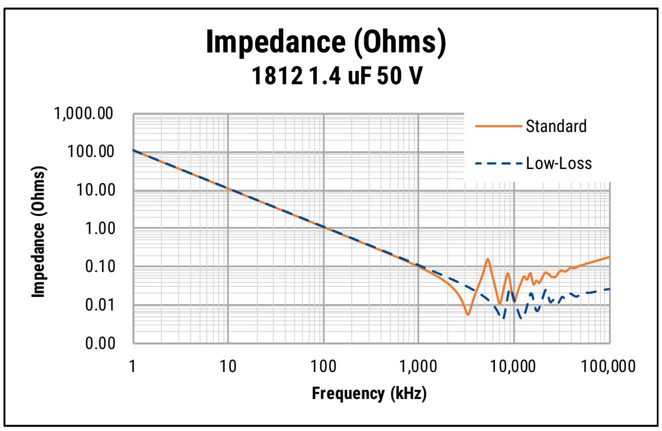
Typical Performance

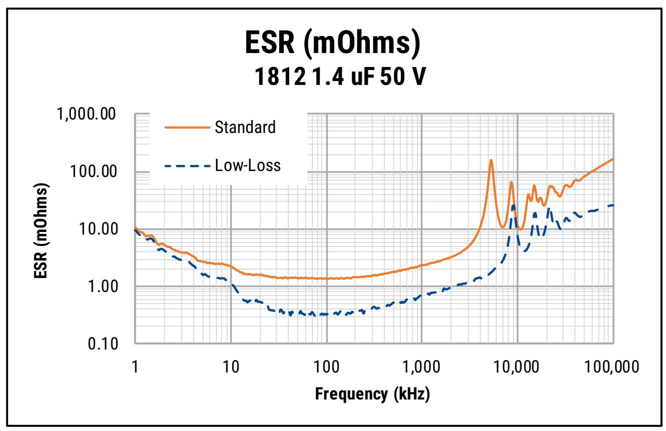
				Typical Ripple Current (A_{rms})[1]		
Part Type	**Mounting Configuration**	**Typical ESR at 25°C, 100 kHz**	**Typical ESL at 25°C**	**100 kHz**	**200 kHz**	**300 kHz**
1812 940 nF	Standard	1.15 mΩ	1.1 nH	12.0	12.0	11.5
	Low Loss	0.77 mΩ	0.45 nH	18.0	18.0	16.0
1812 1.4 uF	Standard	1.3 mΩ	1.6 nH	11.0	10.0	10.0
	Low Loss	0.35 mΩ	0.4 nH	20.0	34.0	31.0

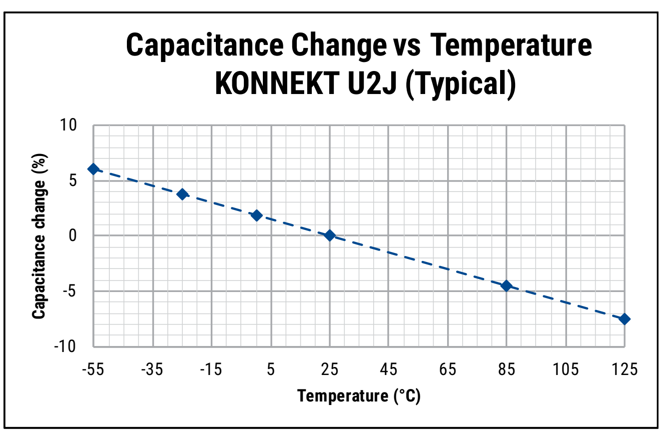
[1] *Ripple current measurements performed at 85°C with a peak capacitor temperature of 95°C. Samples mounted to heat sink with no forced air cooling. Maximum ambient and self heating cannot exceed 125°C.*

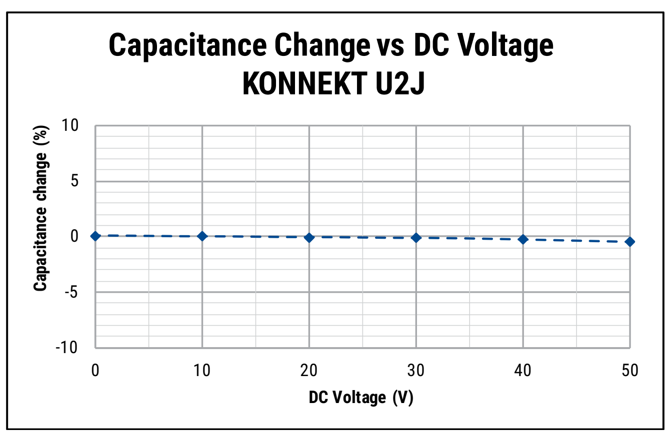




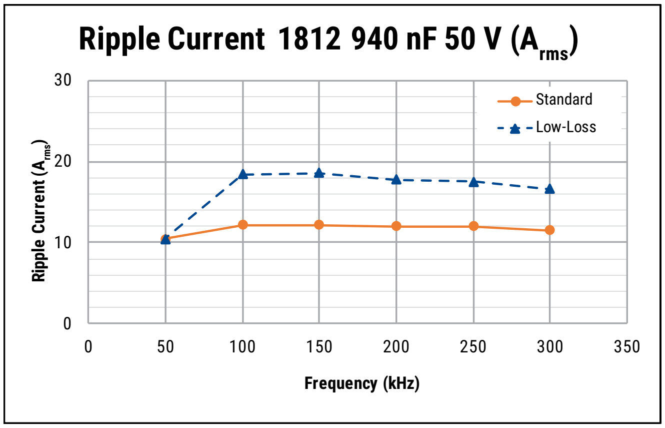


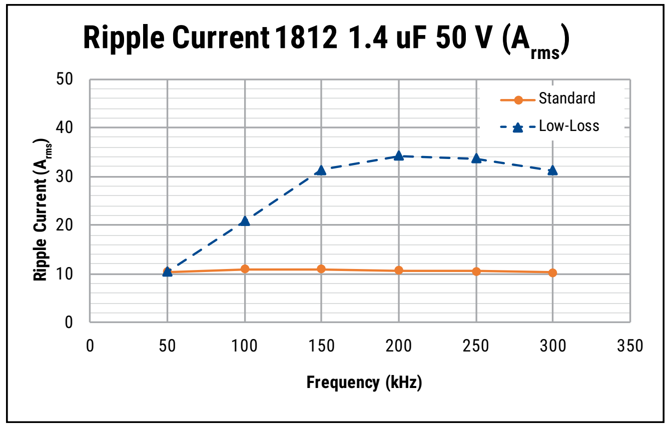






Typical Performance cont.





Ordering Information

C	1812	C	145	J	5	J	L	C	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

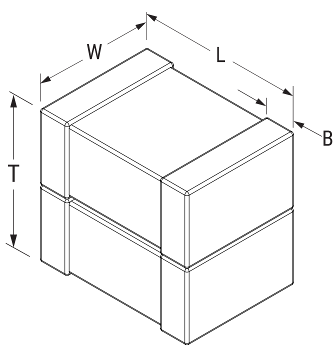
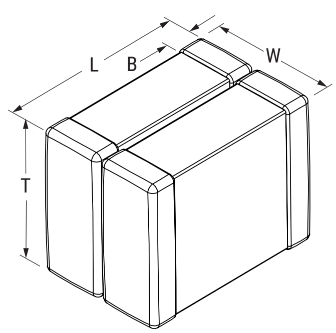
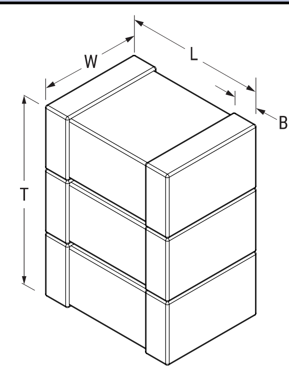
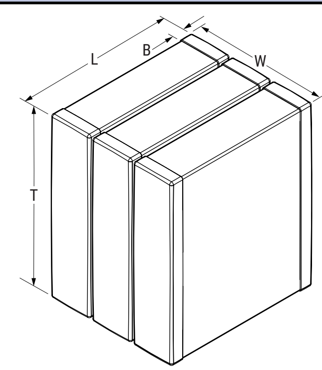
KEMET Part Number[1]	Capacitance	Cap Code	Voltage	Number of Chips	Orientation	Thickness mm (inch)	Typical Average Piece Weight (g)	Tape & Reel Quantity	
								7" Tape & Reel	13" Tape & Reel
C1812C944(a)5JLC(b)	940 nF	944	50 V	2	Standard	3.5 (0.137) ±0.40 (0.016)	0.22	500	2,000
					Low Loss	3.20 (0.126) ±0.30 (0.012)		500	2,200
C1812C145(a)5JLC(b)	1.4 µF	145	50 V	3	Standard	5.3 (0.208) ±0.60 (0.024)	0.33	200	900
					Low Loss	3.20 (0.126) ±0.30 (0.012)		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

Mounting Orientation		Packaging Type	Packaging/Grade Ordering Code (C-Spec)
Standard		7" Reel/Unmarked	TU
		13" Reel/Unmarked	7210
Low Loss		7" Reel/Unmarked	7805
		13" Reel/Unmarked	7810

Dimensions – Millimeters (Inches)

Standard Mounting 2 Chips	Low Loss Mounting 2 Chips	Standard Mounting 3 Chips	Low Loss Mounting 3 Chips
			

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)	0.6 (0.024) ±0.35 (0.014)	Solder Reflow Only
	Low Loss				3.5 (0.137) ±0.4 (0.016)	3.2 (0.126) ±0.3 (0.012)		
3	Standard				3.2 (0.126) ±0.3 (0.012)	5.3 (0.208) ±0.6 (0.024)		
	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

<table>
<tr><th>Test</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Visual and Mechanical</td><td>KEMET Internal</td><td>No defects that may affect performance (10X)</td><td>Dimensions according KEMET Spec Sheet</td></tr>
<tr><td>Capacitance (Cap)</td><td>KEMET Internal</td><td>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</td><td>Within Tolerance</td></tr>
<tr><td>Dissipation Factor (DF)</td><td>KEMET Internal</td><td>1 kHz ±50 Hz and 1.0 ±0.2 V_{rms}</td><td>Dissipation factor (DF) maximum limit at 25°C = 0.1%</td></tr>
<tr><td>Insulation Resistance (IR)</td><td>KEMET Internal</td><td>Apply rated voltage for 120 seconds at 25°C</td><td>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</td></tr>
<tr><td>Temperature Coefficient of Capacitance (TCC)</td><td>KEMET Internal</td><td>Frequency: 1 kHz ±50 Hz
Capacitance Change with Reference to +25°C and 0 VDC Applied

* See part number specification sheet for voltage
<table>
<tr><th>Step</th><th>Temperature (°C)</th></tr>
<tr><td>1</td><td>+25°C</td></tr>
<tr><td>2</td><td>-55°C</td></tr>
<tr><td>3</td><td>+25°C (Reference Temperature)</td></tr>
<tr><td>4</td><td>+125°C</td></tr>
</table></td><td>−750 ±120 ppm/°C</td></tr>
<tr><td>Dielectric Withstanding Voltage (DWV)</td><td>KEMET Internal</td><td>250% of rated voltage
(5 ±1 seconds and charge/discharge not exceeding 50 mA)</td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit

Withstand test voltage without insulation breakdown or damage.</td></tr>
<tr><td>Aging Rate (Maximum % Capacitance Loss/Decade Hour)</td><td>KEMET Internal</td><td>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.</td><td>0.1% Loss/Decade Hour</td></tr>
<tr><td>Terminal Strength</td><td>KEMET Internal</td><td>Shear stress test per specific case size,
Time: 60±1 seconds
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<tr><th>Case Size</th><th>Force</th></tr>
<tr><td>1812</td><td>18N</td></tr>
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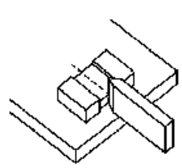
</td><td>No evidence of mechanical damage</td></tr>
</table>

Table 2 - Performance and Reliability: Test Methods and Conditions cont.

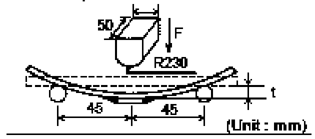
Test	Reference	Test Condition	Limits
Board Flex	AEC-Q200-005	Standard Termination system 2.0 mm Test time: 60± 5 seconds Ramp time: 1 mm/second 	No evidence of mechanical damage
Solderability	KEMET Custom Test	1. Board shear – SAC305 solder. Shear force of 1.8 kg (minimum) 2. Wetting balance – IEC 60068–2–69	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 Method 108	1,000 hours at 125°C with 1.0 X rated voltage applied.	Within Post Environmental Limits Cap: ±0.3% or ±0.25pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5%
Storage Life		1,000 hours at 125°C, Unpowered	
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.

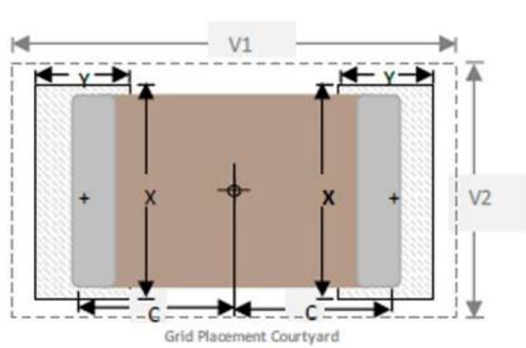
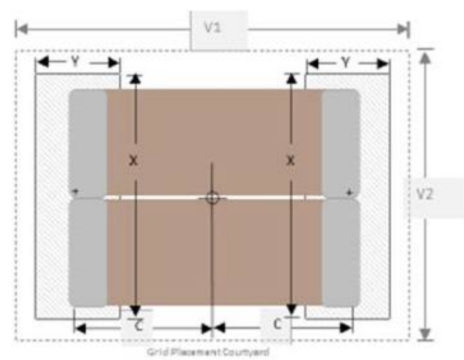
Environmental Compliance

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

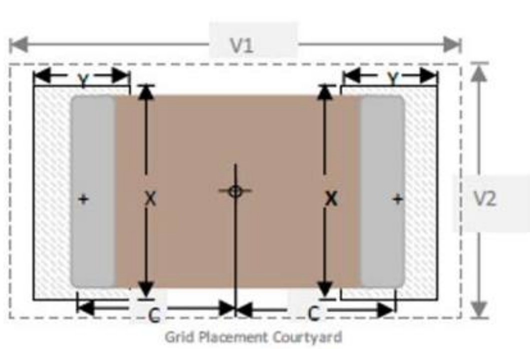
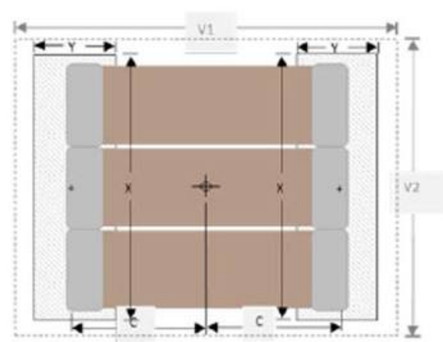
Table 3 – KONNEKT Land Pattern Design Recommendations per IPC-7351 (mm)

Chip Number	Orientation	EIA SIZE CODE	METRIC SIZE CODE	Median (Nominal) Land Protrusion				
				C	Y	X	V1	V2
2	Standard and Low Loss	1812	4532	2.05	1.40	3.50	6.00	4.00
3	Standard			2.05	1.40	3.50	6.00	4.00
	Low loss			2.05	1.40	5.90	6.00	6.40

2 Chips

Standard	Low Loss
(Land Pattern Design Recommendations per IPC-7351, top view)	
	

3 Chips

Standard	Low Loss
(Land Pattern Design Recommendations per IPC-7351, top view)	
	

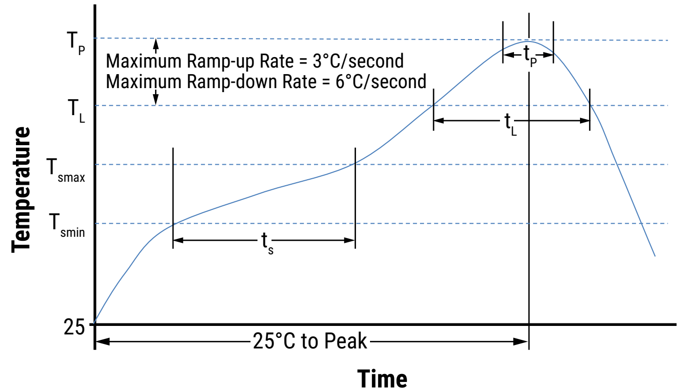
Soldering Process

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
	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

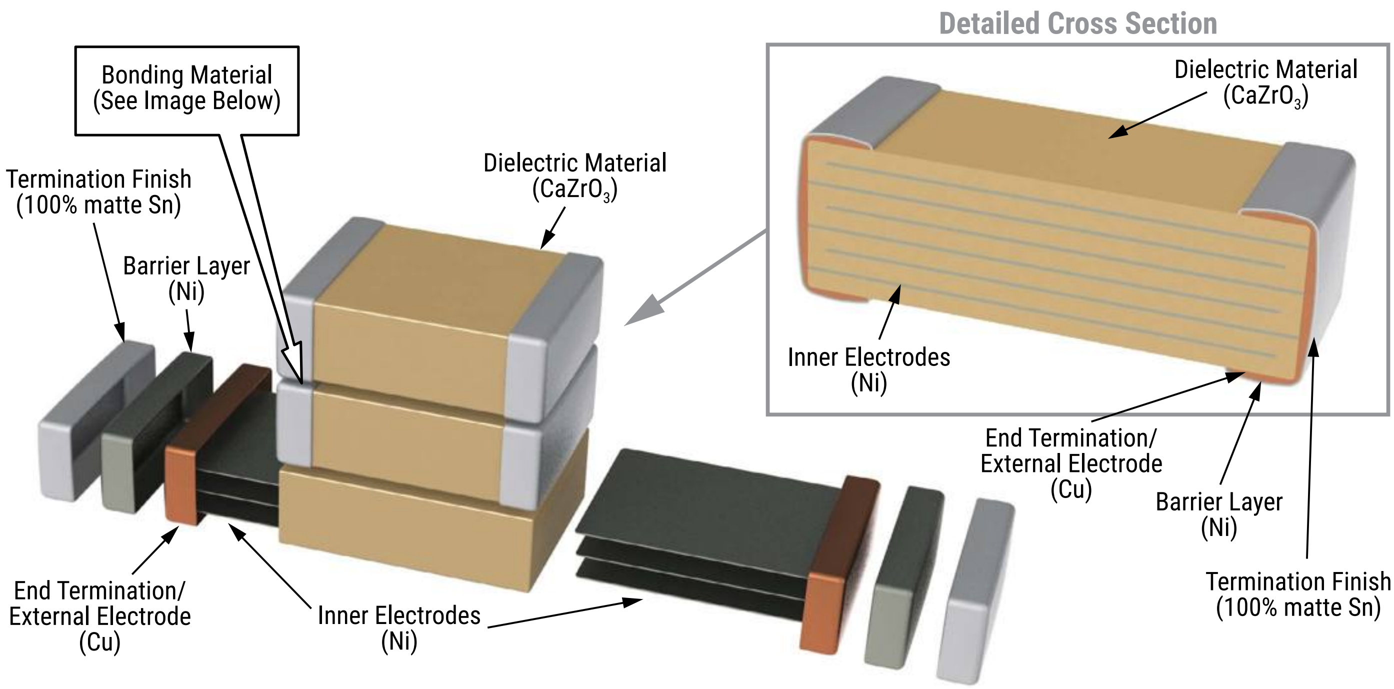
Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.



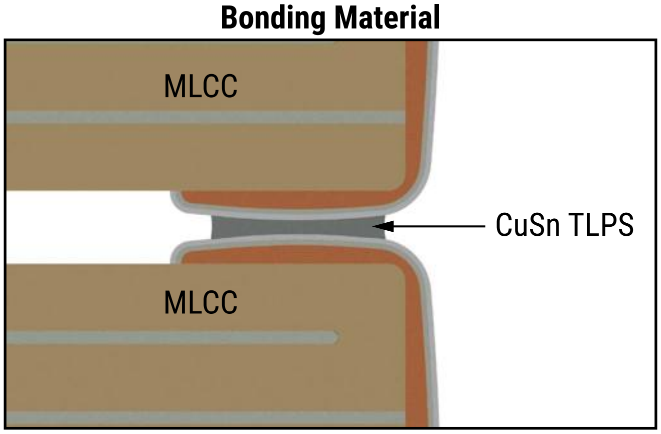
Storage & Handling

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



Bonding Material



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.

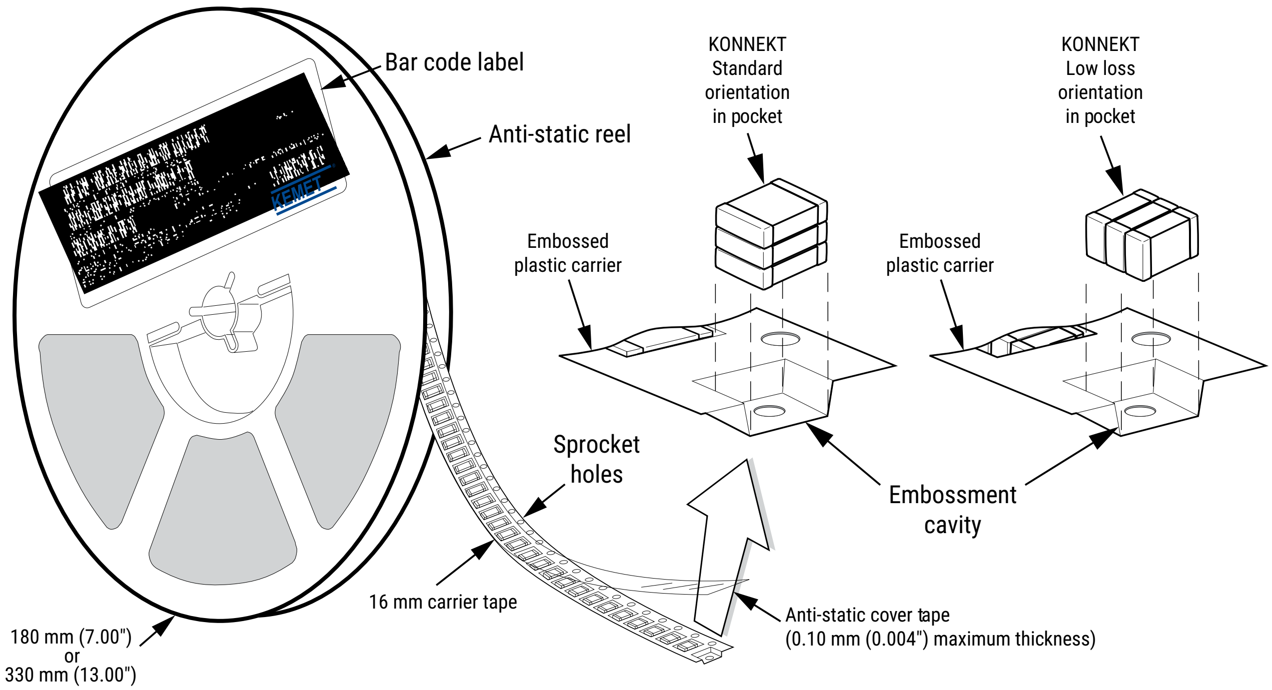


Table 4 – Carrier Tape Configuration, Embossed Plastic (mm)

EIA Case Size	Chip Number	Tape Size (W)*	Embossed Plastic	
			7" Reel	13" Reel
			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

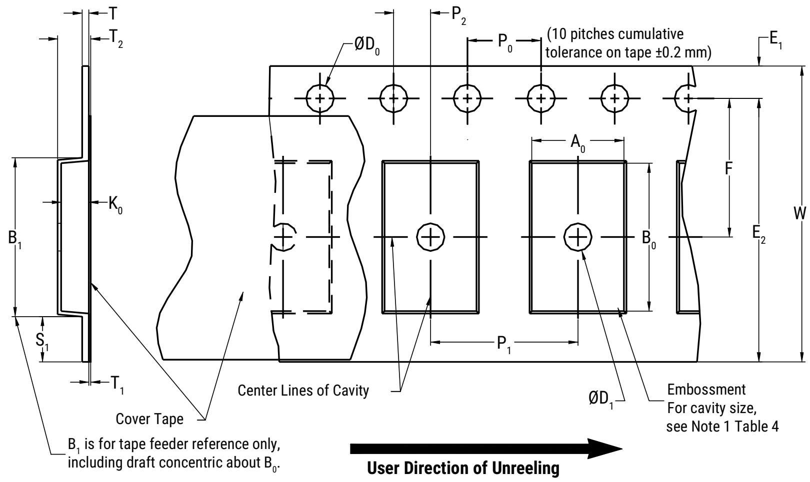


Table 5 – Embossed (Plastic) Carrier Tape Dimensions

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	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	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)	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_0, B_0 and K_0 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

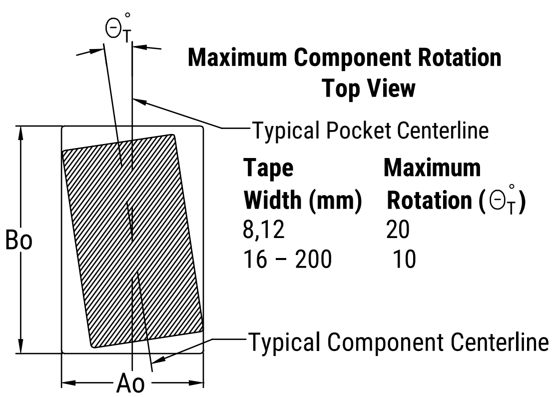
1. Cover Tape Break Force: 1.0 kg minimum.
2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

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



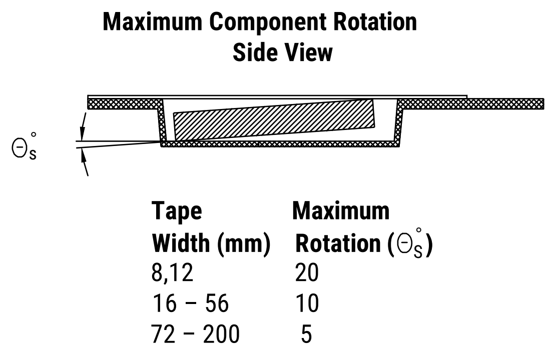


Figure 3 – Maximum Lateral Movement

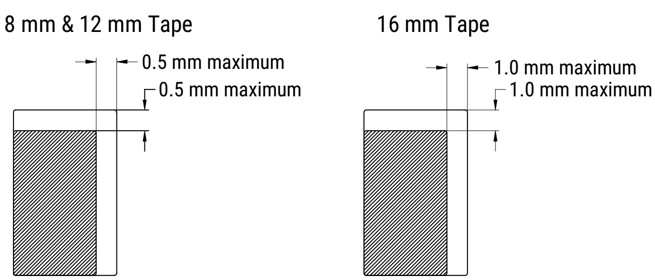


Figure 4 – Bending Radius

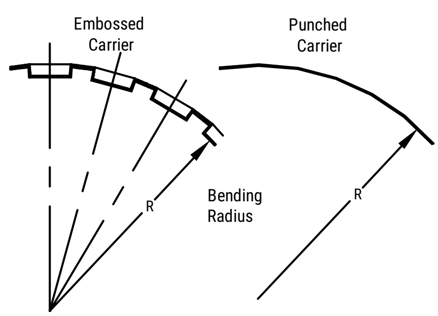
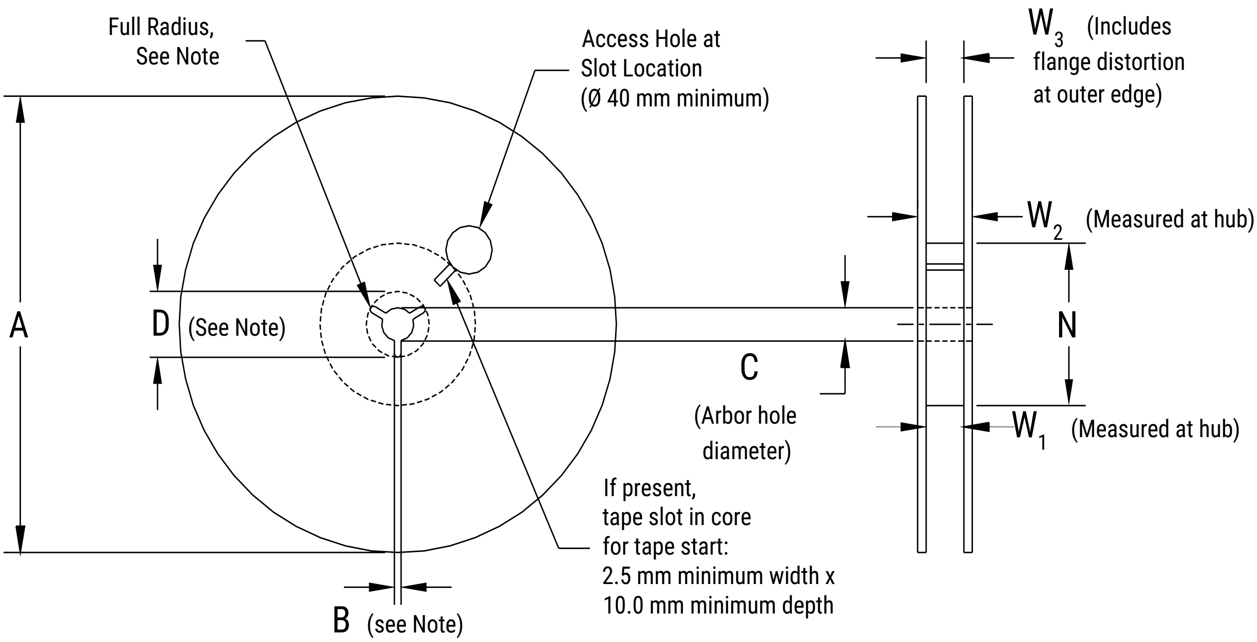


Figure 5 – Reel Dimensions



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	A	B Minimum	C	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

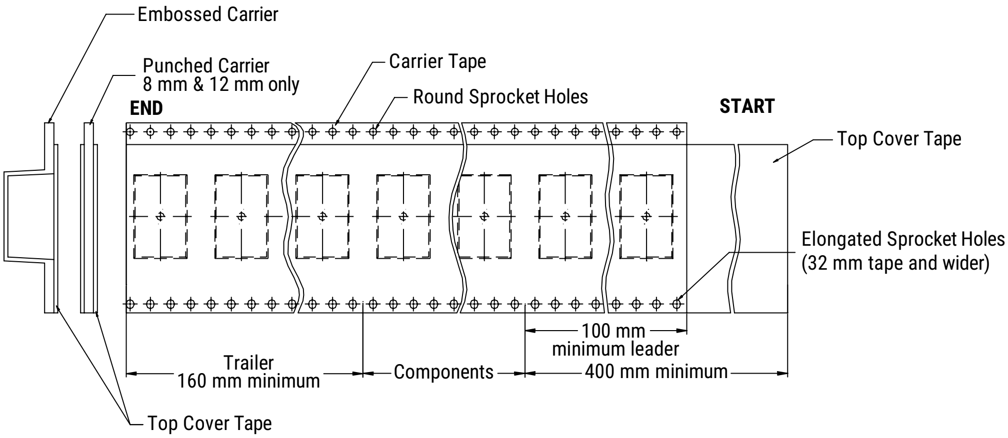
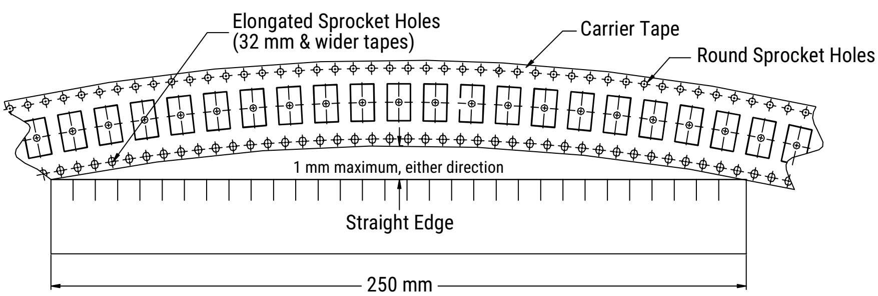


Figure 7 – Maximum Camber



M3 Medical Grade

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 µF. 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

C	0603	T	473	K	5	R	A	C	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)
C	0402 0603 0805 1206 1210	T	Two single digits and number of zeros. Use 9 for 1.0 - 9.9 pF Example: 2.2 pF = 229	B = ±0.1 pF C = ±0.25 pF D = ±0.5 pF F = ±1% G = ±2% J = ±5% K = ±10% M = ±20%	9 = 6.3 8 = 10 4 = 16 3 = 25 5 = 50 1 = 100 2 = 200	G = C0G 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

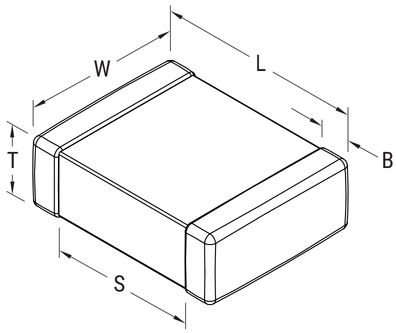
Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)
Standard Packaging (7" Tape & Reel)	Not required (blank)
Waffle Tray	7292

[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)	
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 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	
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	C0G: 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 ≤ 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 MΩ - µF value by the capacitance and compare to GΩ 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 – C0G Product Ordering Codes and Ratings

Cap	Cap Code	Case Size								0402					0603						0805						1206						1210					
		Voltage Code								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
		Rated Voltage (VDC)								10	16	25	50	100	10	16	25	50	100	200	10	16	25	50	100	200	10	16	25	50	100	200	10	16	25	50	100	200
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																												
0.5 pF	508	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
0.75 pF	758	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 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	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
1.2 pF	129	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
1.3 pF	139	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
1.5 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	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
1.8 pF	189	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
2 pF	209	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
2.2 pF	229	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
2.4 pF	249	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
2.7 pF	279	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 pF	309	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
3.3 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
3.6 pF	369	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
3.9 pF	399	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
4.3 pF	439	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
4.7 pF	479	B	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
5.1 pF	519	B	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	B	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
6.2 pF	629	B	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
6.8 pF	689	B	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
7.5 pF	759	B	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
8.2 pF	829	B	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
9.1 pF	919	B	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	100				F	G	J	K	M	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
11 pF	110				F	G	J	K	M	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
12 pF	120				F	G	J	K	M	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	K	M	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
15 pF	150				F	G	J	K	M	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	160				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
18 pF	180				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
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	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
24 pF	240				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
27 pF	270				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
30 pF	300				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
33 pF	330				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
36 pF	360				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
39 pF	390				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
43 pF	430				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
47 pF	470				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
51 pF	510				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
56 pF	560				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
62 pF	620				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
68 pF	680				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
75 pF	750				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
82 pF	820				F	G	J	K	M	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	K	M	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
100 pF	101				F	G	J	K	M	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	K	M	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	121				F	G	J	K	M	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
130 pF	131				F	G	J	K	M	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	K	M	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	K	M	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
Capacitance	Cap Code	Rated Voltage (VDC)								10	16	25	50	100	10	16	25	50	100	200	10	16	25	50	100	200	10	16	25	50	100	200	10	16	25	50	100	200
		Voltage Code								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
		Case Size								0402					0603						0805						1206						1210					

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Table 2A – C0G Product Ordering Codes and Ratings cont.

Cap	Cap Code	Case Size					0402					0603						0805						1206						1210					
		Voltage Code					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
		Rated Voltage (VDC)					10	16	25	50	100	10	16	25	50	100	200	10	16	25	50	100	200	10	16	25	50	100	200	10	16	25	50	100	200
		Capacitance Tolerance					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																														
180 pF	181	F	G	J	K	M	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
200 pF	201	F	G	J	K	M	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
220 pF	221	F	G	J	K	M	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
240 pF	241	F	G	J	K	M	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	
270 pF	271	F	G	J	K	M	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	
300 pF	301	F	G	J	K	M	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	
330 pF	331	F	G	J	K	M	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	
360 pF	361	F	G	J	K	M	BB	BB	BB	BB		CB	CB	CB	CB	CB		DC	DC	DC	DC	DC		EB	EB	EB	EB	EB		FB	FB	FB	FB	FB	
390 pF	391	F	G	J	K	M	BB	BB	BB	BB		CB	CB	CB	CB	CB		DC	DC	DC	DC	DC		EB	EB	EB	EB	EB		FB	FB	FB	FB	FB	
430 pF	431	F	G	J	K	M	BB	BB	BB	BB		CB	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	M	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	F	G	J	K	M	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	F	G	J	K	M	BB	BB	BB	BB		CB	CB	CB	CB	CB		DC	DC	DC	DC	DC		EB	EB	EB	EB	EB		FB	FB	FB	FB	FB	
620 pF	621	F	G	J	K	M	BB	BB	BB	BB		CB	CB	CB	CB	CB		DC	DC	DC	DC	DC		EB	EB	EB	EB	EB		FB	FB	FB	FB	FB	
680 pF	681	F	G	J	K	M	BB	BB	BB	BB		CB	CB	CB	CB	CB		DC	DC	DC	DC	DC		EB	EB	EB	EB	EB		FB	FB	FB	FB	FB	
750 pF	751	F	G	J	K	M	BB	BB	BB			CB	CB	CB	CB	CB		DC	DC	DC	DC	DC		EB	EB	EB	EB	EB		FB	FB	FB	FB	FB	
820 pF	821	F	G	J	K	M	BB	BB	BB			CB	CB	CB	CB	CB		DC	DC	DC	DC	DC		EB	EB	EB	EB	EB		FB	FB	FB	FB	FB	
910 pF	911	F	G	J	K	M	BB	BB	BB			CB	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	M	BB	BB	BB			CB	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	K	M						CB	CB	CB	CB	CB		DC	DC	DC	DC	DC		EB	EB	EB	EB	EB		FB	FB	FB	FB	FB	
1,200 pF	122	F	G	J	K	M						CB	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	M						CB	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	M						CB	CB	CB	CB	CB		DC	DC	DC	DC	DC		EC	EC	EC	EC	EC		FE	FE	FE	FE	FE	
1,600 pF	162	F	G	J	K	M						CB	CB	CB	CB	CB		DC	DC	DC	DC	DC		ED	ED	ED	ED	ED		FE	FE	FE	FE	FE	
1,800 pF	182	F	G	J	K	M						CB	CB	CB	CB	CB		DC	DC	DC	DC	DC		ED	ED	ED	ED	ED		FE	FE	FE	FE	FE	
2,000 pF	202	F	G	J	K	M						CB	CB	CB	CB	CB		DC	DC	DC	DC	DC		EB	EB	EB	EB	EB		FE	FE	FE	FE	FE	
2,200 pF	222	F	G	J	K	M						CB	CB	CB	CB	CB		DC	DC	DC	DC	DC		EB	EB	EB	EB	EB		FG	FG	FG	FG	FG	
2,400 pF	242	F	G	J	K	M						CB	CB	CB	CB			DC	DC	DC	DC	DC		EB	EB	EB	EB	EB		FC	FC	FC	FC	FC	
2,700 pF	272	F	G	J	K	M						CB	CB	CB	CB			DC	DC	DC	DC	DC		EB	EB	EB	EB	EB		FC	FC	FC	FC	FC	
3,000 pF	302	F	G	J	K	M						CB	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	M						CB	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	M						CB	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	M						CB	CB	CB	CB			DD	DD	DD	DD	DD		EB	EB	EB	EB	EB		FB	FB	FB	FB	FB	
4,300 pF	432	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	M						CB	CB	CB	CB			DD	DD	DD	DD	DD		EB	EB	EB	EB	EB		FB	FB	FB	FB	FB	
5,100 pF	512	F	G	J	K	M						CB	CB	CB				DD	DD	DD	DD	DD		EB	EB	EB	EB	EB		FB	FB	FB	FB	FB	
5,600 pF	562	F	G	J	K	M						CB	CB	CB				DD	DD	DD	DD	DD		EB	EB	EB	EB	EB		FB	FB	FB	FB	FB	
6,200 pF	622	F	G	J	K	M						CB	CB	CB				DG	DG	DG	DG	DG		EB	EB	EB	EB	EB		FB	FB	FB	FB	FB	
6,800 pF	682	F	G	J	K	M						CB	CB	CB				DG	DG	DG	DG	DG		EB	EB	EB	EB	EB		FB	FB	FB	FB	FB	
7,500 pF	752	F	G	J	K	M												DG	DG	DG	DG	DG		EB	EB	EB	EB	EB		FB	FB	FB	FB	FB	
8,200 pF	822	F	G	J	K	M												DG	DG	DG	DG	DG		EC	EC	EC	EC	EC		FB	FB	FB	FB	FB	
9,100 pF	912	F	G	J	K	M												DD	DD	DD	DD			EC	EC	EC	EC	EC		FB	FB	FB	FB	FB	
10,000 pF	103	F	G	J	K	M												DD	DD	DD	DD			EC	EC	EC	EC	EC		FB	FB	FB	FB	FB	
12,000 pF	123	F	G	J	K	M												DC	DC	DC				ED	ED	ED	ED	ED		FB	FB	FB	FB	FB	
15,000 pF	153	F	G	J	K	M												DD	DD	DD				EF	EF	EF	EF	EF		FC	FC	FC	FC	FC	
18,000 pF	183	F	G	J	K	M																		EH	EH	EH	EH	EH		FC	FC	FC	FC	FC	
22,000 pF	223	F	G	J	K	M																		EC	EC	EC	EC			FF	FF	FF	FF	FF	
27,000 pF	273	F	G	J	K	M																		EE	EE	EE	EE			FG	FG	FG	FG	FG	
33,000 pF	333	F	G	J	K	M																		EB	EB	EB				FH	FH	FH	FH	FH	
39,000 pF	393	F	G	J	K	M																								FE	FE	FE	FE		
47,000 pF	473	F	G	J	K	M																								FE	FE	FE	FE		
56,000 pF	563	F	G	J	K	M																								FB	FB	FB			
Capacitance	Cap Code	Rated Voltage (VDC)					10	16	25	50	100	10	16	25	50	100	200	10	16	25	50	100	200	10	16	25	50	100	200	10	16	25	50	100	200
		Voltage Code					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
		Case Size					0402					0603						0805						1206						1210					

Table 2B – X7R Product Ordering Codes and Ratings

Cap	Cap Code	Case Size								0402					0603						0805						1206							1210						
		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
		Rated Voltage (VDC)								6.3	10	16	25	50	6.3	10	16	25	50	100	6.3	10	16	25	50	100	6.3	10	16	25	50	100	200	6.3	10	16	25	50	100	200
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																														
0.5 pF	508	B	C	D						BB	BB	BB	BB	BB																										
0.75 pF	758	B	C	D						BB	BB	BB	BB	BB																										
1 pF	109	B	C	D						BB	BB	BB	BB	BB																										
1.1 pF	119	B	C	D						BB	BB	BB	BB	BB																										
1.2 pF	129	B	C	D						BB	BB	BB	BB	BB																										
1.3 pF	139	B	C	D						BB	BB	BB	BB	BB																										
1.5 pF	159	B	C	D						BB	BB	BB	BB	BB																										
1.6 pF	169	B	C	D						BB	BB	BB	BB	BB																										
1.8 pF	189	B	C	D						BB	BB	BB	BB	BB																										
2 pF	209	B	C	D						BB	BB	BB	BB	BB																										
2.2 pF	229	B	C	D						BB	BB	BB	BB	BB																										
2.4 pF	249	B	C	D						BB	BB	BB	BB	BB																										
2.7 pF	279	B	C	D						BB	BB	BB	BB	BB																										
3 pF	309	B	C	D						BB	BB	BB	BB	BB																										
3.3 pF	339	B	C	D						BB	BB	BB	BB	BB																										
3.6 pF	369	B	C	D						BB	BB	BB	BB	BB																										
3.9 pF	399	B	C	D						BB	BB	BB	BB	BB																										
4.3 pF	439	B	C	D						BB	BB	BB	BB	BB																										
4.7 pF	479	B	C	D						BB	BB	BB	BB	BB																										
5.1 pF	519	B	C	D						BB	BB	BB	BB	BB																										
5.6 pF	569	B	C	D						BB	BB	BB	BB	BB																										
6.2 pF	629	B	C	D						BB	BB	BB	BB	BB																										
6.8 pF	689	B	C	D						BB	BB	BB	BB	BB																										
7.5 pF	759	B	C	D						BB	BB	BB	BB	BB																										
8.2 pF	829	B	C	D						BB	BB	BB	BB	BB																										
9.1 pF	919	B	C	D						BB	BB	BB	BB	BB																										
10 pF	100				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
11 pF	110				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
12 pF	120				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
13 pF	130				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
15 pF	150				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
16 pF	160				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
18 pF	180				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
20 pF	200				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
22 pF	220				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
24 pF	240				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
27 pF	270				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
30 pF	300				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
33 pF	330				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
36 pF	360				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
39 pF	390				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
43 pF	430				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
47 pF	470				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
51 pF	510				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
56 pF	560				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
62 pF	620				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
68 pF	680				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
75 pF	750				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
82 pF	820				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
91 pF	910				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
100 pF	101				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	EB	EB	FB	FB	FB	FB	FB	FB	FB
120 pF	121				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	EB		FB	FB	FB	FB	FB	FB	FB
150 pF	151				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	EB		FB	FB	FB	FB	FB	FB	FB
180 pF	181				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	EB		FB	FB	FB	FB	FB	FB	FB
220 pF	221				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	EB		FB	FB	FB	FB	FB	FB	FB
270 pF	271				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	EB		FB	FB	FB	FB	FB	FB	
Capacitance	Cap Code	Rated Voltage (VDC)								6.3	10	16	25	50	6.3	10	16	25	50	100	6.3	10	16	25	50	100	6.3	10	16	25	50	100	200	6.3	10	16	25	50	100	200
		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								0402					0603						0805						1206							1210						

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Table 2B – X7R Product Ordering Codes and Ratings cont.

Cap	Cap Code	Case Size	0402					0603						0805						1206							1210						
		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
		Rated Voltage (VDC)	6.3	10	16	25	50	6.3	10	16	25	50	100	6.3	10	16	25	50	100	6.3	10	16	25	50	100	200	6.3	10	16	25	50	100	200
		Capacitance Tolerance	Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																														
330 pF	331	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	EB		FB	FB	FB	FB	FB	FB	
390 pF	391	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	EB		FB	FB	FB	FB	FB	FB	
470 pF	471	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	EB		FB	FB	FB	FB	FB	FB	
560 pF	561	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	EB		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	EB		FB	FB	FB	FB	FB	FB	
820 pF	821	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	EB		FB	FB	FB	FB	FB	FB	
1,000 pF	102	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	EB		FB	FB	FB	FB	FB	FB	
1,200 pF	122	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	EB		FB	FB	FB	FB	FB	FB	
1,500 pF	152	F G J K M	BB	BB	BB	BB		CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	EC	EC	EC	EC	EC	EC		FE	FE	FE	FE	FE	FE	
1,800 pF	182	F G J K M	BB	BB	BB	BB		CB	CB	CB	CB	CB	CB	DC	DC	DC	DC	DC	DC	ED	ED	ED	ED	ED	ED		FE	FE	FE	FE	FE	FE	
2,200 pF	222	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	EB		FG	FG	FG	FG	FG	FG	
2,700 pF	272	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	EB		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	EB		FF	FF	FF	FF	FF	FF	
3,900 pF	392	F G J K M	BB	BB	BB	BB		CB	CB	CB	CB	CB	CB	DD	DD	DD	DD	DD	DD	EB	EB	EB	EB	EB	EB		FB	FB	FB	FB	FB	FB	
4,700 pF	472	F G J K M	BB	BB	BB	BB		CB	CB	CB	CB	CB	CB	DD	DD	DD	DD	DD	DD	EB	EB	EB	EB	EB	EB		FB	FB	FB	FB	FB	FB	
5,600 pF	562	F G J K M	BB	BB	BB	BB		CB	CB	CB	CB	CB	CB	DD	DD	DD	DD	DD	DD	EB	EB	EB	EB	EB	EB		FB	FB	FB	FB	FB	FB	
6,800 pF	682	F G J K M	BB	BB	BB	BB		CB	CB	CB	CB	CB	CB	DG	DG	DG	DG	DG	DG	EB	EB	EB	EB	EB	EB		FB	FB	FB	FB	FB	FB	
8,200 pF	822	F G J K M	BB	BB	BB	BB		CB	CB	CB	CB	CB	CB	DD	DD	DD	DD	DD	DD	EC	EC	EC	EC	EC	EC		FB	FB	FB	FB	FB	FB	
10,000 pF	103		BB	BB	BB	BB		CB	CB	CB	CB	CB	CB	DD	DD	DD	DD	DD	DD	EC	EC	EC	EC	EC	EC		FB	FB	FB	FB	FB	FB	
12,000 pF	123		BB	BB	BB	BB		CB	CB	CB	CB	CB	CB	DG	DG	DG	DG	DG	DG	ED	ED	ED	ED	ED	ED		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	EF	EF	EF	EF	EF	EF		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	EH	EH		FC	FC	FC	FC	FC	FC	
22,000 pF	223		BB	BB	BB	BB		CB	CB	CB	CB	CB		DG	DG	DG	DG	DG	DG	EH	EH	EH	EH	EH	EH		FF	FF	FF	FF	FF	FF	
27,000 pF	273		BB	BB				CB	CB	CB	CB	CB		DG	DG	DG	DG	DG	DG	EB	EB	EB	EB	EB	EB		FG	FG	FG	FG	FG	FG	
33,000 pF	333		BB	BB				CB	CB	CB	CB	CB		DG	DG	DG	DG	DG	DG	EB	EB	EB	EB	EB	EB		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	EB		FE	FE	FE	FE	FE	FE	
47,000 pF	473		BB	BB				CB	CB	CB	CB	CB		DG	DG	DG	DG	DG	DG	EB	EB	EB	EB	EB	EB		FE	FE	FE	FE	FE	FE	
56,000 pF	563							CB	CB	CB	CB			DG	DG	DG	DG	DG	DG	EC	EC	EC	EC	EC	EC		FE	FE	FE	FE	FE	FE	
68,000 pF	683							CB	CB	CB	CB			DD	DD	DD	DD	DD		EC	EC	EC	EC	EC	EC		FE	FE	FE	FE	FE	FE	
82,000 pF	823							CB	CB	CB	CB			DD	DD	DD	DD	DD		ED	ED	ED	ED	ED	ED		FE	FE	FE	FE	FE	FE	
0.1 uF	104							CB	CB	CB	CB			DG	DG	DG	DG	DG		ED	ED	ED	ED	ED	ED		FE	FE	FE	FE	FE	FE	
0.12 uF	124							CB	CB	CB	CB			DG	DG	DG	DG	DG		EM	EM	EM	EM	EM	EM		FE	FE	FE	FE	FE	FE	
0.15 uF	154							CB	CB	CB	CB			DG	DG	DG	DG	DG		EM	EM	EM	EM	EM	EM		FF	FF	FF	FF	FF	FF	
0.18 uF	184							CB	CB					DD	DD	DD	DD			EC	EC	EC	EC	EC			FF	FF	FF	FF	FF	FF	
0.22 uF	224							CB	CB					DD	DD	DD	DD			ED	ED	ED	ED	ED			FC	FC	FC	FC	FC		
0.27 uF	274													DD	DD	DD	DD			EM	EM	EM	EM	EM			FC	FC	FC	FC	FC		
0.33 uF	334													DD	DD	DD	DD			EM	EM	EM	EM	EM			FE	FE	FE	FE	FE		
0.39 uF	394													DE	DE	DE	DE			EC	EC	EC	EC				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				FH	FH	FH	FH	FH		
0.68 uF	684													DG	DG					ED	ED	ED	ED				FH	FH	FH	FH	FH		
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				FG	FG	FG	FG			
1.5 uF	155																			EH	EH	EH	EH				FG	FG	FG	FG			
1.8 uF	185																			EF	EF						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					
Capacitance	Cap Code	Rated Voltage (VDC)	6.3	10	16	25	50	6.3	10	16	25	50	100	6.3	10	16	25	50	100	6.3	10	16	25	50	100	200	6.3	10	16	25	50	100	200
		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	0402					0603						0805						1206							1210						

Table 2C – X5R Product Ordering Codes and Ratings

Cap	Cap Code	Case Size					0402				0603						0805						1206						1210					
		Voltage 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
		Rated Voltage (VDC)					6.3	10	16	25	6.3	10	16	25	50	100	6.3	10	16	25	50	100	6.3	10	16	25	50	100	6.3	10	16	25	50	100
		Capacitance Tolerance					"Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions"																											
3,900 pF	392	F	G	J	K	M					CB	CB	CB	CB	CB	CB																		
4,700 pF	472	F	G	J	K	M					CB	CB	CB	CB	CB	CB																		
5,600 pF	562	F	G	J	K	M					CB	CB	CB	CB	CB	CB																		
6,800 pF	682	F	G	J	K	M					CB	CB	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	CB	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	BB	CB	CB	CB	CB	CB		DG	DG	DG	DG	DG	DG												
27,000 pF	273	F	G	J	K	M	BB	BB			CB	CB	CB	CB	CB		DG	DG	DG	DG	DG	DG	EB	EB	EB	EB	EB	EB						
33,000 pF	333	F	G	J	K	M	BB	BB			CB	CB	CB	CB	CB		DG	DG	DG	DG	DG	DG	EB	EB	EB	EB	EB	EB						
39,000 pF	393	F	G	J	K	M	BB	BB			CB	CB	CB	CB	CB		DG	DG	DG	DG	DG	DG	EB	EB	EB	EB	EB	EB						
47,000 pF	473	F	G	J	K	M	BB	BB			CB	CB	CB	CB	CB		DG	DG	DG	DG	DG	DG	EB	EB	EB	EB	EB	EB						
56,000 pF	563	F	G	J	K	M					CB	CB	CB	CB			DG	DG	DG	DG	DG	DG	EC	EC	EC	EC	EC	EC	FE	FE	FE	FE	FE	FE
68,000 pF	683	F	G	J	K	M					CB	CB	CB	CB			DD	DD	DD	DD	DD		EC	EC	EC	EC	EC	EC	FE	FE	FE	FE	FE	FE
82,000 pF	823	F	G	J	K	M					CB	CB	CB	CB			DD	DD	DD	DD	DD		ED	ED	ED	ED	ED	ED	FE	FE	FE	FE	FE	FE
0.1 µF	104	F	G	J	K	M					CB	CB	CB	CB			DG	DG	DG	DG	DG		ED	ED	ED	ED	ED	ED	FE	FE	FE	FE	FE	FE
0.12 µF	124	F	G	J	K	M					CB	CB	CB	CB			DG	DG	DG	DG	DG		EM	EM	EM	EM	EM	EM	FE	FE	FE	FE	FE	FE
0.15 µF	154	F	G	J	K	M					CB	CB	CB	CB			DG	DG	DG	DG	DG		EM	EM	EM	EM	EM	EM	FF	FF	FF	FF	FF	FF
0.18 µF	184	F	G	J	K	M					CB	CB					DD	DD	DD	DD			EC	EC	EC	EC	EC		FF	FF	FF	FF	FF	FF
0.22 µF	224	F	G	J	K	M					CB	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	K	M											DD	DD	DD	DD			EM	EM	EM	EM	EM		FE	FE	FE	FE	FE	
0.39 µF	394	F	G	J	K	M											DE	DE	DE	DE			EC	EC	EC	EC			FG	FG	FG	FG	FG	
0.47 µF	474	F	G	J	K	M											DE	DE	DE	DE			EC	EC	EC	EC			FG	FG	FG	FG	FG	
0.56 µF	564	F	G	J	K	M											DG	DG	DG	DG			EC	EC	EC	EC			FH	FH	FH	FH	FH	
0.68 µF	684	F	G	J	K	M											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	M											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	M																	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 µF	395	F	G	J	K	M																							FG	FG				
4.7 µF	475	F	G	J	K	M																							FG	FG				
5.6 µF	565	F	G	J	K	M																							FH	FH				
Capacitance	Cap Code	Rated Voltage (VDC)					6.3	10	16	25	6.3	10	16	25	50	100	6.3	10	16	25	50	100	6.3	10	16	25	50	100	6.3	10	16	25	50	100
		Voltage 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
		Case Size					0402				0603						0805						1206						1210					

Table 3 – Chip Thickness/Tape & Reel Packaging Quantities

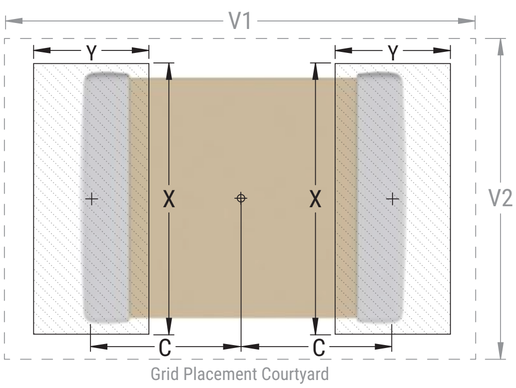
Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
BB	0402	0.50 ± 0.05	10,000	50,000	0	0
CB	0603	0.80 ± 0.07	4,000	10,000	0	0
DC	0805	0.78 ± 0.10	4,000	10,000	0	0
DD	0805	0.90 ± 0.10	4,000	10,000	0	0
DE	0805	1.00 ± 0.10	0	0	2,500	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 Code	**Case Size[1]**	**Thickness ± Range (mm)**	**7" Reel**	**13" Reel**	**7" Reel**	**13" Reel**
			Paper Quantity[1]		**Plastic Quantity**	

Table 4 – 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)				
		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	Termination Finish	
	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.

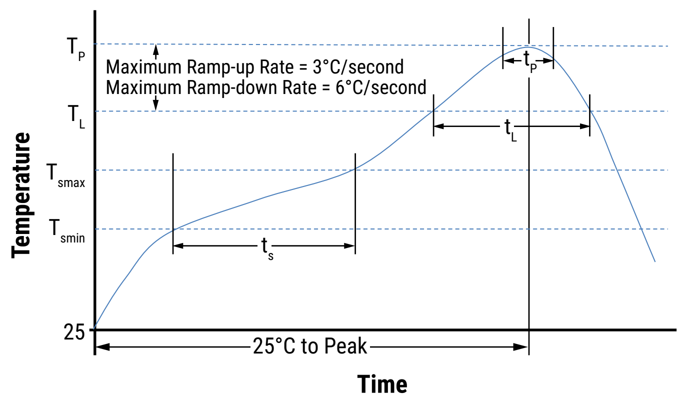


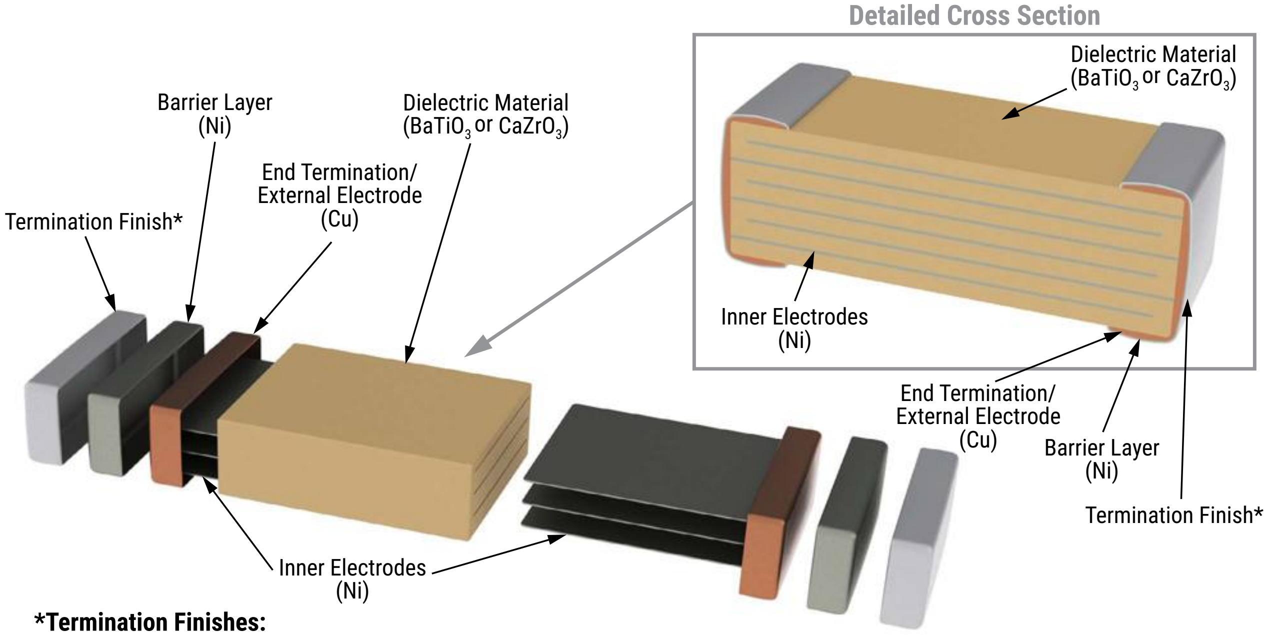
Table 5 – Performance & Reliability: Test Methods and Conditions

<table>
<tr><th>Stress</th><th>Reference</th><th colspan="2">Test or Inspection Method</th></tr>
<tr><td>Terminal Strength</td><td>AEC–Q200–006</td><td colspan="2"><table><tr><th>Case Size</th><th>Force</th><th>Duration</th></tr><tr><td>< 0805</td><td>5 N (0.51 kg)</td><td rowspan="2">60 seconds</td></tr><tr><td>≥ 0805</td><td>10 N (1.02 kg)</td></tr></table></td></tr>
<tr><td>Board Flex</td><td>AEC–Q200–005</td><td colspan="2">C0G – 3.0 mm (minimum)
X7R/X5R – 2.0 mm (minimum)</td></tr>
<tr><td>Resistance to Soldering Heat</td><td>MIL–STD–202
Method 210</td><td colspan="2">Test Condition J, 1 heat cycle</td></tr>
<tr><td rowspan="2">Solderability</td><td rowspan="2">J–STD–002</td><td colspan="2">Magnification 50X. Conditions:</td></tr>
<tr><td colspan="2">a) Method B, 4 hours at 155°C, dry heat at 235°C</td></tr>
<tr><td>Temperature Cycling</td><td>JESD22
Method JA–104</td><td colspan="2">1,000 cycles (-55°C to +125°C), measurement at 24 hours, ±4 hours after test conclusion</td></tr>
<tr><td>Biased Humidity</td><td>MIL–STD–202
Method 103</td><td colspan="2">Load Humidity: 1,000 hours 85°C/85% RH and 200 VDC maximum. Add 100 KΩ resistor.
Measurement at 24 hours, ±4 hours after test conclusion</td></tr>
<tr><td>High Temperature Life</td><td>MIL-STD-202
Method 108/EIA -198</td><td colspan="2">C0G/X7R: 1,000 hours at 125°C with 2.0 X rated voltage applied
X5R: 1,000 hours at 85°C with 2.0 X rated voltage applied</td></tr>
</table>

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

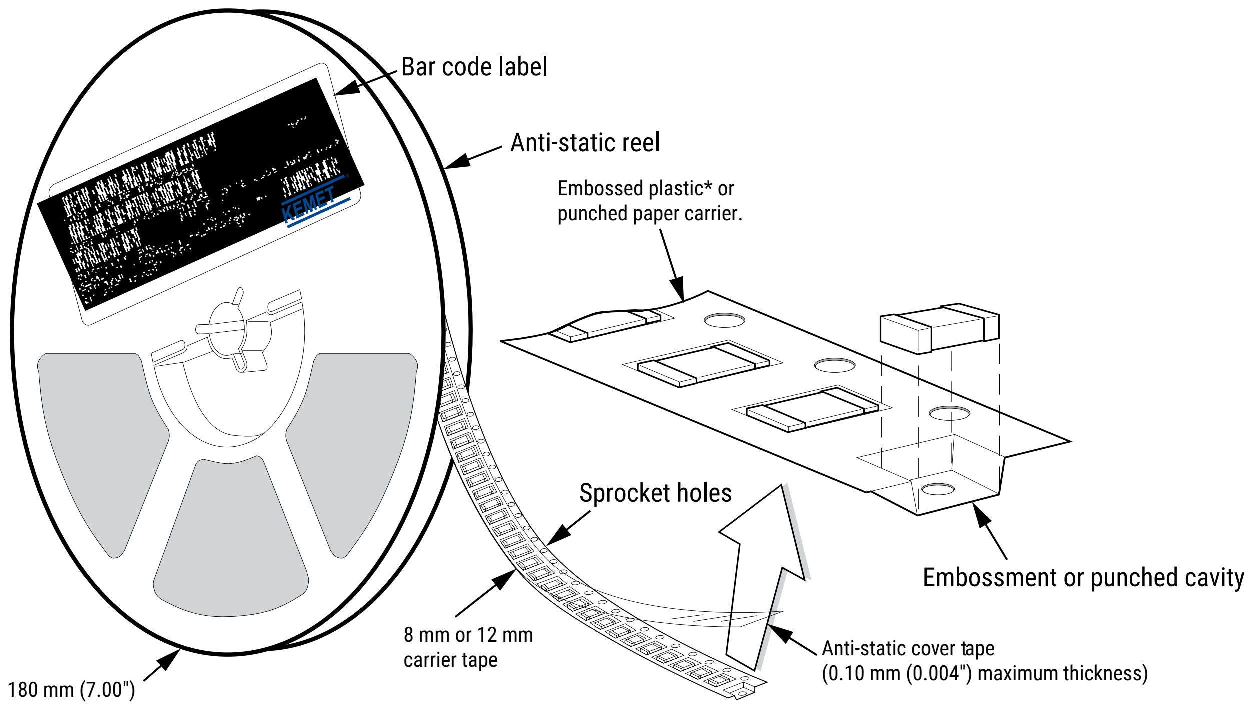


***Termination Finishes:**

100% Matte Sn	G = Gold (Au) 50 -100 µin	SnPb - 5% Pb minimum

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.



*EIA 0402 and 0603 case sizes available on punched paper carrier only.

Table 6 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

EIA Case Size	Tape Size (W)*	Embossed Plastic	
		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 P_1 carrier tape reference locations.*
**Refer to Tables 2A, 2B and 2C for tolerance specifications.*

Figure 1 – Embossed (Plastic) Carrier Tape Dimensions

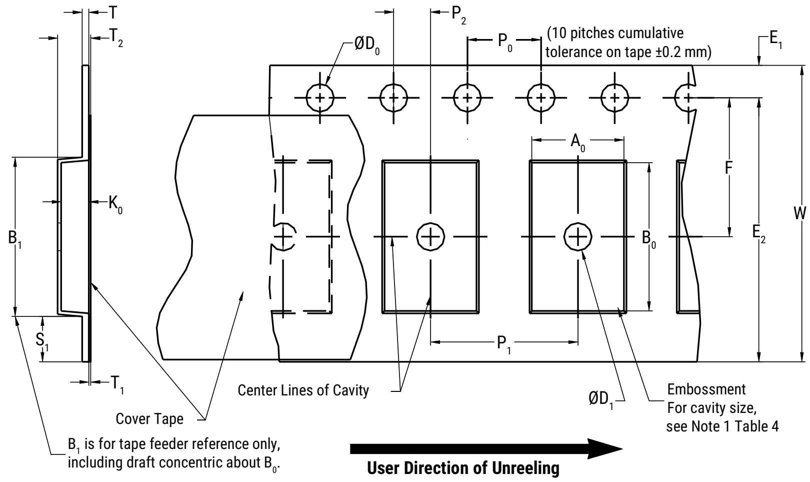


Table 7 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

Constant 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
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 & 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 independently of each other.*
2. *The tape with or without components shall pass around R without damage (see Figure 6.)*
3. *If S_1 < 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_0, B_0 and K_0 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_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	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
	Single (4 mm)			4.0 ±0.10 (0.157 ±0.004)		8.3 (0.327)	

1. The cavity defined by A_0, B_0 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

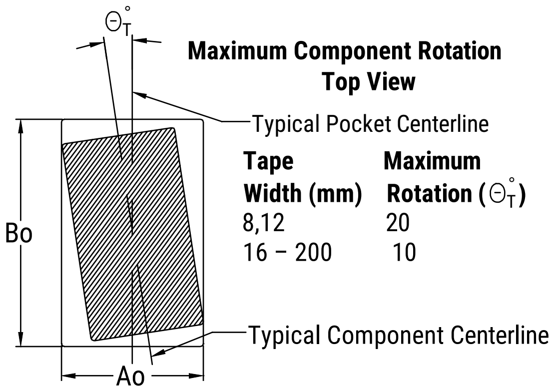
1. Cover Tape Break Force: 1.0 kg minimum.
2. Cover Tape Peel Strength: The total peel strength of the cover tape from the carrier tape shall be:

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*.

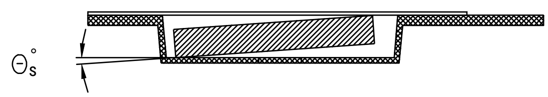
Figure 2 – Maximum Component Rotation

Maximum Component Rotation
Top View



Tape Width (mm)	Maximum Rotation (Θ_T°)
8,12	20
16 – 200	10

Maximum Component Rotation
Side View



Tape Width (mm)	Maximum Rotation (Θ_S°)
8,12	20
16 – 56	10
72 – 200	5

Figure 3 – Maximum Lateral Movement

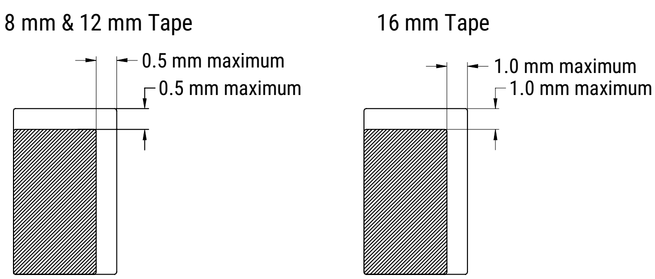


Figure 4 – Bending Radius

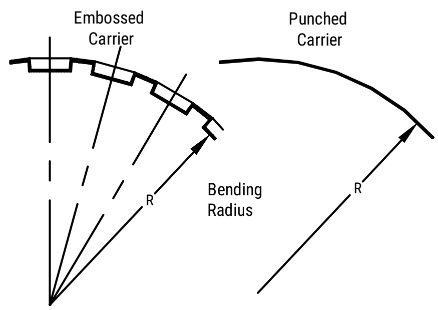
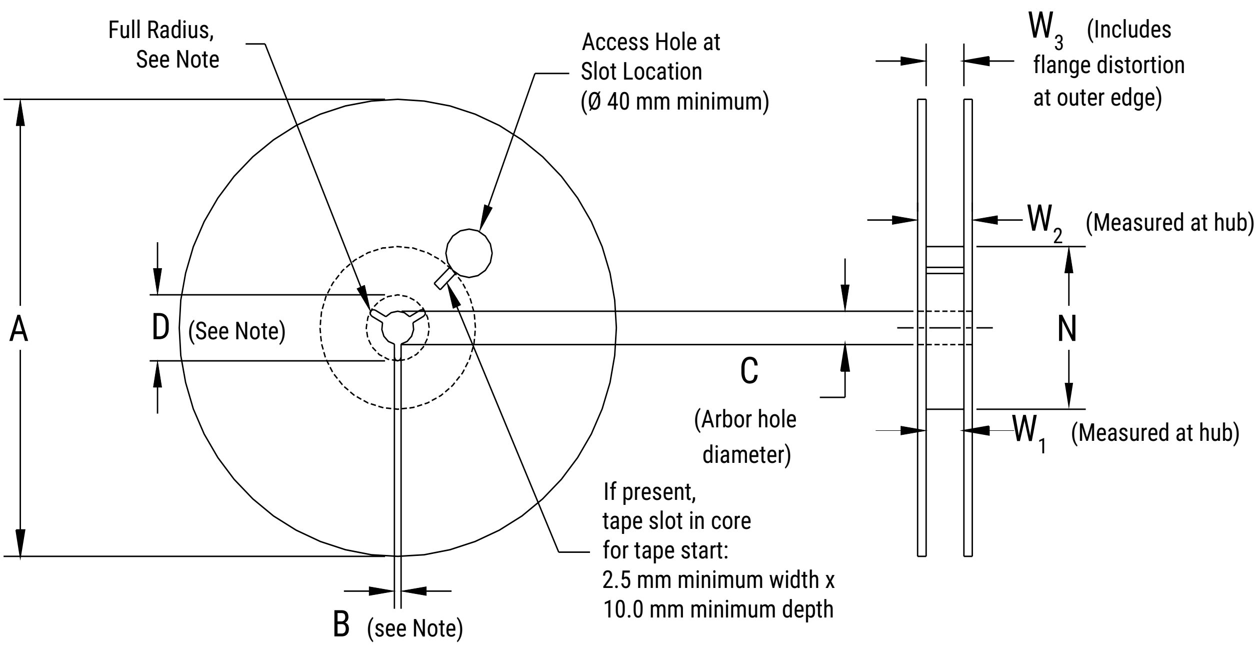


Figure 5 – Reel Dimensions



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

Table 9 – Reel Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)				
Tape Size	A	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				
Variable Dimensions — Millimeters (Inches)				
Tape Size	N Minimum See Note 2, Tables 6 – 7	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 accomadate tape width without interference
12 mm		12.4 + 2.0/−0.0 (0.488 + 0.078/−0.0)	18.4 (0.724)	

Figure 6 – Tape Leader & Trailer Dimensions

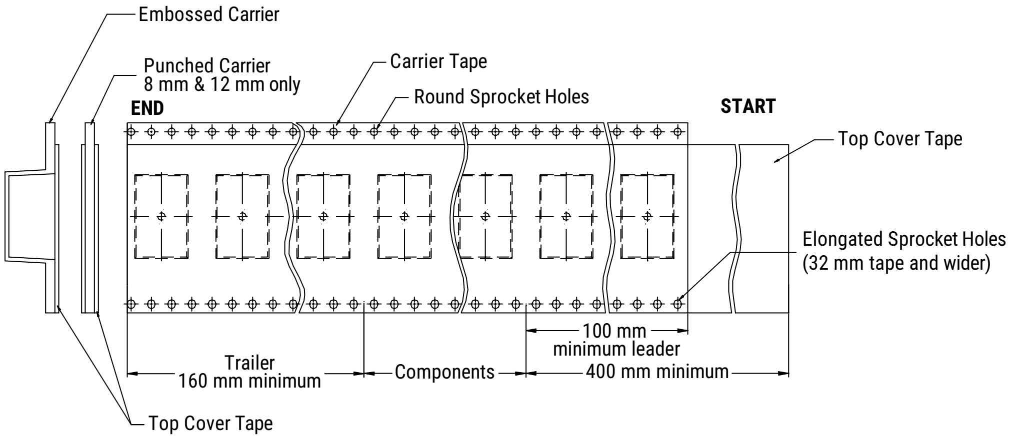
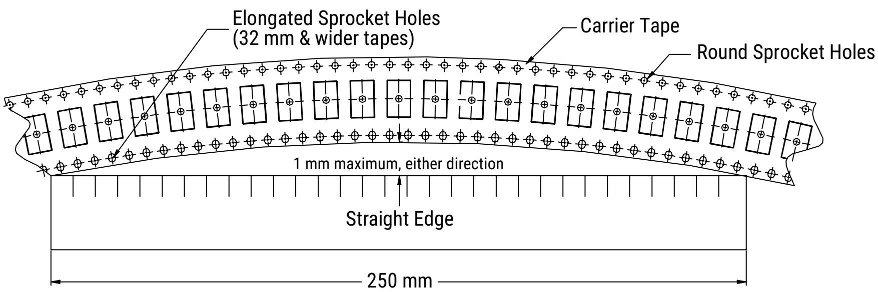


Figure 7 – Maximum Camber



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

Figure 8 – Waffle Tray Dimensions – Inches (Millimeters)

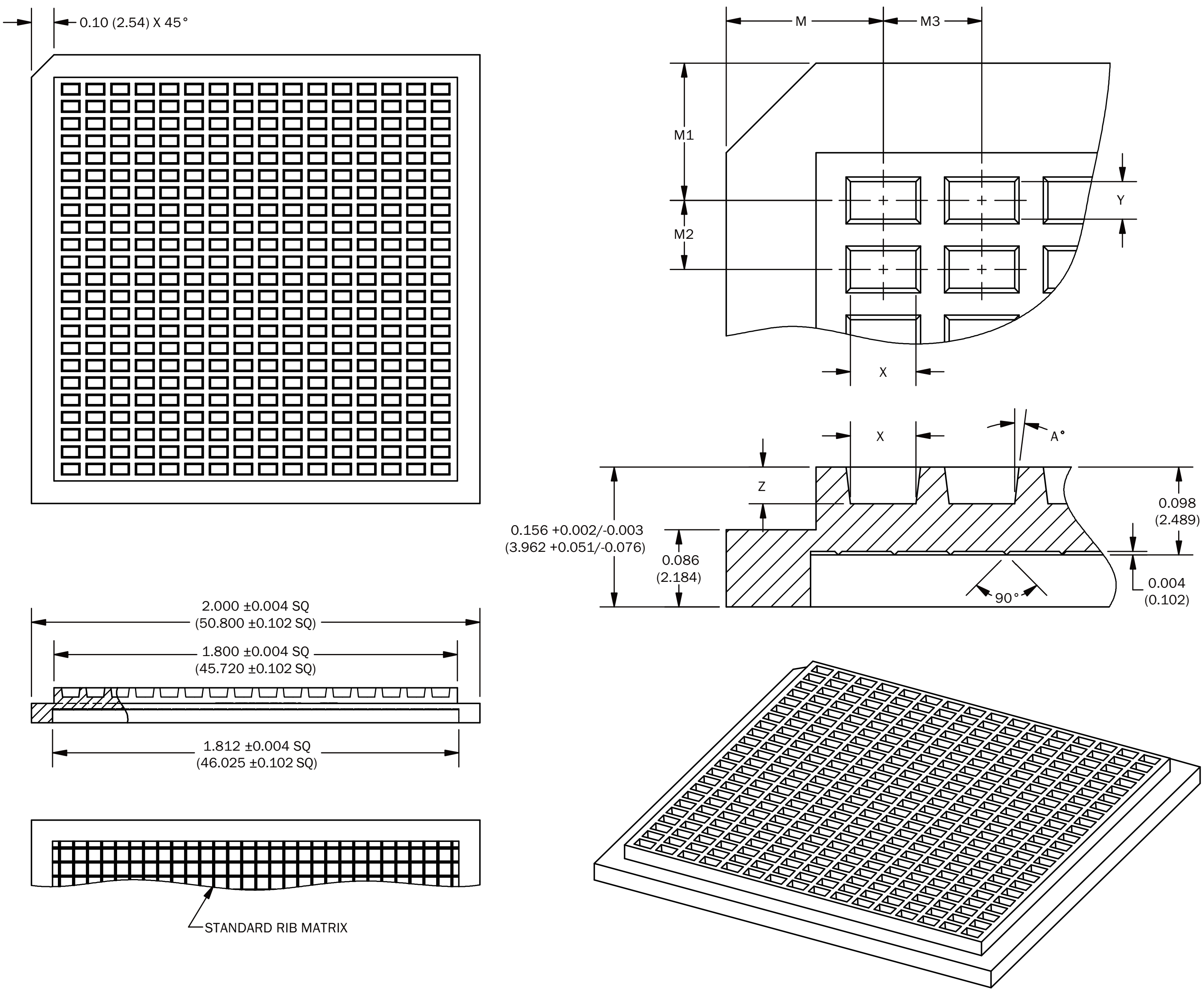


Table 10A – Waffle Tray Dimensions – Inches

Case Size		2" x 2" Waffle Tray Dimensions – Inches									Packaging Quantity (pcs/unit packaging)
		M	M1	M2	M3	X	Y	Z	A°	MATRIX	
EIA (in)	Metric (mm)	±0.003	±0.003	±0.002	±0.002	±0.002	±0.002	±0.003	± 1/2°	(X x Y)	
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 quantities for specified part number.*
[2] *Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of ≤ 1.25mm (0.049 inches).*
[3] *Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of > 1.25mm (0.049 inches).*

Table 10B – Waffle Tray Dimensions – Millimeters

Case Size		2" x 2" Waffle Tray Dimensions – Millimeters									Packaging Quantity (pcs/unit packaging)
		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)	
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

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

KPS-MCL Low-Loss High Temperature 200°C SMPS Stacks, 200 – 2,000 VDC (Industrial Grade)

Overview

KEMET Power Solutions - Low loss (KPS MCL) High Temperature SMPS Ceramic Stacked Capacitors combine a robust and proprietary C0G/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.

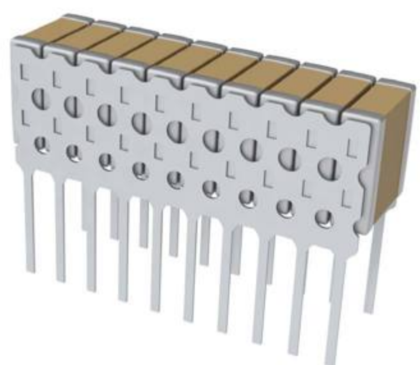
The KPS-MCL is constructed with large chip multilayer ceramic capacitors (MLCCs), vertically stacked and secured to a lead-frame termination system, using a high melting point (HMP) solder alloy. Vertically stacking the capacitors in lead frames allows for much lower ESR (low loss) and thermal resistance, 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 C0G capacitors are temperature-compensating 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/ºC 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	C	224	K	A	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 C0G (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

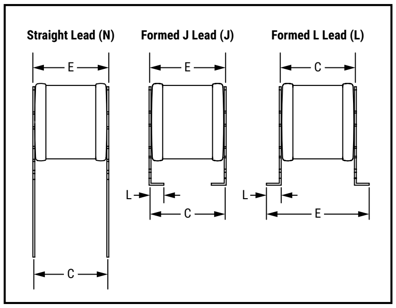
[1] *Lead configuration and dimension details are outlined in the "Dimensions" section of this document. Additional lead configurations may be available. Contact KEMET for details.*
[2] *Solder coated (60/40) lead termination finish (H) only available for Straight pin (N) lead configuration.*

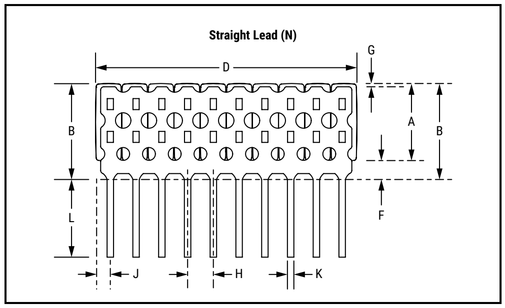
Lead Configurations – Inches (Millimeters)

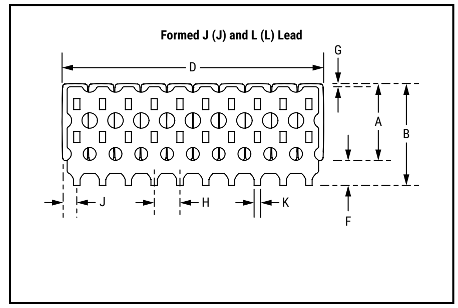
Lead Style Symbol	Lead Style	L Lead Length
N	(N) Straight	0.250 minimum (6.35)
L	(L) Formed	0.055±0.005 (1.4±0.13)
J	(J) Formed	0.055±0.005 (1.4±0.13)

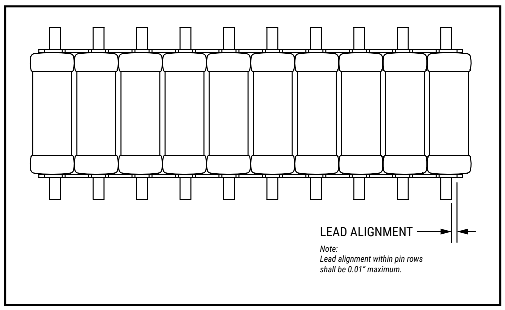
Additional lead configurations may be available. Contact KEMET for details.

Dimensions – Inches (Millimeters)









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
69	0.25 (6.35)	For straight lead (N) and (J) lead: E = 0.30 (7.62) maximum For (L) lead: E = 0.38 (9.65) maximum	3	0.32 (8.13)	0.21 (5.33)	0.29 (7.37)	0.1 (2.54)	0.02 (0.5)	For straight lead (N), seating plane is 0.055 (1.397) For (L) and (J) lead, seating plane is 0.070 (1.778)	Solder reflow only
			5	0.53 (13.5)						
			10	1.06 (26.9)						
70			3	0.32 (8.13)	0.26 (6.60)	0.34 (8.64)				
			5	0.53 (13.5)						
			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 ≥ 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 ≥ 500 to < 1,000 V 120% of rated voltage for voltage rating of ≥ 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 MΩ µF or 100 GΩ (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 ≤ 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 MΩ - µF value by the capacitance and compare to GΩ 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	0.28	69	2220	3	0.21 (5.3)	0.32 (8.13)	No
L1G(a)702364(b)(c)03	0.36	70	2225	3	0.26 (6.6)	0.32 (8.13)	No
L1G(a)692464(b)(c)05	0.46	69	2220	5	0.21 (5.3)	0.53 (13.5)	No
L1G(a)702604(b)(c)05	0.6	70	2225	5	0.26 (6.6)	0.53 (13.5)	No
L1G(a)692924(b)(c)10	0.92	69	2220	10	0.21 (5.3)	1.06 (26.92)	No
L1G(a)702125(b)(c)10	1.2	70	2225	10	0.26 (6.6)	1.06 (26.92)	No
500 V							
L1G(a)69C114(b)(c)03	0.11	69	2220	3	0.21 (5.3)	0.32 (8.13)	Yes (see Note 4)
L1G(a)70C144(b)(c)03	0.14	70	2225	3	0.26 (6.6)	0.32 (8.13)	
L1G(a)69C184(b)(c)05	0.18	69	2220	5	0.21 (5.3)	0.53 (13.5)	
L1G(a)70C234(b)(c)05	0.23	70	2225	5	0.26 (6.6)	0.53 (13.5)	
L1G(a)69C364(b)(c)10	0.36	69	2220	10	0.21 (5.3)	1.06 (26.9)	
L1G(a)70C474(b)(c)10	0.47	70	2225	10	0.26 (6.6)	1.06 (26.9)	
630 V							
L1G(a)69B663(b)(c)03	0.066	69	2220	3	0.21 (5.3)	0.32 (8.13)	Yes (see Note 4)
L1G(a)70B843(b)(c)03	0.084	70	2225	3	0.26 (6.6)	0.32 (8.13)	
L1G(a)69B114(b)(c)05	0.11	69	2220	5	0.21 (5.3)	0.53 (13.5)	
L1G(a)70B144(b)(c)05	0.14	70	2225	5	0.26 (6.6)	0.53 (13.5)	
L1G(a)69B224(b)(c)10	0.22	69	2220	10	0.21 (5.3)	1.06 (26.9)	
L1G(a)70B284(b)(c)10	0.28	70	2225	10	0.26 (6.6)	1.06 (26.9)	
1,000 V							
L1G(a)69D393(b)(c)03	0.039	69	2220	3	0.21 (5.3)	0.32 (8.13)	Yes (see Note 4)
L1G(a)70D543(b)(c)03	0.054	70	2225	3	0.26 (6.6)	0.32 (8.13)	
L1G(a)69D653(b)(c)05	0.065	69	2220	5	0.21 (5.3)	0.53 (13.5)	
L1G(a)70D903(b)(c)05	0.090	70	2225	5	0.26 (6.6)	0.53 (13.5)	
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)	Yes (see Note 4)
L1G(a)70F203(b)(c)03	0.020	70	2225	3	0.26 (6.6)	0.32 (8.13)	
L1G(a)69F273(b)(c)05	0.027	69	2220	5	0.21 (5.3)	0.53 (13.5)	
L1G(a)70F343(b)(c)05	0.034	70	2225	5	0.26 (6.6)	0.53 (13.5)	
L1G(a)69F533(b)(c)10	0.053	69	2220	10	0.21 (5.3)	1.06 (26.9)	
L1G(a)70F683(b)(c)10	0.068	70	2225	10	0.26 (6.6)	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)	Yes (see Note 4)
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)	
L1G(a)70G233(b)(c)05	0.023	70	2225	5	0.26 (6.6)	0.53 (13.5)	
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 ≥ 500 V with Ag plating are RoHS compliant by exemption 7a.

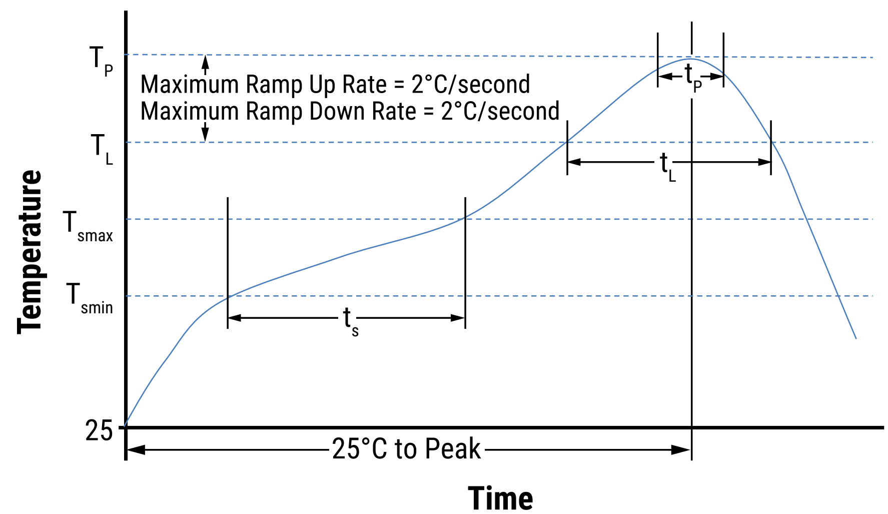
Soldering Process

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:



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_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.

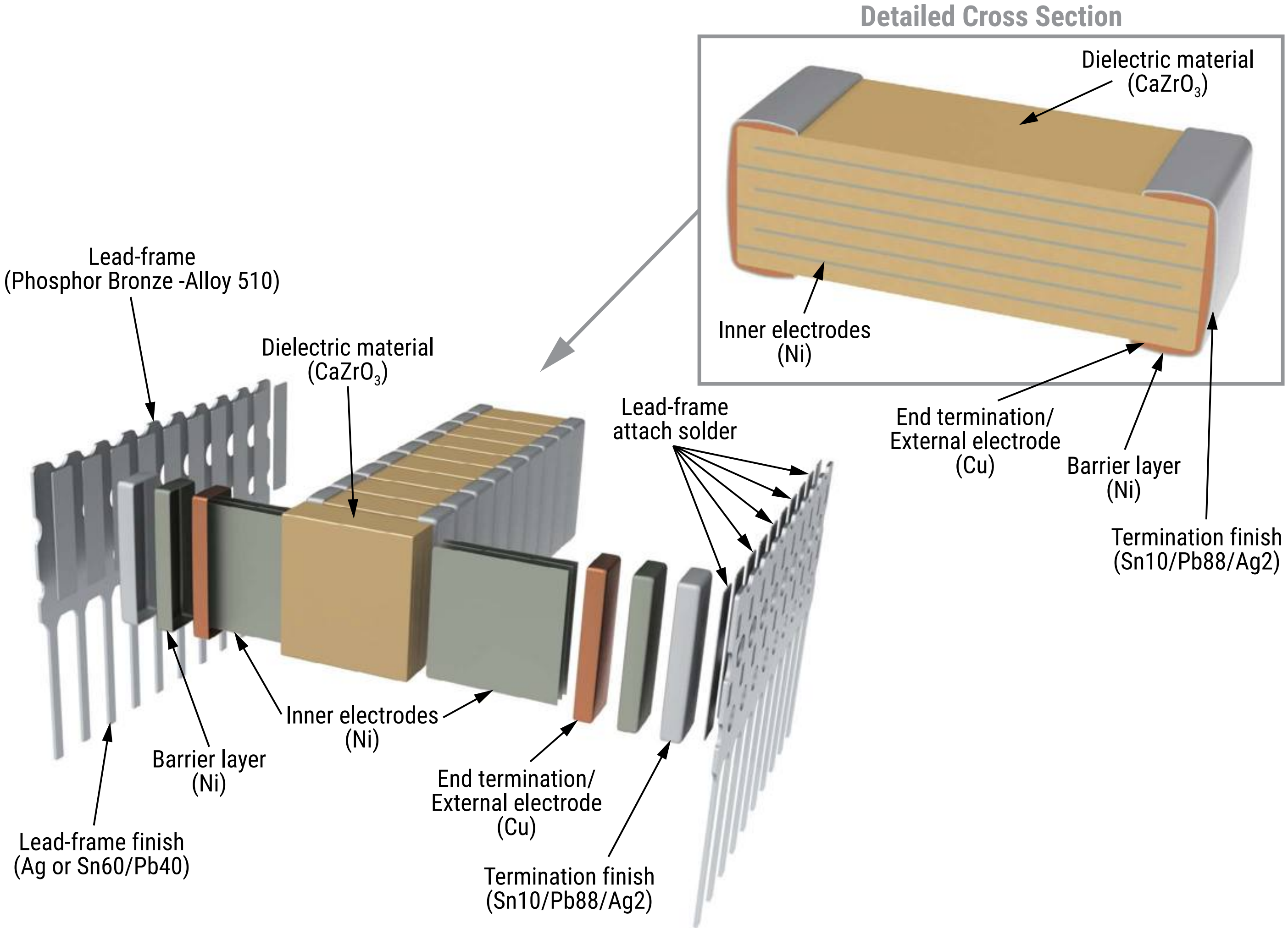
Storage & Handling

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

Construction



Packaging

Waffle Packaging Quantities

Case Code	Lead Style	Number of Chips in Stack	Waffle Pack Quantity[1]
69	L/J/N	3 and 5	50
		10	25
70	L/J/N	3 and 5	50
		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)

KEMET a YAGEO company

RoHS Lead-free REACH COMPLIANT

KONNEKT™ High Density Packaging

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 Liquid Phase Sintering (TLPS) material to create a surface mount multi-chip solution for high density packaging. By utilizing KEMET's robust and proprietary C0G 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 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.

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

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

Standard

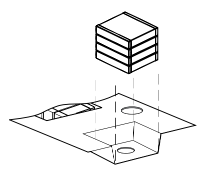
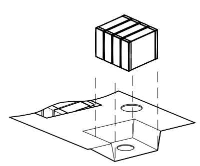
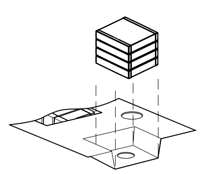
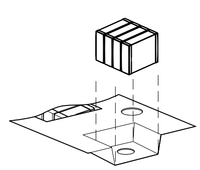
Low Loss

Ordering Information

CKC	33	C	884	K	C	G	L	C	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 = C0G	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

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
Low Loss			7" Reel/Unmarked	7805
			13" Reel/Unmarked	7810
Automotive Grade				
Standard			7" Reel/Unmarked	AUTO
			13" Reel/Unmarked	AUTO7210
Low Loss			7" Reel/Unmarked	AUTO7805
			13" Reel/Unmarked	AUTO7810

[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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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.*

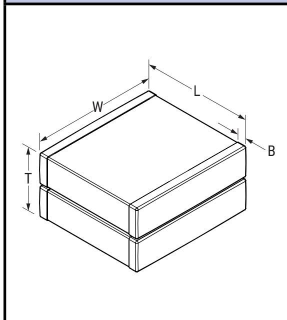
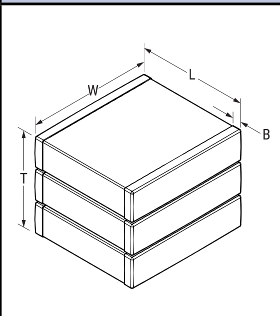
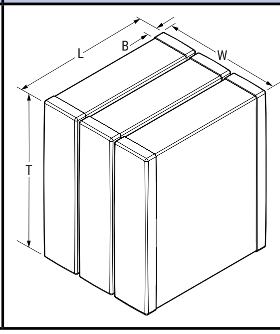
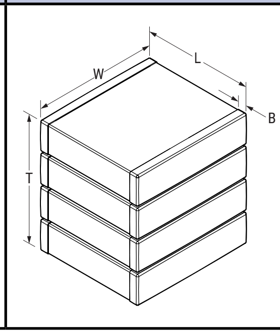
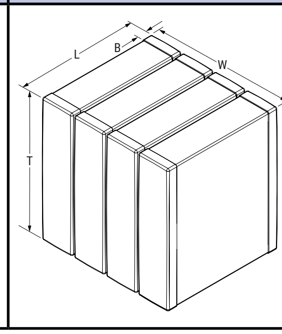
Production Part Approval Process (PPAP)
The purpose of the Production Part Approval Process is:
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements 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	○		○		

[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 2 Chips	Standard Mounting 3 Chips	Low Loss Mounting 3 Chips	Standard Mounting 4 Chips	Low Loss Mounting 4 Chips
				

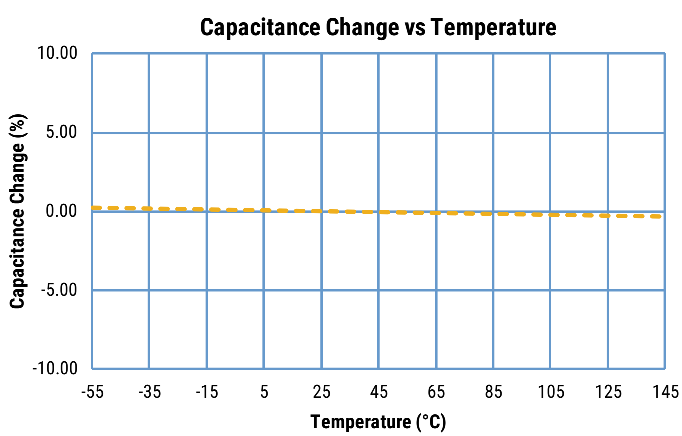
EIA SIZE CODE	METRIC SIZE CODE	Number of Chips	Mounting	L LENGTH	W WIDTH	T THICKNESS	B BANDWIDTH	Mounting Technique	Typical Average Piece Weight (g)
1812	4532	2	Standard	4.50 (0.177) ±0.30 (0.012)	3.20 (0.126) ±0.30 (0.012)	5.10 (0.201) ±0.40 (0.016)	0.60 (0.024) ±0.35 (0.014)	Solder Reflow Only	0.3
		3	Standard		3.20 (0.126) ±0.30 (0.012)	7.70 (0.303) ±0.60 (0.24)			0.45
			Low Loss		7.70 (0.303) ±0.60 (0.24)	3.20 (0.126) ±0.30 (0.012)			0.45
2220	5750	2	Standard	5.70 (0.224) ±0.40 (0.016)	5.00 (0.197) ±0.40 (0.016)	5.00 (0.197) ±0.40 (0.016)	0.60 (0.024) ±0.35 (0.014)		0.6
			Low Loss		5.10 (0.201) ±0.40 (0.016)				
		3	Standard		5.00 (0.197) ±0.40 (0.016)	7.70 (0.303) ±0.60 (0.24)			1.0
			Low Loss		7.70 (0.303) ±0.60 (0.24)	5.00 (0.197) ±0.40 (0.016)			1.0
		4	Low Loss		10.30 (0.405) ±0.80 (0.031)	5.00 (0.197) ±0.40 (0.016)			1.4
3640	9210	2	Standard	9.30 (0.366) ±0.60 (0.024)	10.20 (0.402) ±0.40 (0.016)	5.10 (0.201) ±0.40 (0.016)	1.27 (0.050) ±0.40 (0.016)		2.2
		3	Standard		10.20 (0.402) ±0.40 (0.016)	7.70 (0.303) ±0.60 (0.24)			3.3
			Low Loss		7.70 (0.303) ±0.60 (0.24)	10.20 (0.402) ±0.40 (0.016)			3.3
		4	Standard		10.20 (0.402) ±0.40 (0.016)	10.30 (0.405) ±0.80 (0.031)			4.3
			Low Loss		10.30 (0.405) ±0.80 (0.031)	10.20 (0.402) ±0.40 (0.016)			4.3

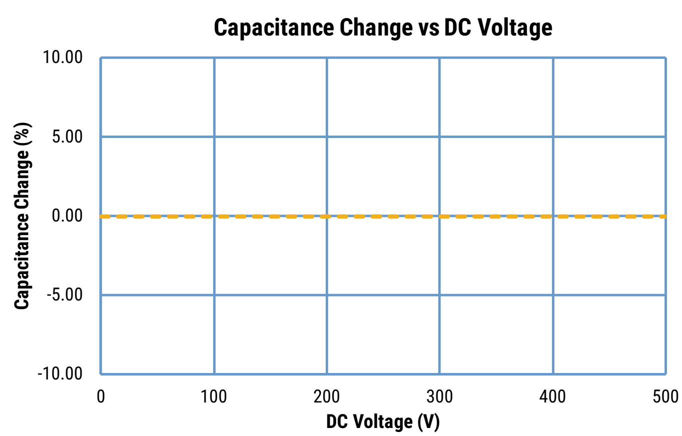
Environmental Compliance

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

Typical Performance

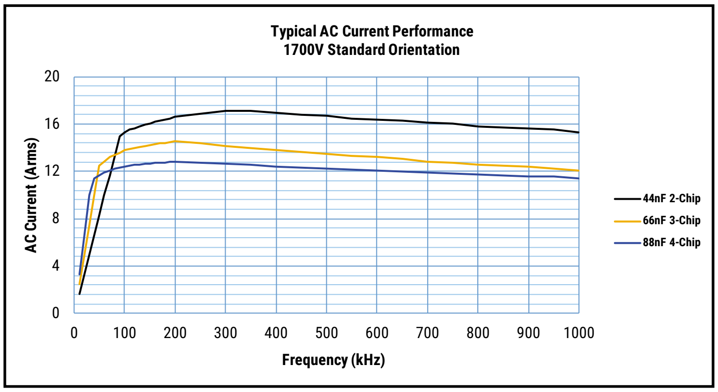
Number of Chips	Mounting Configuration	Typical ESR at 25°C, 100 kHz	Typical ESL at 25°C	Typical Ripple Current
2	Standard	< 2.5 mΩ	< 1.5 nH	See Typical Performance Curves Below
3	Standard	< 2.5 mΩ	< 2.2 nH	
3	Low Loss	< 1.6 mΩ	< 0.75 nH	
4	Standard	< 2.5 mΩ	< 2.7 nH	
4	Low Loss	< 1.1 mΩ	< 0.45 nH	

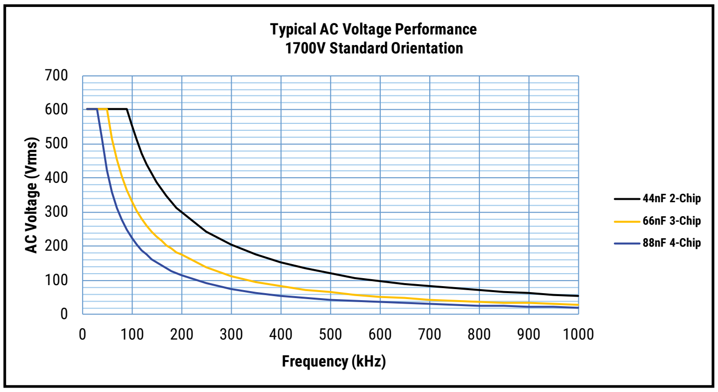


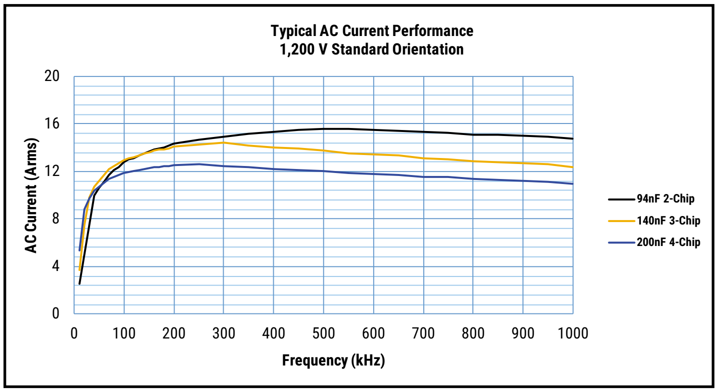


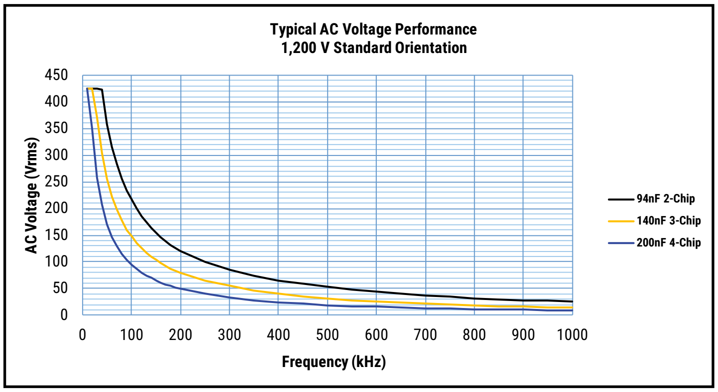
Typical Performance cont.

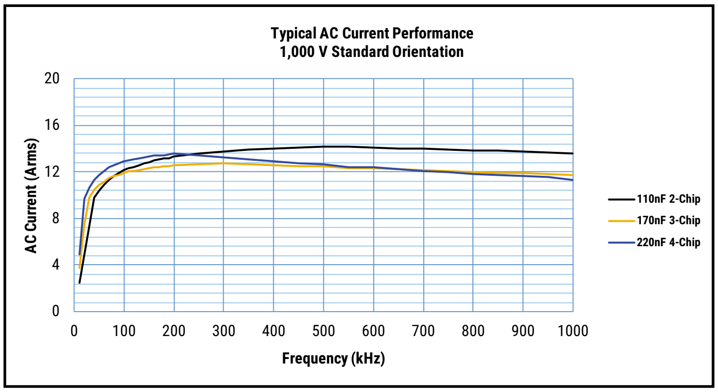
Standard Orientation

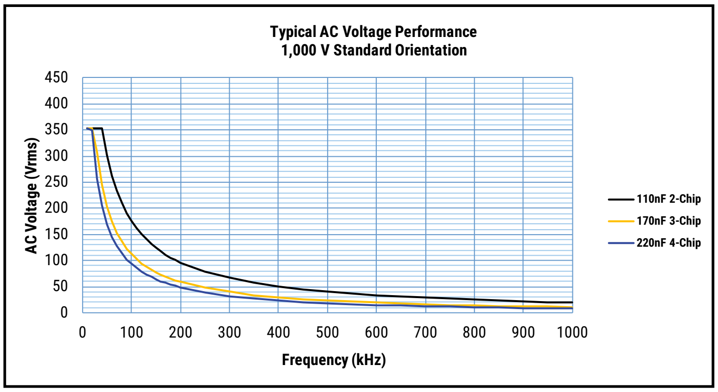






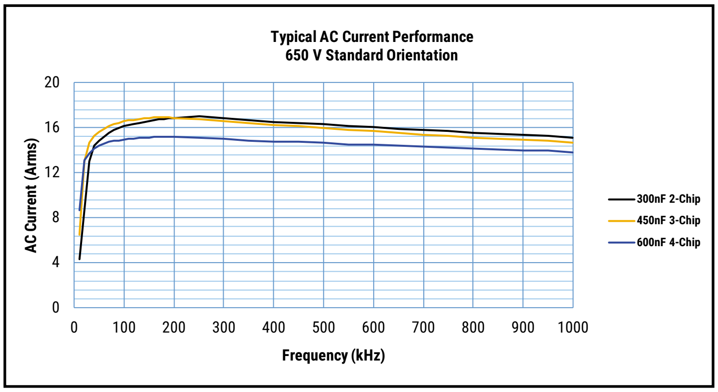


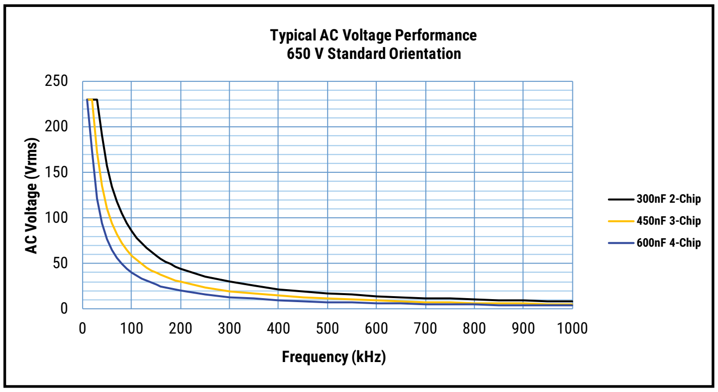


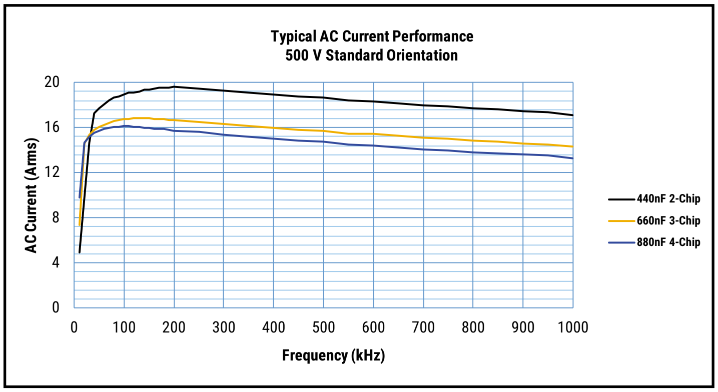


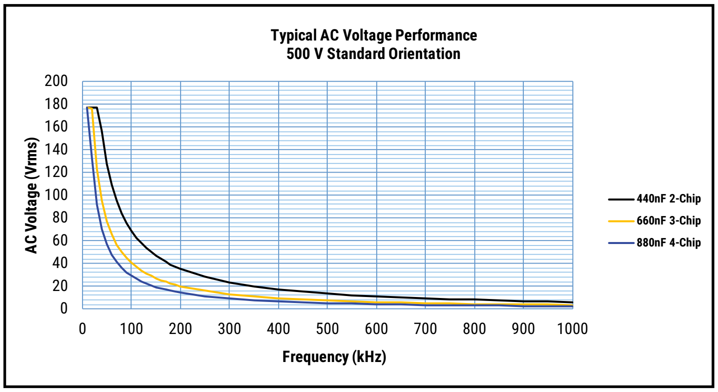
Typical Performance cont.

Standard Orientation



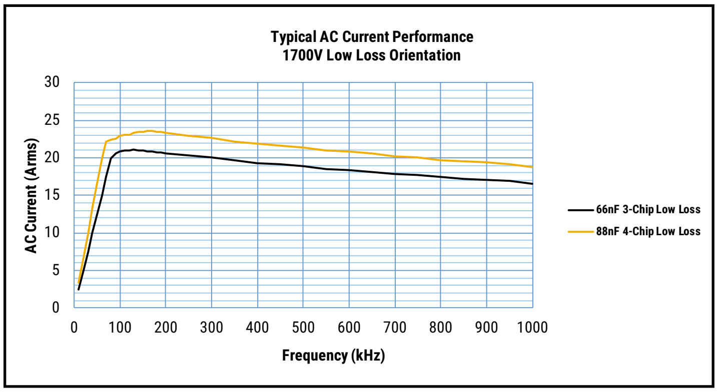


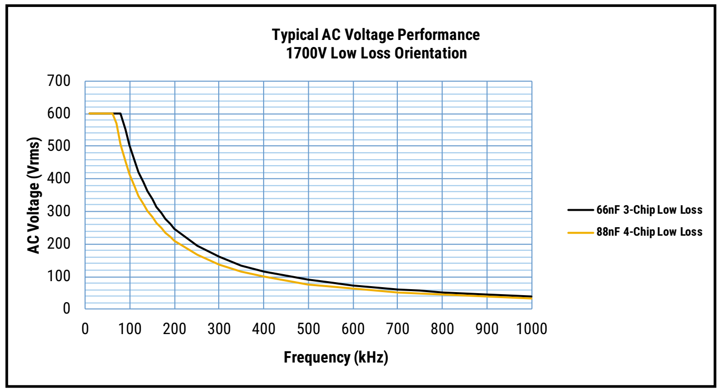


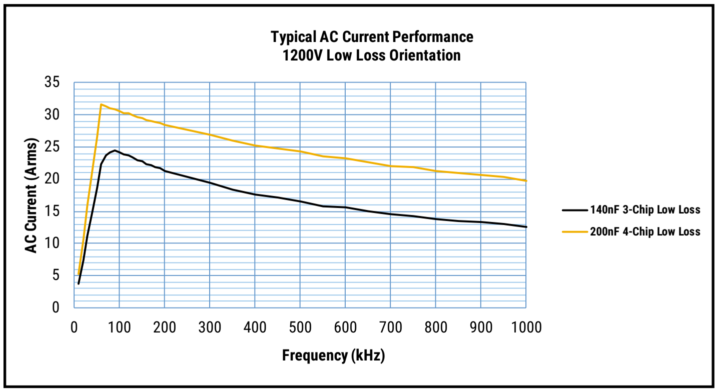


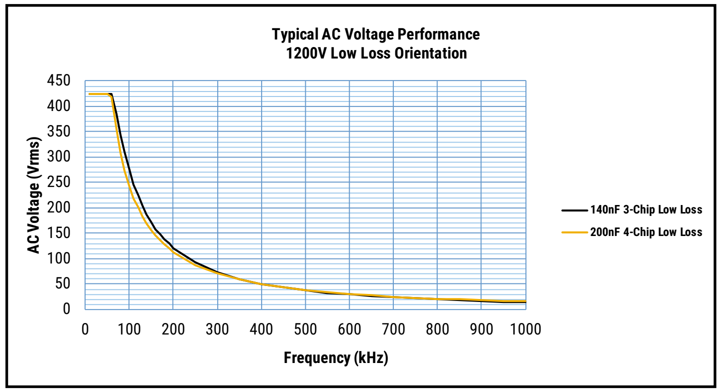
Typical Performance cont.

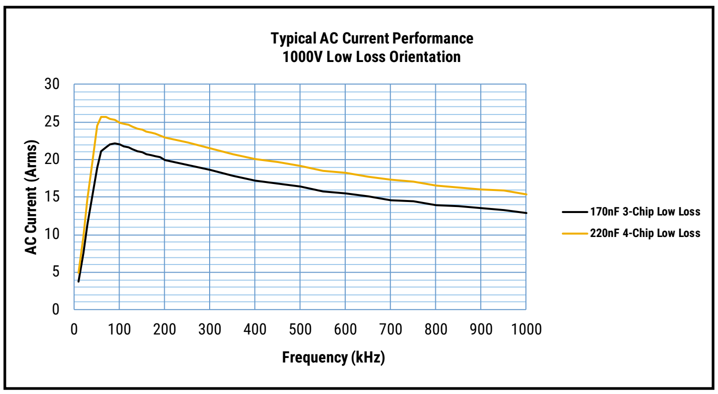
Low Loss Orientation

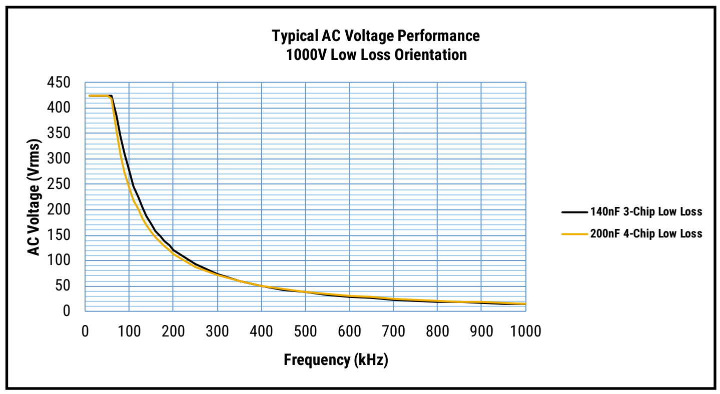






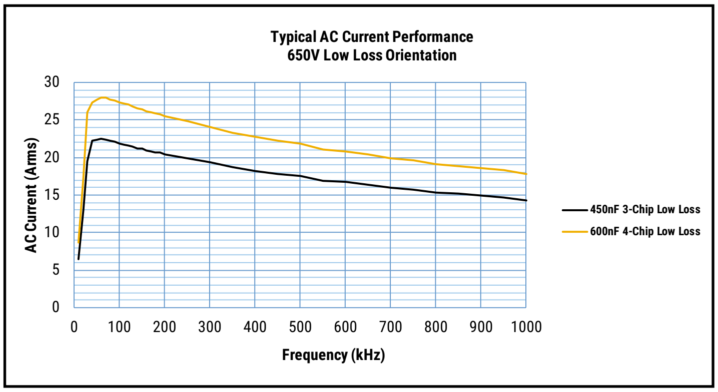


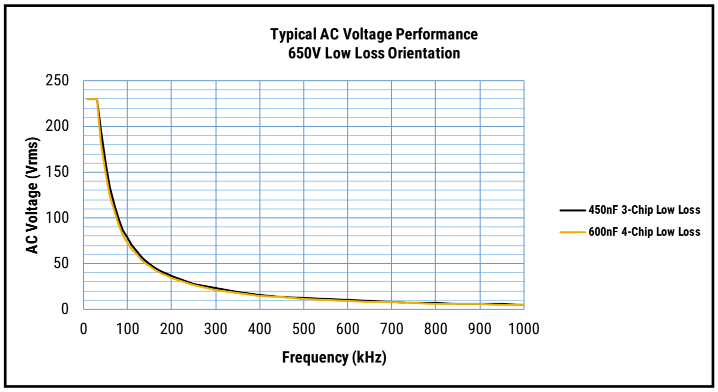


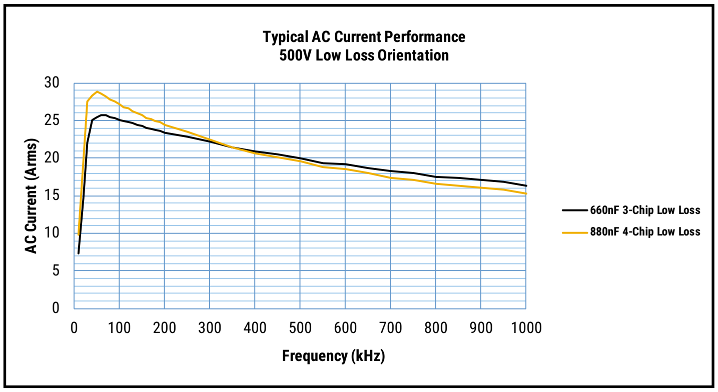


Typical Performance cont.

Low Loss Orientation







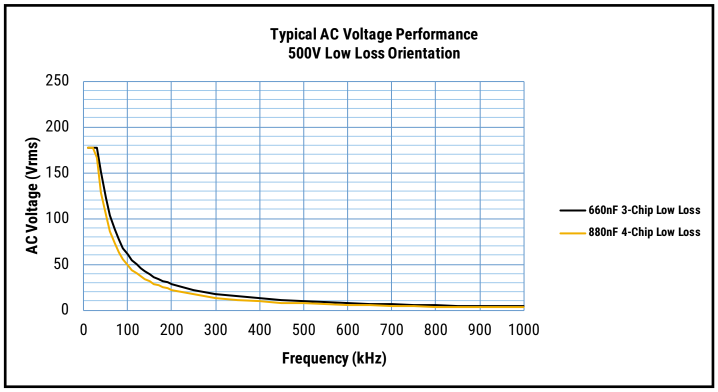


Table 1A - Product Ordering Codes and Ratings

Capacitance	Capacitance Code	Number of Chips	Case Size	1812			2220					3640					
			Voltage Code	C	W	D	C	W	D	E	J	C	W	D	E	J	G
			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	K								•						
20 nF	203	3	K								•						
24 nF	243	2	K							•							
27 nF	273	4	K								•						
30 nF	303	2	K			•											•
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	K						•								
		3	K													•	
88 nF	883	4	K													•	
94 nF	943	2	K	•	•										•		
100 nF	104	3	K						•								
110 nF	114	2	K											•			
130 nF	134	4	K						•								
140 nF	144	3	K	•	•										•		
170 nF	174	3	K											•			
190 nF	194	4	K												•		
200 nF	204	2	K				•	•									
		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	K									•					
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 Size	Number of Chips	Orientation	Plastic Quantity	
			7" Reel	13" Reel
1812	2	Standard	200	900
	3	Standard	100	600
		Low Loss	350	1,350
2220	2	Standard	300	1,250
		Low Loss	225	900
	3	Standard	125	575
		Low Loss	160	675
	4	Low Loss	125	525
3640	2	Standard	125	575
	3	Standard	75	375
		Low Loss	50	275
	4	Standard	50	225
		Low Loss		

Detailed Part Number List

KEMET Part Number[1]	Case Size	Capacitance	Voltage	Number of Chips	Orientation	Thickness mm (inch)
CKC18C303KDGLC(a)	1812	30 nF	1,000 V	2	Standard	5.10 (0.201) ±0.40 (0.016)
CKC18C943KWGLC(a)		94 nF	650 V			
CKC18C943KCGLC(a)		94 nF	500 V			
CKC18C453KDGLC(a)		45 nF	1,000 V	3	Standard Low Loss	Standard: 7.70 (0.303) ±0.60 (0.24) Low Loss: 3.20 (0.126) ±0.30 (0.012)
CKC18C144KWGLC(a)		140 nF	650 V			
CKC18C144KCGLC(a)		140 nF	500 V			
CKC21C143KJGLC(a)	2220	14 nF	1,700 V	2	Standard Low Loss	5.00 (0.197) ±0.40 (0.016)
CKC21C243KEGLC(a)		24 nF	1,200 V			
CKC21C663KDGLC(a)		66 nF	1,000 V			
CKC21C204KWGLC(a)		200 nF	650 V			
CKC21C204KCGLC(a)		200 nF	500 V			
CKC21C203KJGLC(a)		20 nF	1,700 V	3	Standard Low Loss	Standard: 7.70 (0.303) ±0.60 (0.24) Low Loss: 5.00 (0.197) ±0.40 (0.016)
CKC21C363KEGLC(a)		36 nF	1,200 V			
CKC21C104KDGLC(a)		100 nF	1,000 V			
CKC21C304KWGLC(a)		300 nF	650 V			
CKC21C304KCGLC(a)		300 nF	500 V			
CKC21C273KJGLC(a)		27 nF	1,700 V	4	Low Loss	5.00 (0.197) ±0.40 (0.016
CKC21C483KEGLC(a)		48 nF	1,200 V			
CKC21C134KDGLC(a)		130 nF	1,000 V			
CKC21C404KWGLC(a)		400 nF	650 V			
CKC21C404KCGLC(a)		400 nF	500 V			
CKC33C303KGGLC(a)	3640	30 nF	2,000 V	2	Standard	5.10 (0.201) ±0.40 (0.016)
CKC33C443KJGLC(a)		44 nF	1,700 V			
CKC33C943KEGLC(a)		94 nF	1,200 V			
CKC33C114KDGLC(a)		110 nF	1,000 V			
CKC33C304KWGLC(a)		300 nF	650 V			
CKC33C444KCGLC(a)		440 nF	500 V			
CKC33C453KGGLC(a)		45 nF	2,000 V	3	Standard Low Loss	Standard: 7.70 (0.303) ±0.60 (0.24) Low Loss: 10.20 (0.402) ±0.40 (0.016)
CKC33C663KJGLC(a)		66 nF	1,700 V			
CKC33C144KEGLC(a)		140 nF	1,200 V			
CKC33C174KDGLC(a)		170 nF	1,000 V			
CKC33C454KWGLC(a)		450 nF	650 V			
CKC33C664KCGLC(a)		660 nF	500 V			
CKC33C603KGGLC(a)		60 nF	2,000 V	4	Standard Low Loss	Standard: 10.30 (0.405) ±0.80 (0.031) Low Loss: 10.20 (0.402) ±0.40 (0.016)
CKC33C883KJGLC(a)		88 nF	1,700 V			
CKC33C194KEGLC(a)		190 nF	1,200 V			
CKC33C204KEGLC(a)		200 nF	1,200 V			
CKC33C224KDGLC(a)		220 nF	1,000 V			
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

<table>
<tr><th>Test</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Visual and Mechanical</td><td>KEMET Internal</td><td>No defects that may affect performance (10X)</td><td>Dimensions according KEMET Spec Sheet</td></tr>
<tr><td>Capacitance (Cap)</td><td>KEMET Internal</td><td>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</td><td>Within Tolerance</td></tr>
<tr><td>Dissipation Factor (DF)</td><td>KEMET Internal</td><td>1 kHz ±50 Hz and 1.0 ±0.2 V_{rms}</td><td>Dissipation factor (DF) maximum limit at 25°C = 0.1%</td></tr>
<tr><td>Insulation Resistance (IR)</td><td>KEMET Internal</td><td>500 VDC applied for 120±5 seconds at 25°C</td><td>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</td></tr>
<tr><td>Temperature Coefficient of Capacitance (TCC)</td><td>KEMET Internal</td><td>Frequency: 1 kHz ±50 Hz
Capacitance change with reference to +25°C and 0 VDC applied.
* See part number specification sheet for voltage
<table>
<tr><th>Step</th><th>Temperature (°C)</th></tr>
<tr><td>1</td><td>+25°C</td></tr>
<tr><td>2</td><td>−55°C</td></tr>
<tr><td>3</td><td>+25°C (Reference)</td></tr>
<tr><td>4</td><td>+150°C</td></tr>
</table></td><td>±30 PPM / °C</td></tr>
<tr><td>Dielectric Withstanding Voltage (DWV)</td><td>KEMET Internal</td><td>
<table>
<tr><th>Rated DC Voltage</th><th>DWV Voltage (% of Rated)</th></tr>
<tr><td>500 V</td><td>150%</td></tr>
<tr><td>650 V</td><td>130%</td></tr>
<tr><td>≥ 1,000 V</td><td>120%</td></tr>
</table>
(5 ±1 seconds and charge/discharge not exceeding 50 mA)</td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit

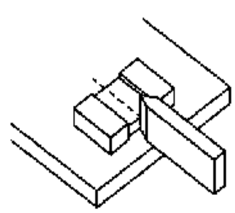
Withstand test voltage without insulation breakdown or damage.</td></tr>
<tr><td>Aging Rate (Maximum % Capacitance Loss/Decade Hour)</td><td>KEMET Internal</td><td>Maximum % capacitance loss/decade hour</td><td>0% Loss/Decade Hour</td></tr>
<tr><td>Terminal Strength</td><td>Kemet Internal</td><td>Shear stress test per specific case size,
Time: 60±1 seconds
<table>
<tr><th>Case Size</th><th>Force</th></tr>
<tr><td>1812</td><td rowspan="3">18N</td></tr>
<tr><td>2220</td></tr>
<tr><td>3640</td></tr>
</table>
</td><td>No evidence of mechanical damage</td></tr>
</table>

Table 2 – Performance & Reliability: Test Methods and Conditions cont.

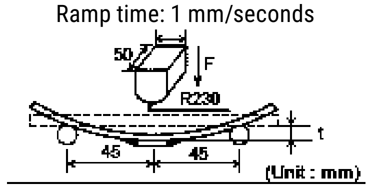
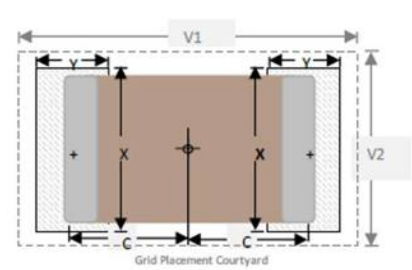
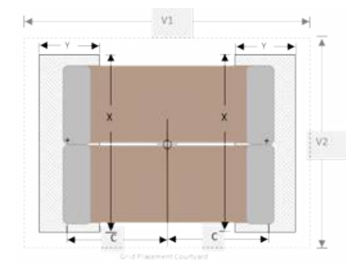
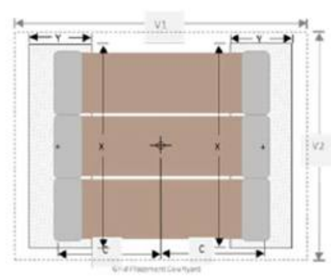
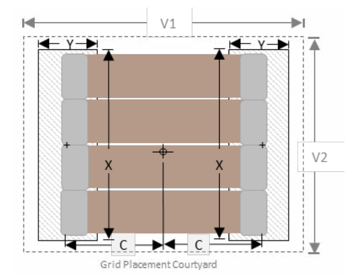
Test	Reference	Test Condition	Limits
Board Flex	AEC-Q200-005	Standard Termination system 3.0 mm Test time: 60±5 seconds Ramp time: 1 mm/seconds 	No evidence of mechanical damage
Solderability	J-STD-002	Magnification 10X. Conditions: Category 2 (Dry Bake 155°C / 4 hours ±15 minutes) a) Method B, 245°C, 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 Method 108	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 IR: 10% of Initial Limit DF Limits Maximum: 0.5%
Storage Life		1,000 hours at 150°C, Unpowered	
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)

EIA SIZE CODE	METRIC SIZE CODE	Thickness Code	Median (Nominal) Land Protrusion									
			Standard Orientation					Low Loss Orientation				
												
			2, 3, & 4-Chip Stack Pad Size					2-Chip Stack Pad 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					

EIA SIZE CODE	METRIC SIZE CODE	Thickness Code	Median (Nominal) Land Protrusion									
			Low Loss Orientation									
												
			3-Chip Stack Pad Size					4-Chip Stack Pad 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

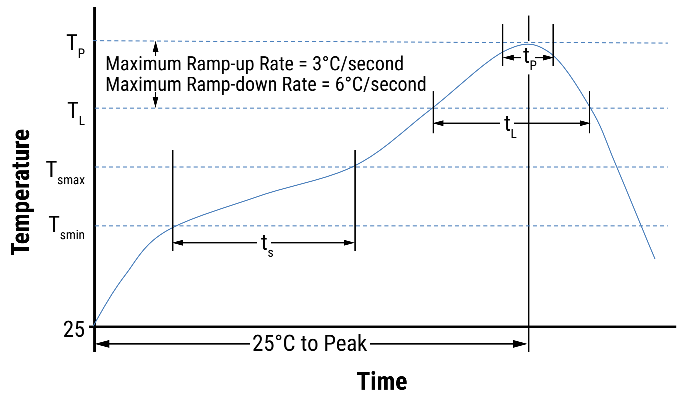
Soldering Process

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.

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.



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.

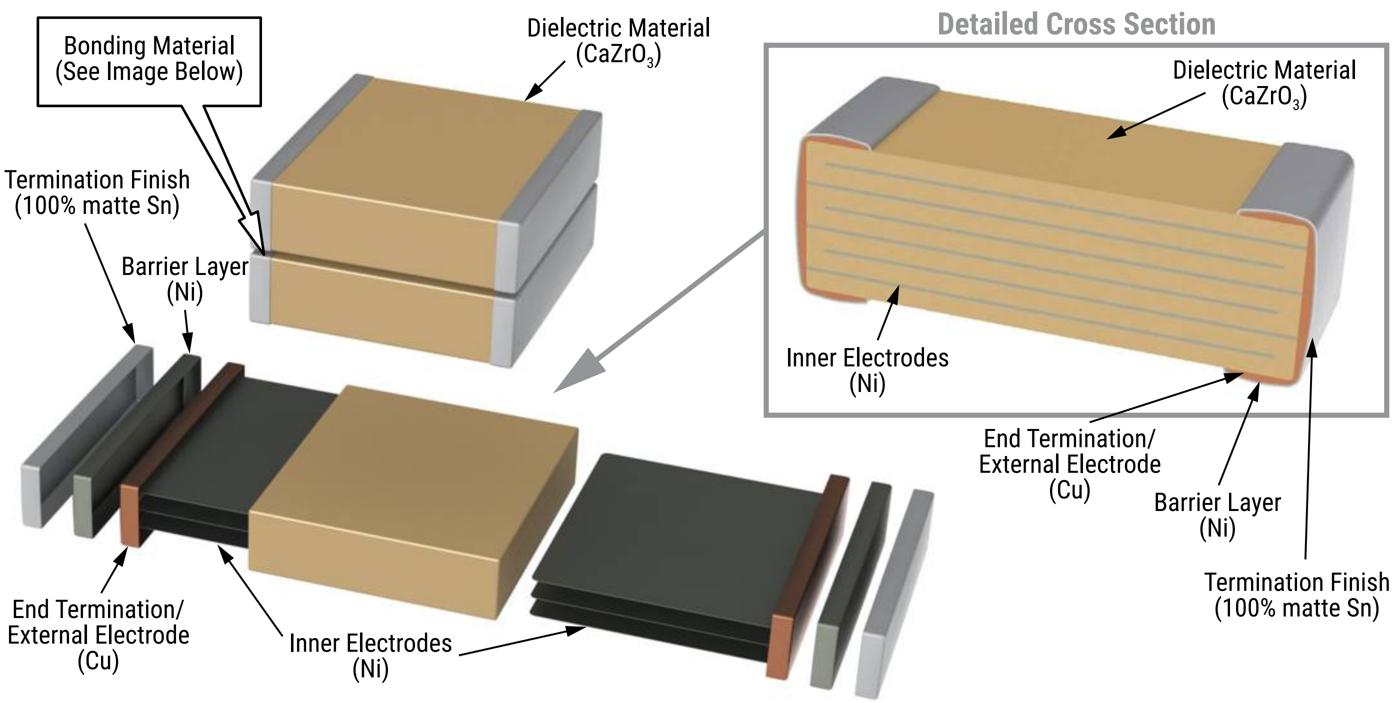
However, it is understood that the manual attachment of KONNEKT capacitors is necessary for prototype and lab testing. In these instances, care must be taken not to introduce excessive temperature gradients in the KONNEKT part type that may lead to cracking in the ceramic or separation of the TLPS material.

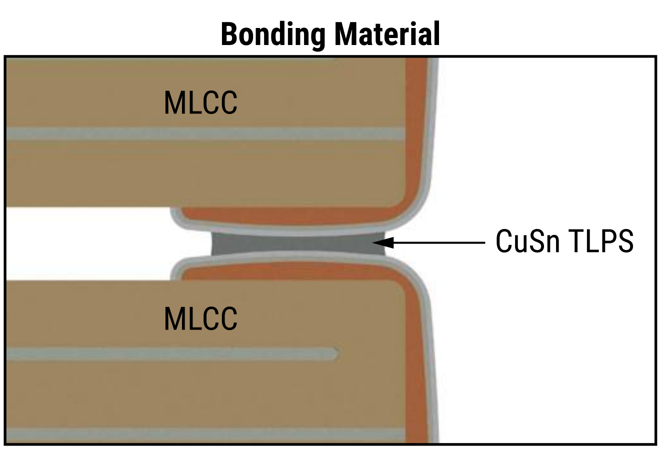
Please see KEMET's KONNEKT Soldering Guidelines here.

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.

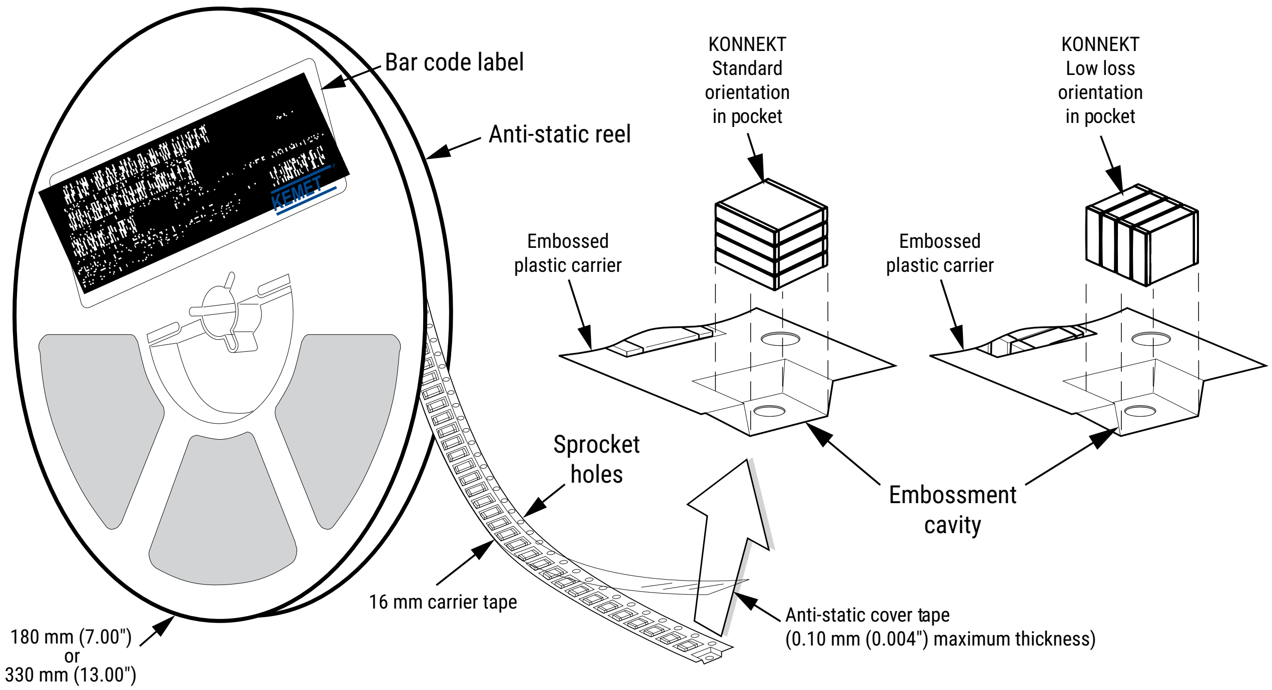


Table 4 – Carrier Tape Configuration, Embossed Plastic (mm)

EIA Case Size	Number of Chips	Part Orientation	Tape Size (W)[1]	Embossed Plastic	
				7" Reel	13" Reel
				Pitch (P_1)[2]	
1812	2	Standard	16	12	12
	3	Standard		16	16
	3	Low Loss		8	8
2220	2	Standard	16	8	8
	2	Low Loss		12	12
	3	Standard		12	12
	3	Low Loss		16	16
	4	Low Loss		20	20
3640	2	Standard	24	20	20
	3	Standard		20	20
	3	Low Loss		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

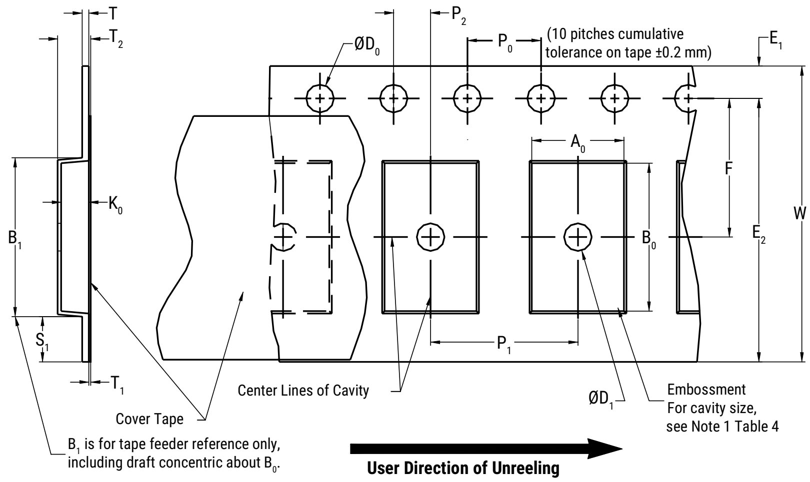


Table 5 – Embossed (Plastic) Carrier Tape Dimensions

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	9.0 (0.354)	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) ------------ **Low Loss Orientation 1812** 4.2 (0.166) **2220** 6.0 (0.236)	16.3 (0.642)	Note 5
	12 mm				12.0±0.10 (0.472±0.004)			
	16 mm				16.0±0.10 (0.630±0.004)			
	20 mm				20.0±0.10 (0.787±0.004)			
24 mm	20 mm	14.5 (0.571)	22.25 (0.875)	11.5+/−0.10 (0.452±0.004)	20.0±0.10 (0.787±0.004)	**3640** 11.2 (0.441)	"24.3 (0.957)"	Note 5
	24 mm				24.0±0.10 (0.944±0.004)			

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_0, B_0 and K_0 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)
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

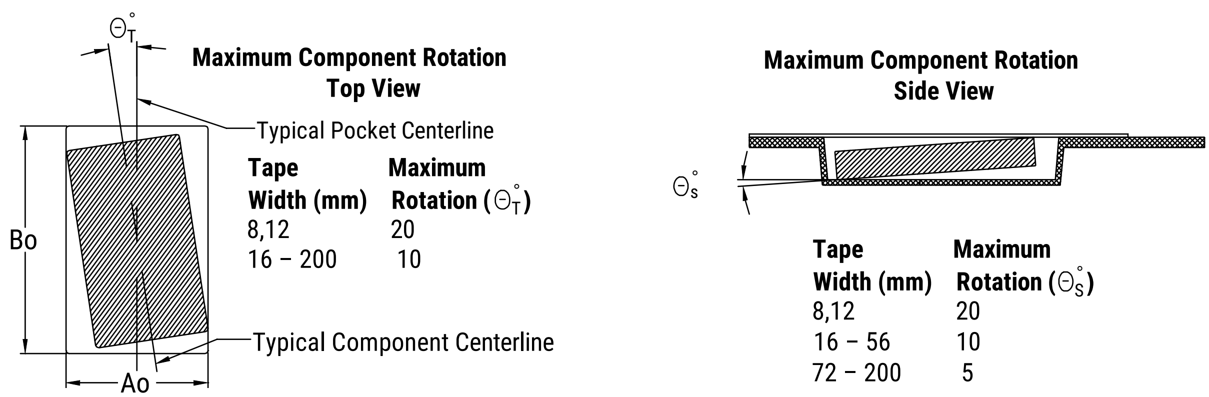


Figure 3 – Maximum Lateral Movement

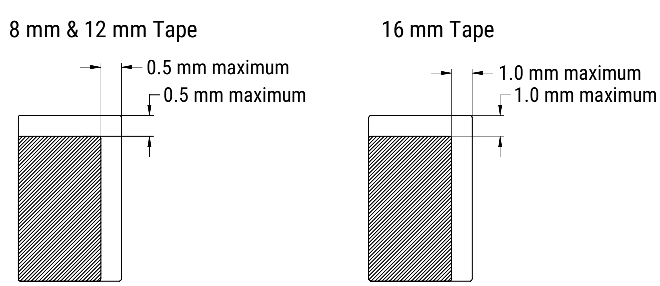


Figure 4 – Bending Radius

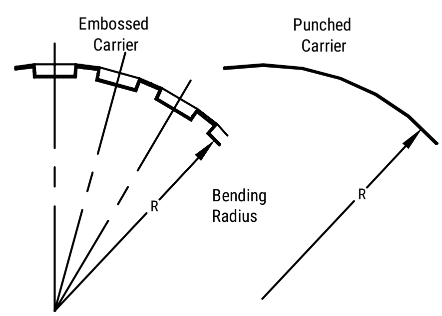
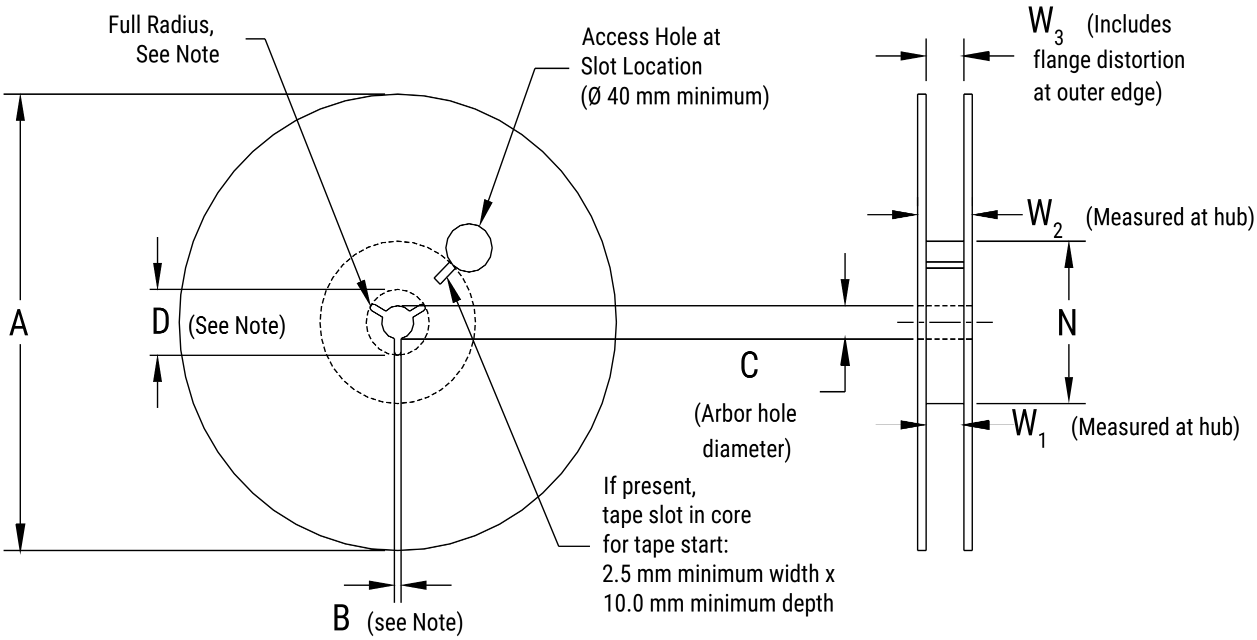


Figure 5 – Reel Dimensions



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	C	D Minimum
16 mm 24 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
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)	

Figure 6 – Tape Leader & Trailer Dimensions

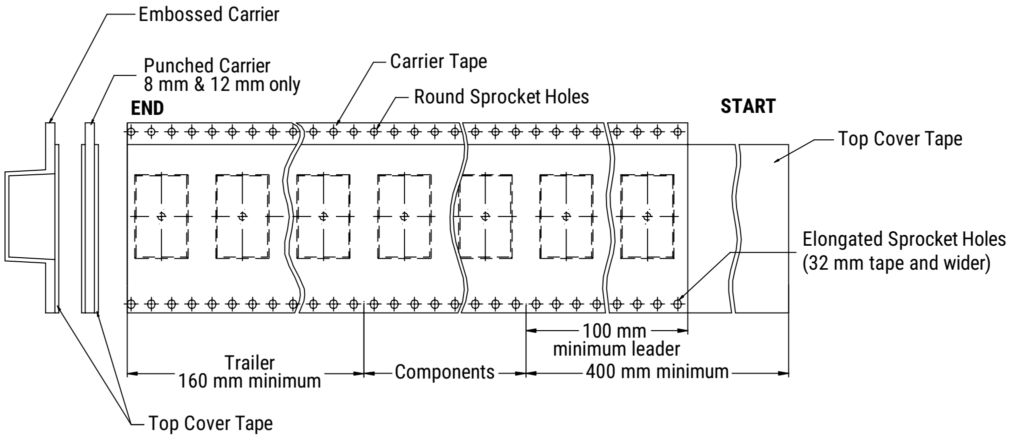
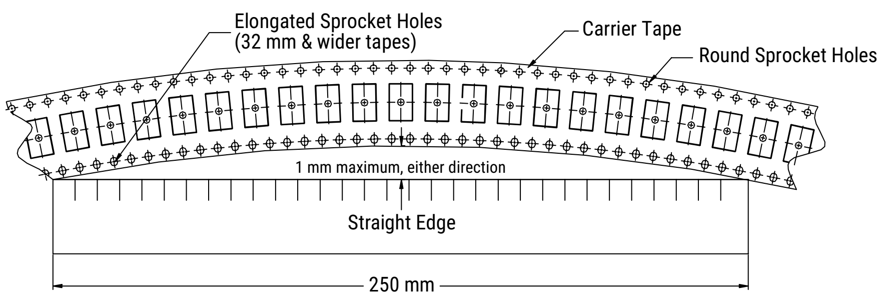


Figure 7 – Maximum Camber



Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs)

X7R with KONNEKT™ Technology, 25 – 3,000 VDC (Commercial & Automotive Grade)

KEMET a YAGEO company

RoHS Lead-free REACH COMPLIANT

KONNEKT™ High Density Packaging

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 multi-chip 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 ±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 µF
- 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

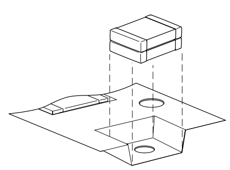
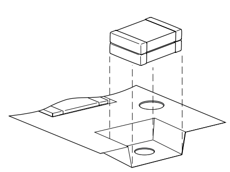
- SMPS (Switch Mode Power Supplies)
- Lighting ballasts, HID lighting
- DC/DC Converters
- Telecom equipment
- Industrial and medical equipment
- Filters
- Snubbers
- DC Blocking
- Bypass

Ordering Information

C	1812	C	944	K	C	R	L	C	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 X = Flexible Termination	Two single digits + number of zeros.	K = ±10% M = ±20%	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	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		AUTO7210

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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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.

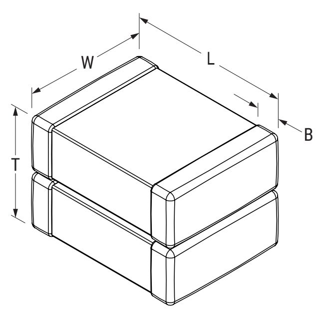
KEMET Automotive C-Spec	PPAP (Product Part Approval Process) Level				
	1	2	3	4	5
KEMET assigned[1]	●	●	●	●	●
AUTO			○		

[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
2 Chips**



Number of Chips	EIA SIZE CODE	METRIC SIZE CODE	TERMINATION	L LENGTH	W WIDTH	T THICKNESS	B BANDWIDTH	Mounting Technique
2	1812	4532	Standard	4.50 (0.177) ±0.30 (0.012)	3.20 (0.126) ±0.30 (0.012)	See Table 1A for Thickness	0.60 (0.024) ±0.35 (0.014)	Solder Reflow Only
			Flexible	4.50 (0.178) ±0.40 (0.016)	3.20 (0.126) ±0.30 (0.012)		0.70 (0.028) ±0.35 (0.014)	
2	2220	5750	Standard	5.70 (0.224) ±0.40 (0.016)	5.00 (0.197) ±0.40 (0.016	See Table 1B for Thickness	0.60 (0.024) ±0.35 (0.014	Solder Reflow Only
			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)	

Table 1A - 1812 Product Ordering Codes, Ratings, and Package Quantities

KEMET Part Number[1]	Capacitance	Cap Code	Voltage	Number of Chips	Thickness mm (inch)	Typical Average Piece Weight (g)	Tape & Reel Quantity	
							7" Tape & Reel	13" Tape & Reel
C1812(a)206(b)3RLC(c)	20 µF	206	25 V	2	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		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

KEMET Part Number[1]	Capacitance	Cap Code	Voltage	Number of Chips	Thickness mm (inch)	Typical Average Piece Weight (g)	Tape & Reel Quantity	
							7" Tape & Reel	13" Tape & Reel
C2220(a)206(b)5RLC(c)	20 µF	206	50 V	2	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		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)

<table>
<tr><th>Test</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Visual and Mechanical</td><td>KEMET Internal</td><td>No defects that may affect performance (10X)</td><td>Dimensions according KEMET Spec Sheet</td></tr>
<tr><td>Capacitance (Cap)</td><td>KEMET Internal</td><td>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</td><td>Within Tolerance</td></tr>
<tr><td>Dissipation Factor (DF)</td><td>KEMET Internal</td><td>C ≤ 10 µF
Frequency: 1 kHz ±50 Hz
Voltage: 1.0 ±0.2 V_{rms},0.5 ±0.2 V_{rms}

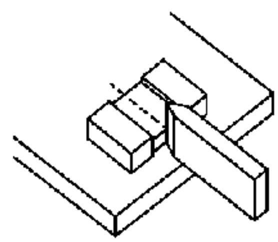
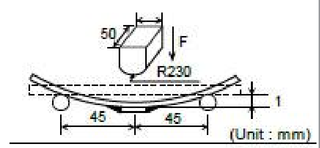
C > 10 µF
Frequency: 120 Hz ±10 Hz
Voltage: 0.5 ±0.1 V_{rms}</td><td>Within Specification
<table>
<tr><th>EIA Case Size</th><th>Rated DC Voltage</th><th>Capacitance</th><th>Dissipation Factor (Maximum %)</th></tr>
<tr><td rowspan="2">1812</td><td rowspan="3">ALL</td><td>< 20 µF</td><td>2.5</td></tr>
<tr><td>20 µF</td><td>3.5</td></tr>
<tr><td>2220</td><td>ALL</td><td>2.5</td></tr>
</table></td></tr>
<tr><td>Insulation Resistance (IR)</td><td>KEMET Internal</td><td>Apply rated voltage for 120 seconds at 25°C</td><td>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.
<table>
<tr><th>EIA Case Size</th><th>Rated DC Voltage</th><th>IR Limit</th></tr>
<tr><td rowspan="4">1812</td><td>25 – 100 V</td><td>500 megaohm microfarads or 10 GΩ</td></tr>
<tr><td>200 – 250 V</td><td>1,000 megaohm microfarads or 100 GΩ</td></tr>
<tr><td>500 – 1,000 V</td><td>100 megaohm microfarads or 10 GΩ</td></tr>
<tr><td>1,500 – 3,000 V</td><td>1,000 megaohm microfarads or 100 GΩ</td></tr>
<tr><td rowspan="4">2220</td><td>50 – 100 V</td><td>500 megaohm microfarads or 10 GΩ</td></tr>
<tr><td>200 – 250 V</td><td>1,000 megaohm microfarads or 100 GΩ</td></tr>
<tr><td>500 – 630 V</td><td>100 megaohm microfarads or 10 GΩ</td></tr>
<tr><td>1,000 – 3,000 V</td><td>1,000 megaohm microfarads or 100 GΩ</td></tr>
</table></td></tr>
<tr><td>Temperature Coefficient of Capacitance (TCC)</td><td>KEMET Internal</td><td>C ≤ 10µF
Frequency: 1 kHz ±50 Hz
Voltage*: 1.0 ±0.2 V_{rms}

C > 10µF
Frequency: 120 Hz ±10 Hz
Voltage: 0.5 ±0.1 V_{rms}

* See part number specification sheet for voltage
<table>
<tr><th>Step</th><th>Temperature (°C)</th></tr>
<tr><td>1</td><td>+25°C</td></tr>
<tr><td>2</td><td>−55°C</td></tr>
<tr><td>3</td><td>+25°C (Reference)</td></tr>
<tr><td>4</td><td>+125°C</td></tr>
</table></td><td>Capacitance ±15% over −55°C to +125°C</td></tr>
</table>

Performance and Reliability: Test Methods and Conditions (Commercial Only) cont.

<table>
<tr><th>Test</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Dielectric Withstanding Voltage (DWV)</td><td>KEMET Internal</td><td><table><tr><th>Rated DC Voltage</th><th>DWV Voltage (% of Rated)</th></tr><tr><td>< 500</td><td>250%</td></tr><tr><td>500/630</td><td>150%</td></tr><tr><td>≥ 1,000</td><td>120%</td></tr></table>(5 ±1 seconds and charge/discharge not exceeding 50 mA)</td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit

Withstand test voltage without insulation breakdown or damage.</td></tr>
<tr><td>Aging Rate (Maximum % Capacitance Loss/Decade Hour)</td><td>KEMET Internal</td><td>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.</td><td>3% Loss/Decade Hour</td></tr>
<tr><td>Terminal Strength</td><td>KEMET Internal</td><td>Shear stress test per specific case size, Time: 60±1 seconds<table><tr><th>Case Size</th><th>Force</th></tr><tr><td>1812</td><td rowspan="2">18N</td></tr><tr><td>2220</td></tr></table></td><td>No evidence of mechanical damage</td></tr>
<tr><td>Board Flex</td><td>AEC-Q200-005</td><td>Standard Termination System 2.0 mm
Flexible Termination System 3.0 mm
Test time: 60± 5 seconds
Ramp time: 1 mm/second
</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Solderability</td><td>KEMET Custom Test</td><td>1. Board shear – SAC305 solder. Shear force of 1.8 kg (minimum)
2. Wetting balance – IEC 60068–2–69</td><td>Visual Inspection.
95% coverage on termination.
No leaching</td></tr>
<tr><td>Temperature Cycling</td><td>JESD22 Method JA-104</td><td>1,000 cycles (−55°C to +125°C)
2 – 3 cycles per hour
Soak Time 1 or 5 minutes</td><td>Measurement at 24 hours ±4 hours after test conclusion.
Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit</td></tr>
</table>

Performance and Reliability: Test Methods and Conditions (Commercial Only) cont.

<table>
<tr><th>Test</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Biased Humidity</td><td>MIL-STD-202
Method 103</td><td>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.</td><td>Measurement at 24 hours ±4 hours after test conclusion.
Within Post Environmental Limits
Cap: ±20% shift
IR: 10% of Initial Limit
<table><tr><th colspan="2">DF Limits Maximum (%)</th></tr><tr><th>Initial</th><th>Post</th></tr><tr><td>2.5</td><td>3.0</td></tr><tr><td>3.5</td><td>5.0</td></tr></table></td></tr>
<tr><td>Moisture Resistance</td><td>MIL-STD-202
Method 106</td><td>Number of cycles required 10, 24 hours per cycle.
Steps 7a and 7b not required.</td><td>Measurement at 24 hours ±4 hours after test conclusion.
Within Post Environmental Limits
Cap: ±20% shift
IR: 10% of Initial Limit
<table><tr><th colspan="2">DF Limits Maximum (%)</th></tr><tr><th>Initial</th><th>Post</th></tr><tr><td>2.5</td><td>3.0</td></tr><tr><td>3.5</td><td>5.0</td></tr></table></td></tr>
<tr><td>Thermal Shock</td><td>MIL-STD-202
Method 107</td><td>Number of cycles required 5, (−55°C to 125°C)
Dwell time 15 minutes.</td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit</td></tr>
<tr><td>High Temperature Life</td><td rowspan="2">MIL-STD-202
Method 108</td><td>1,000 hours at 125°C with 1.0 X rated voltage applied</td><td rowspan="2">Within Post Environmental Limits
Cap: ±20% shift
IR: 10% of Initial Limit
<table><tr><th colspan="2">DF Limits Maximum (%)</th></tr><tr><th>Initial</th><th>Post</th></tr><tr><td>2.5</td><td>3.0</td></tr><tr><td>3.5</td><td>5.0</td></tr></table></td></tr>
<tr><td>Storage Life</td><td>1,000 hours at 125°C, Unpowered</td></tr>
</table>

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	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.

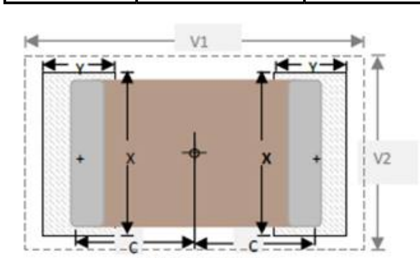
Environmental Compliance

RoHS Lead-free REACH COMPLIANT

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	Median (Nominal) Land Protrusion				
					C	Y	X	V1	V2
2	Standard	1812	4532	Standard	2.05	1.40	3.50	6.00	4.00
				Flexible	2.00	1.60	3.50	6.10	4.00
2	Standard	2220	5750	Standard	2.65	1.50	5.40	7.30	5.90
				Flexible	2.75	1.90	5.40	7.90	5.90



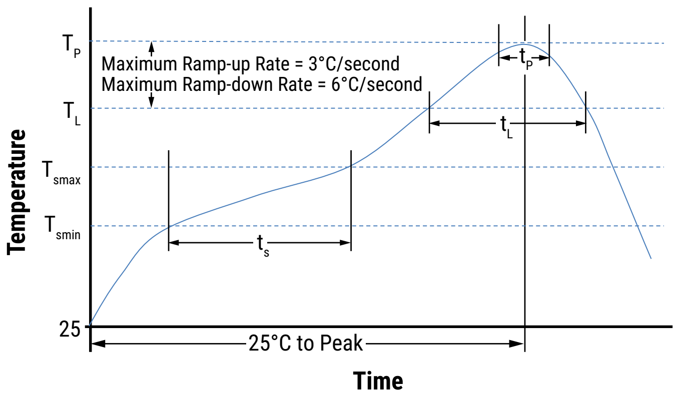
Soldering Process

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.

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.



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.

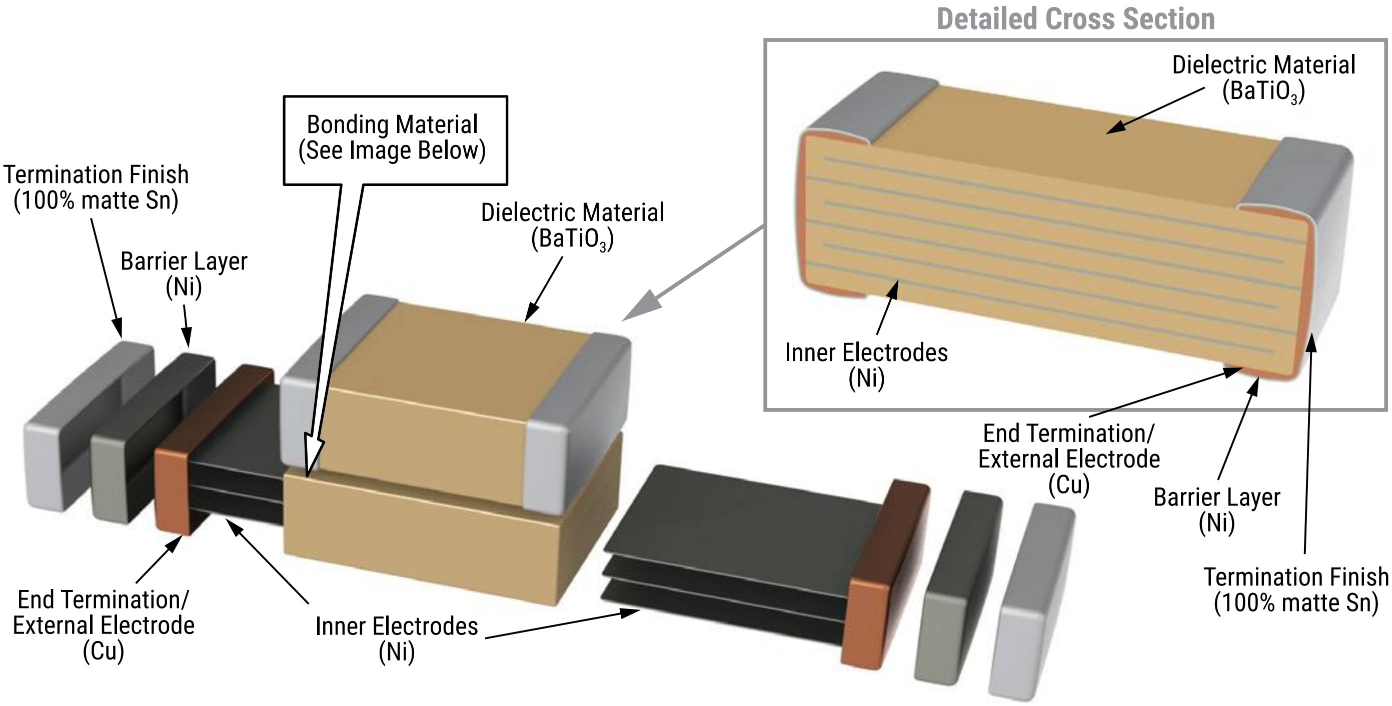
However, it is understood that the manual attachment of KONNEKT capacitors is necessary for prototype and lab testing. In these instances, care must be taken not to introduce excessive temperature gradients in the KONNEKT part type that may lead to cracking in the ceramic or separation of the TLPS material.

Please see KEMET's KONNEKT Soldering Guidelines here.

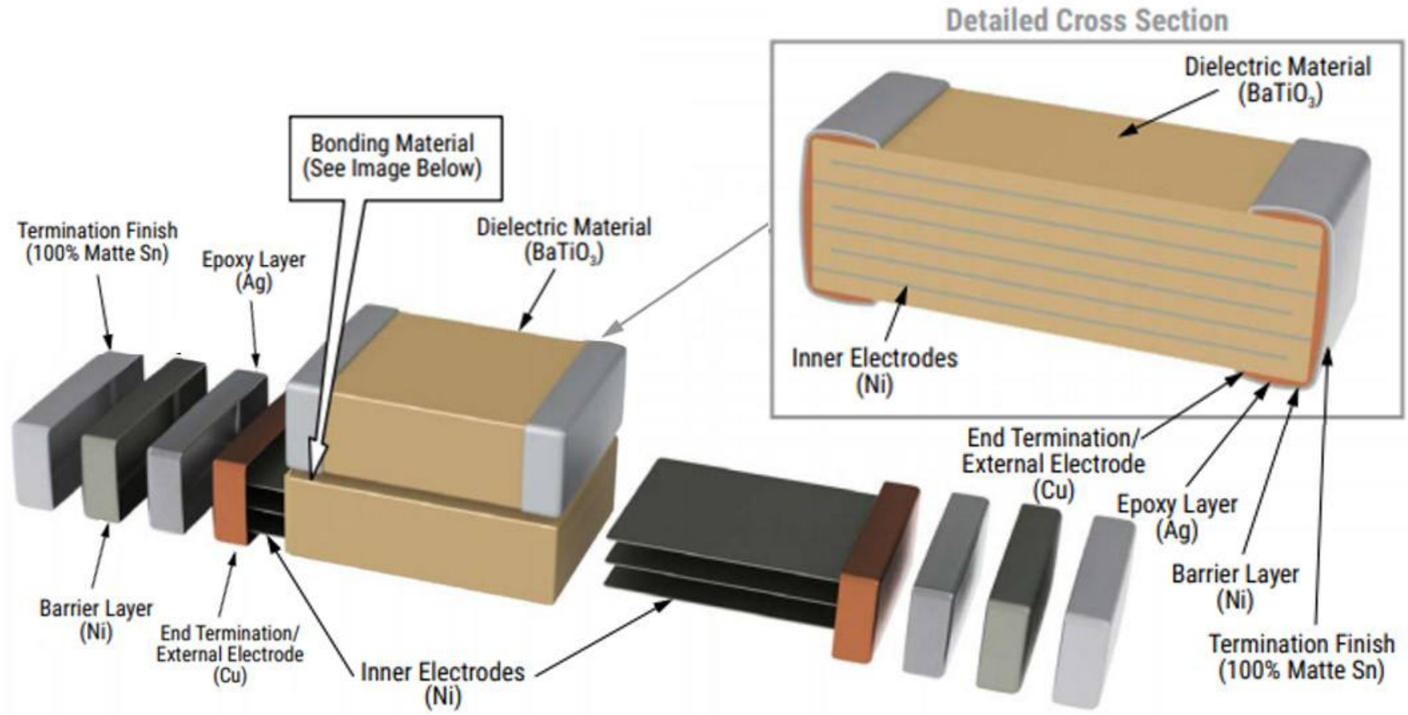
Storage & Handling

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.

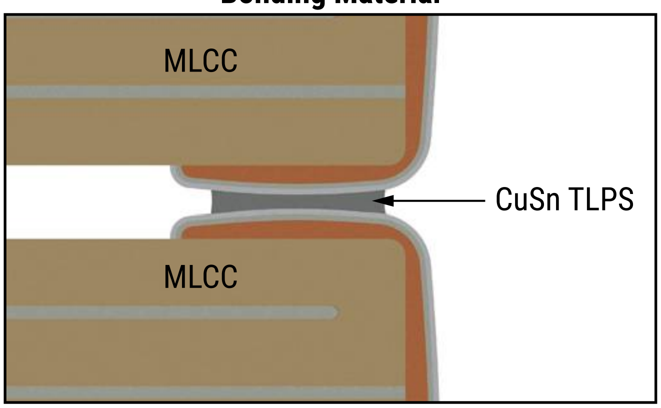
Construction – Standard Termination



Construction – Flexible Termination



Bonding Material



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.

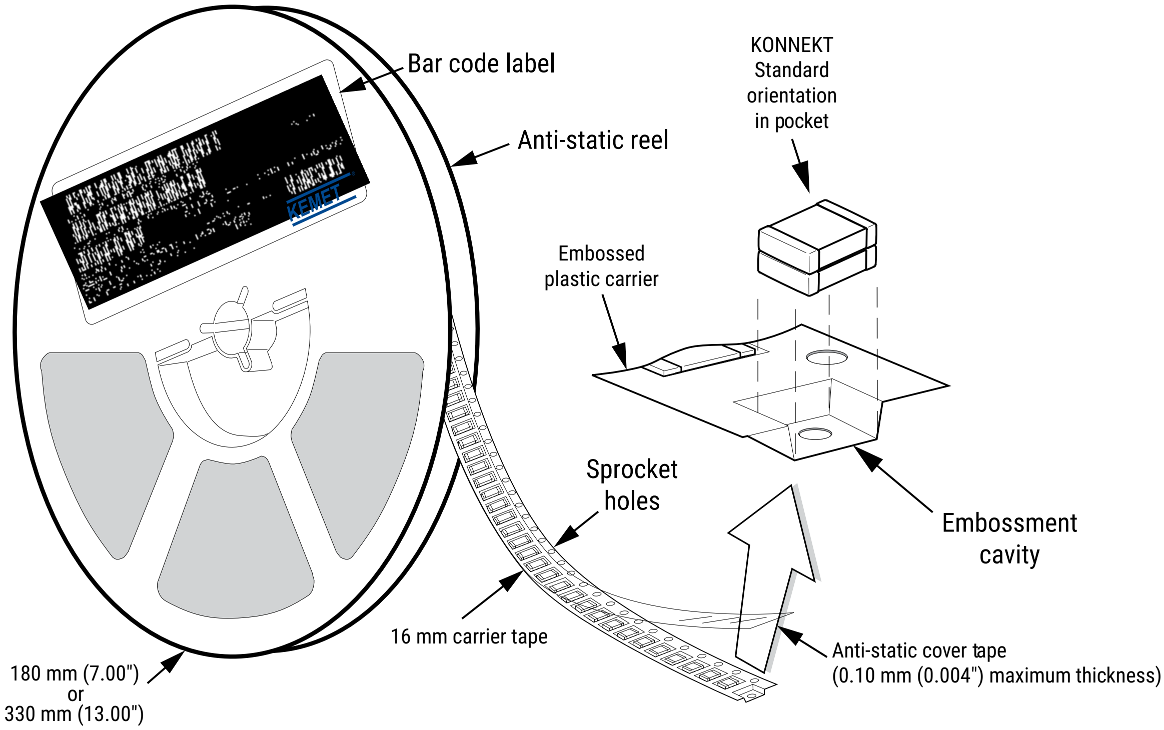


Table 4 – Carrier Tape Configuration, Embossed Plastic (mm)

EIA Case Size	Number of Chips	Chip Thickness	Tape Size (W)[1]	Embossed Plastic 7" Reel	Embossed Plastic 13" Reel
				Pitch (P_1)[2]	
KONNEKT 1812	2	≤ 3.5 mm	16	8	8
		> 3.5 mm		12	12
KONNEKT 2220	2	≤ 3.5 mm >5.0 mm & ≤ 5.3 mm	16	8	8
		> 3.5 mm ≤ 5.0		12	12

1. Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations.
2. Refer to Tables 4 and 5 for tolerance specifications.

Figure 1 – Embossed (Plastic) Carrier Tape Dimensions

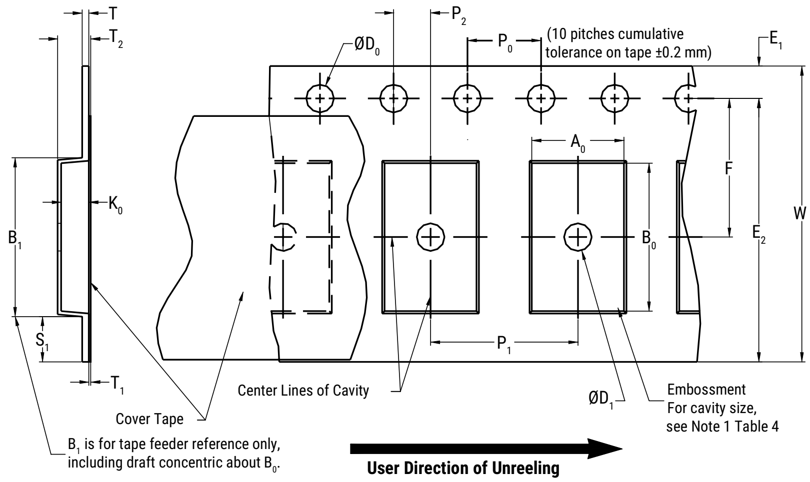


Table 5 – Embossed (Plastic) Carrier Tape Dimensions

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)	7.9 (0.311)	14.25 (0.561)	7.5±0.05 (0.138±0.002)	12.0±0.10 (0.472±0.004)	6.5 (0.256)	16.3 (0.642)	Note 5
			Double (8mm)	7.5 (0.295)			8.0±0.10 (0.315±0.004)			
2220	2	16 mm	Triple (12mm)	8.5 (0.335)	14.25 (0.561)	7.5±0.05 (0.138±0.002)	12.0±0.10 (0.472±0.004)	6.5 (0.256)	16.3 (0.642)	Note 5
			Double (8mm)	9.2 (0.363)			8.0±0.10 (0.315±0.004)			

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 S_1 < 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_0, B_0 and K_0 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_0 and B_0 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

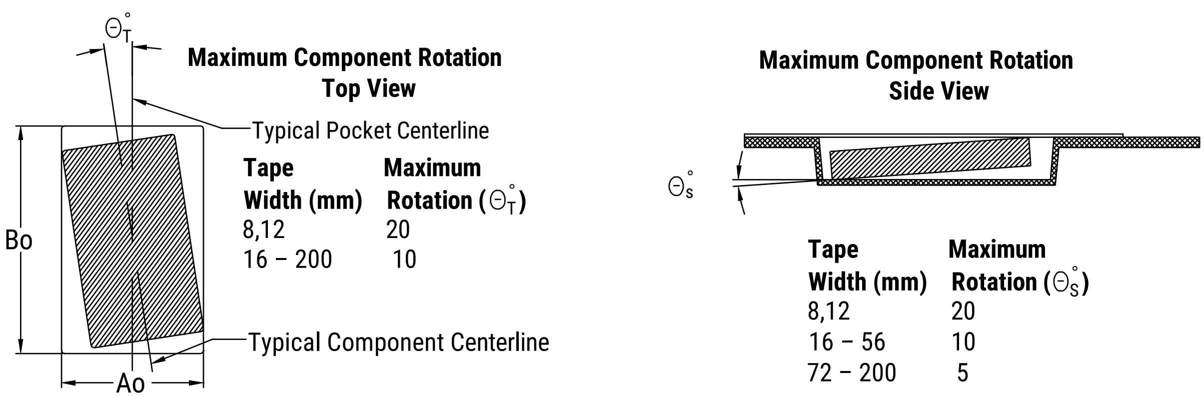


Figure 3 – Maximum Lateral Movement

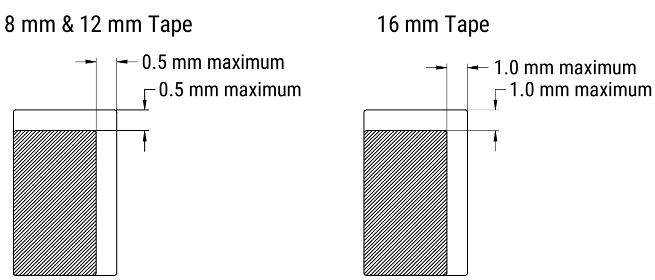
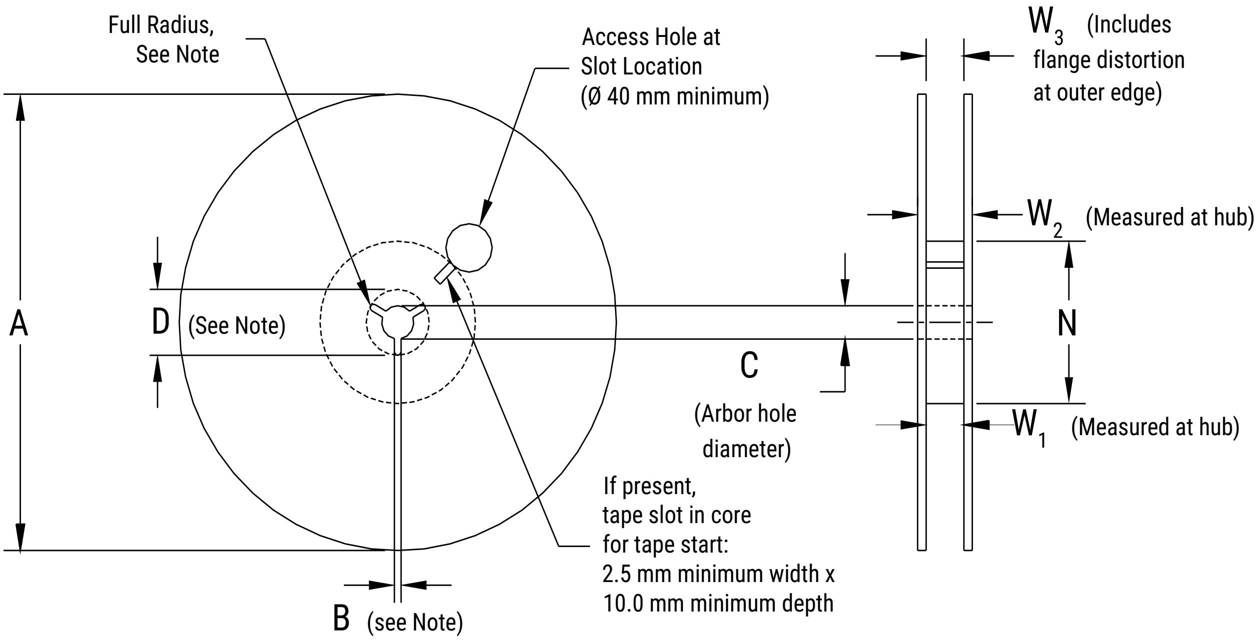


Figure 5 – Reel Dimensions



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

Table 6 – Reel Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)				
Tape Size	A	B Minimum	C	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

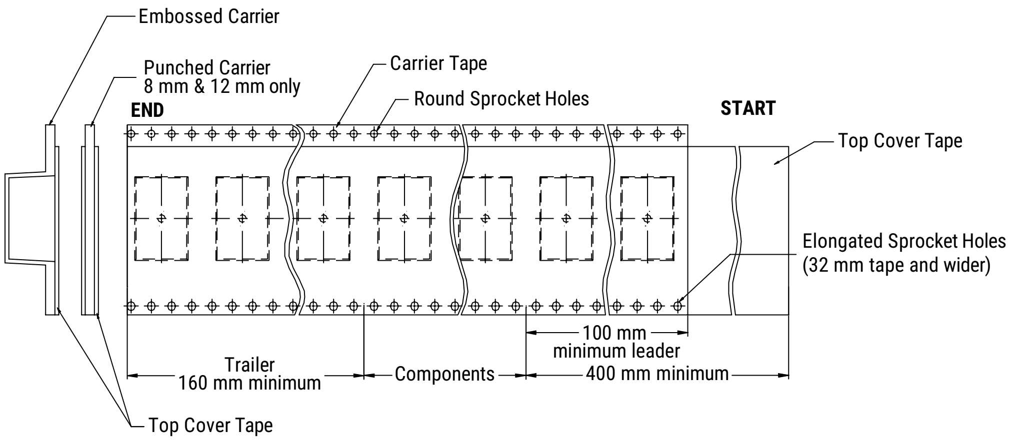
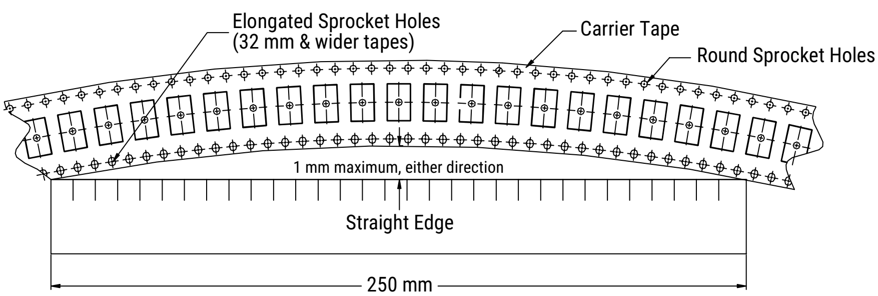


Figure 7 – Maximum Camber



Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs)

High Temperature 150°C, X8G Dielectric, 10 – 250 VDC (Commercial & Automotive Grade)

RoHS Lead-free REACH COMPLIANT

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.

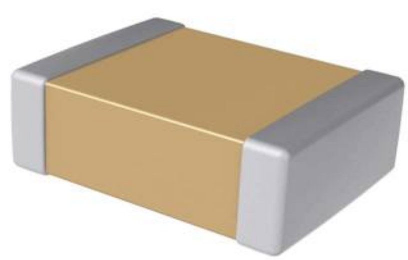
In addition to commercial grade, automotive grade devices are available and meet Automotive Electronics Council's AEC-Q200 qualification requirements. Also available with flexible termination technology which inhibits the transfer of board stress to the rigid ceramic body, therefore mitigating flex cracks 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 0.47μF
- 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	T	A	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 = ±0.10 pF C = ±0.25 pF D = ±0.5 pF F = ±1% G = ±2% J = ±5% K = ±10% M = ±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)
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	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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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:

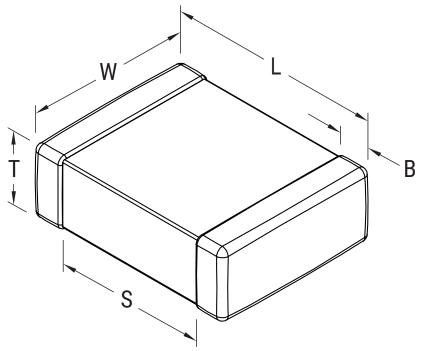
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

[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)	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)		
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)	See Table 2 for Thickness	0.45 (0.018) ±0.15 (0.006)	0.58 (0.023)	Solder Wave or Solder Reflow
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)	
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	
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
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)		
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)

Capacitance	Cap Code	Case Size/Series								C0402C							C0603C							C0805C							C1206C						
		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
		Rated Voltage (VDC)								10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Table 2 for Chip 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	DN	DN							
1.0 - 9.1 pF*	109 - 919*	B	C	D						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
10 pF	100				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				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
12 pF	120				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
13 pF	130				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
15 pF	150				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
16 pF	160				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
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				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
24 pF	240				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
27 pF	270				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
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				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
39 pF	390				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
43 pF	430				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
47 pF	470				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
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	680				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
75 pF	750				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
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	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 pF	111				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	EB	EB	EB	EB	EB	EB	EB
120 pF	121				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	EB	EB	EB	EB	EB	EB	EB
130 pF	131				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	EB	EB	EB	EB	EB	EB	EB
150 pF	151				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	EB	EB	EB	EB	EB	EB	EB
160 pF	161				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	EB	EB	EB	EB	EB	EB	EB
180 pF	181				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	EB	EB	EB	EB	EB	EB	EB
200 pF	201				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	EB	EB	EB	EB	EB	EB	EB
220 pF	221				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	EB	EB	EB	EB	EB	EB	EB
240 pF	241				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	EB	EB	EB	EB	EB	EB	EB
270 pF	271				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	EB	EB	EB	EB	EB	EB	EB
300 pF	301				F	G	J	K	M	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	K	M	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	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
390 pF	391				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
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
750 pF	751				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
820 pF	821				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
910 pF	911				F	G	J	K	M	BB	BB	BB	BB	BB			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				F	G	J	K	M	BB	BB	BB	BB	BB			CF	CF	CF	CF	CF	CF	CF	DN	DN	DN	DN	DP	DP	DP	EB	EB	EB	EB	EB	EE	EE
1,100 pF	112				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
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
Capacitance	Cap Code	Rated Voltage (VDC)								10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250
		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								C0402C							C0603C							C0805C							C1206C						

Table 1A – Standard Termination Capacitance Range/Selection Waterfall (0402 – 1206 Case Sizes) cont.

Capacitance	Cap Code	Case Size/Series					C0402C							C0603C							C0805C							C1206C						
		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
		Rated Voltage (VDC)					10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250
		Capacitance Tolerance					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																											
1,300 pF	132	F	G	J	K	M	BB	BB	BB	BB				CF	CF	CF	CF	CF	CH	CH	DP	DP	DP	DP	DP	DN	DN	EB	EB	EB	EB	EC	EC	EC
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	EB	EB	EB	EB	ED	EC	EC
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	EB	EB	EB	EB	ED	ED	ED
1,800 pF	182	F	G	J	K	M	BB	BB	BB					CF	CF	CF	CF	CF	CH	CH	DP	DP	DP	DP	DP	DN	DN	EB	EB	EB	EB	ED	ED	ED
2,000 pF	202	F	G	J	K	M	BB	BB	BB					CF	CF	CF	CF	CF	CH	CH	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	CH	CH	DN	DN	DN	DN	DN	DN	DN	EB	EB	EB	EB	EE	EE	ED
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	F	G	J	K	M								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			DN	DN	DN	DN	DN	DN	DN	EC	EC	EC	EC	EC	EB	EB
3,300 pF	332	F	G	J	K	M								CF	CF	CF	CF	CF			DN	DN	DN	DN	DN	DN	DN	EC	EC	EC	EC	EE	EB	EB
3,600 pF	362	F	G	J	K	M								CF	CF	CF	CF	CF			DN	DN	DN	DN	DN	DP	DP	EC	EC	EC	EC	EE	EB	EB
3,900 pF	392	F	G	J	K	M								CF	CF	CF	CF	CF			DN	DN	DN	DN	DN	DP	DP	EC	EC	EC	EC	EF	EB	EB
4,300 pF	432	F	G	J	K	M								CF	CF	CF	CF	CF			DN	DN	DN	DN	DN	DP	DP	EC	EC	EC	EC	EC	EB	EB
4,700 pF	472	F	G	J	K	M								CF	CF	CF	CF	CF			DN	DN	DN	DN	DN	DP	DP	EC	EC	EC	EC	EC	EB	EB
5,100 pF	512	F	G	J	K	M								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	K	M								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	K	M								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	K	M								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	K	M								CF	CF	CF					DN	DN	DN	DN	DN	DG	DG	EB	EB	EB	EB	EB	EB	EB
8,200 pF	822	F	G	J	K	M								CF	CF	CF					DN	DN	DN	DN	DN	DG	DG	EB	EB	EB	EB	EB	EC	EC
9,100 pF	912	F	G	J	K	M								CF	CF	CF					DN	DN	DN	DN	DN			EB	EB	EB	EB	EB	EC	EC
10,000 pF	103	F	G	J	K	M								CF	CF	CF					DN	DN	DN	DN	DP			EB	EB	EB	EB	EB	EC	EC
12,000 pF	123	F	G	J	K	M								CF	CF	CF					DN	DN	DN	DN	DE			EB	EB	EB	EB	EB	ED	ED
15,000 pF	153	F	G	J	K	M								CF	CF	CF					DN	DN	DN	DP	DG			EB	EB	EB	EB	EB	EF	EF
18,000 pF	183	F	G	J	K	M															DN	DN	DN	DP				EB	EB	EB	EB	EB	EH	EH
22,000 pF	223	F	G	J	K	M															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	F	G	J	K	M															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			
100,000 pF	104	F	G	J	K	M																						EH	EH	EH				
Capacitance	Cap Code	Rated Voltage (VDC)					10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250
		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					C0402C							C0603C							C0805C							C1206C						

Table 1B – Standard Termination Capacitance Range/Selection Waterfall (1210 – 2220 Case Sizes)

Capacitance	Cap Code	Case Size/Series								C1210C							C1812C				C2220C		
		Voltage Code								8	4	3	5	1	2	A	5	1	2	A	5	1	2
		Rated Voltage (VDC)								10	16	25	50	100	200	250	50	100	200	250	50	100	200
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions													
1.0 - 9.1 pF*	109 - 919*	B	C	D						FB	FB	FB	FB	FB	FB	FB							
10 pF	100				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB							
11 pF	110				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	150				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB							
16 pF	160				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	K	M	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	270				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB							
30 pF	300				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB							
33 pF	330				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB							
36 pF	360				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB							
39 pF	390				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB							
43 pF	430				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB							
47 pF	470				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	M	FB	FB	FB	FB	FB	FB	FB							
68 pF	680				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB							
75 pF	750				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB							
82 pF	820				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB							
91 pF	910				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB							
100 pF	101				F	G	J	K	M	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				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB							
150 pF	151				F	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	M	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	271				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB							
300 pF	301				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB							
330 pF	331				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB							
360 pF	361				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB							
390 pF	391				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB							
430 pF	431				F	G	J	K	M	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	FB	FB	FB	FB	FB	FB	FB	GB	GB	GB	GB			
560 pF	561				F	G	J	K	M	FB	FB	FB	FB	FB	FB	FB	GB	GB	GB	GB			
620 pF	621				F	G	J	K	M	FB	FB	FB	FB	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	M	FB	FB	FB	FB	FB	FB	FB	GB	GB	GB	GB			
820 pF	821				F	G	J	K	M	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	FB	FB	FB	FB	FB	GB	GB	GB	GB			
1,100 pF	112				F	G	J	K	M	FB	FB	FB	FB	FB	FB	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	M	FB	FB	FB	FB	FB	FE	FE	GB	GB	GB	GB			
Capacitance	Cap Code	Rated Voltage (VDC)								10	16	25	50	100	200	250	50	100	200	250	50	100	200
		Voltage Code								8	4	3	5	1	2	A	5	1	2	A	5	1	2
		Case Size/Series								C1210C							C1812C				C2220C		

Table 1B – Standard Termination Capacitance Range/Selection Waterfall (1210 – 2220 Case Sizes) cont.

Capacitance	Cap Code	Case Size/Series					C1210C							C1812C				C2220C		
		Voltage Code					8	4	3	5	1	2	A	5	1	2	A	5	1	2
		Rated Voltage (VDC)					10	16	25	50	100	200	250	50	100	200	250	50	100	200
		Capacitance Tolerance					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions													
1,600 pF	162	F	G	J	K	M	FB	FB	FB	FB	FB	FE	FE	GB	GB	GB	GB			
1,800 pF	182	F	G	J	K	M	FB	FB	FB	FB	FB	FE	FE	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							
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							
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	M	FB	FB	FB	FB	FF	FF	FF							
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							
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	K	M	FB	FB	FB	FB	FB	FF	FF	GB	GB	GB	GB	JE	JB	JB
27,000 pF	273	F	G	J	K	M	FB	FB	FB	FB	FB	FG	FG	GB	GB	GB	GB	JE	JB	JB
33,000 pF	333	F	G	J	K	M	FB	FB	FB	FB	FB	FH	FH	GB	GB	GB	GB	JB	JB	JB
39,000 pF	393	F	G	J	K	M	FB	FB	FB	FB	FE	FH	FH	GB	GB	GB	GB	JB	JB	JB
47,000 pF	473	F	G	J	K	M	FB	FB	FB	FB	FE	FJ	FJ	GB	GB	GD	GD	JB	JB	JB
56,000 pF	563	F	G	J	K	M	FB	FB	FB	FB	FF			GB	GB	GD	GD	JB	JB	JB
68,000 pF	683	F	G	J	K	M	FB	FB	FB	FC	FG			GB	GB	GK	GK	JB	JB	JB
82,000 pF	823	F	G	J	K	M	FC	FC	FC	FF	FH			GB	GB	GM	GM	JB	JB	JB
100,000 pF	104	F	G	J	K	M	FE	FE	FE	FG	FM			GB	GD	GM	GM	JB	JB	JD
120,000 pF	124	F	G	J	K	M	FG	FG	FG	FH				GB	GH			JB	JB	JD
150,000 pF	154	F	G	J	K	M	FH	FH	FH	FM				GD	GN			JB	JB	JG
180,000 pF	184	F	G	J	K	M	FJ	FJ	FJ					GH				JB	JD	JG
220,000 pF	224	F	G	J	K	M								GK				JB	JD	JL
270,000 pF	274	F	G	J	K	M												JB	JF	
330,000 pF	334	F	G	J	K	M												JD	JG	
390,000 pF	394	F	G	J	K	M												JG		
470,000 pF	474	F	G	J	K	M												JG		
Capacitance	Cap Code	Rated Voltage (VDC)					10	16	25	50	100	200	250	50	100	200	250	50	100	200
		Voltage Code					8	4	3	5	1	2	A	5	1	2	A	5	1	2
		Case Size/Series					C1210C							C1812C				C2220C		

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Table 1C – Flexible Termination Capacitance Range/Selection Waterfall (0603 – 1206 Case Sizes)

Capacitance	Cap Code	Case Size/Series								C0603C							C0805C							C1206C						
		Voltage Code								8	4	3	5	1	2	A	8	4	3	5	1	2	A	8	4	3	5	1	2	A
		Rated Voltage (VDC)								10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																				
0.50 & 0.75 pF	508 & 758	B	C	D						CJ	CJ	CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	DR	DR							
0.75 pF	758	B	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	DR	DR	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ
1.2 pF	129	B	C	D						CJ	CJ	CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ
1.3 pF	139	B	C	D						CJ	CJ	CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ
1.5 pF	159	B	C	D						CJ	CJ	CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ
1.6 pF	169	B	C	D						CJ	CJ	CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ
1.8 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	B	C	D						CJ	CJ	CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ
2.2 pF	229	B	C	D						CJ	CJ	CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ
2.4 pF	249	B	C	D						CJ	CJ	CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ
2.7 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	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ
3.3 pF	339	B	C	D						CJ	CJ	CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ
3.6 pF	369	B	C	D						CJ	CJ	CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ
3.9 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	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
4.7 pF	479	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	B	C	D						CJ	CJ	CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ
5.6 pF	569	B	C	D						CJ	CJ	CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ
6.2 pF	629	B	C	D						CJ	CJ	CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	DR	DR	EQ	EQ	EQ	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
8.2 pF	829	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						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	K	M	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	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ
12 pF	120				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
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	M	CJ	CJ	CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ
16 pF	160				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
18 pF	180				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
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 pF	240				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
27 pF	270				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
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	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
39 pF	390				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
51 pF	510				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	M	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
75 pF	750				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	K	M	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 pF	111				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
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	151				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
160 pF	161				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
Capacitance	Cap Code	Rated Voltage (VDC)								10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250
		Voltage Code								8	4	3	5	1	2	A	8	4	3	5	1	2	A	8	4	3	5	1	2	A
		Case Size/Series								C0603C							C0805C							C1206C						

Table 1C – Flexible Termination Capacitance Range/Selection Waterfall (0603 – 1206 Case Sizes) cont.

Capacitance	Cap Code	Case Size/Series					C0603C							C0805C							C1206C						
		Voltage Code					8	4	3	5	1	2	A	8	4	3	5	1	2	A	8	4	3	5	1	2	A
		Rated Voltage (VDC)					10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250
		Capacitance Tolerance					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																				
180 pF	181	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
200 pF	201	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
220 pF	221	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
240 pF	241	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
270 pF	271	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
300 pF	301	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
330 pF	331	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
360 pF	361	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
390 pF	391	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
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	471	F	G	J	K	M	CJ	CJ	CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DR	DD	DD	EQ	EQ	EQ	EQ	EQ	EQ	EQ
510 pF	511	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
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	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
680 pF	681	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
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	821	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
910 pF	911	F	G	J	K	M	CJ	CJ	CJ	CJ	CJ	CJ	CJ	DR	DR	DR	DR	DD	DD	DD	EQ	EQ	EQ	EQ	EQ	EQ	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	EQ	EQ	EQ	EQ	EQ	EQ
1,100 pF	112	F	G	J	K	M	CJ	CJ	CJ	CJ	CJ	CH	CH	DR	DR	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	EQ	EQ	EQ
1,200 pF	122	F	G	J	K	M	CJ	CJ	CJ	CJ	CJ	CH	CH	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	152	F	G	J	K	M	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	CJ	CJ	CJ	CJ	CH	CH	DD	DD	DD	DD	DD	DR	DR	EQ	EQ	EQ	EQ	ES	ES	ES
1,800 pF	182	F	G	J	K	M	CJ	CJ	CJ	CJ	CJ	CH	CH	DD	DD	DD	DD	DD	DR	DR	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	CH	CH	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	DR	EQ	EQ	EQ	EQ	ER	ER	ER
2,700 pF	272	F	G	J	K	M	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DR	DR	EQ	EQ	EQ	EQ	ER	ER	ER
3,000 pF	302	F	G	J	K	M	CJ	CJ	CJ	CJ	CJ			DD	DD	DR	DR	DR	DR	DR	ER	ER	ER	ER	ER	EQ	EQ
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	K	M	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	K	M	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
4,700 pF	472	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	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	K	M	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	752	F	G	J	K	M	CJ	CJ	CJ					DR	DR	DR	DR	DR	DG	DG	EQ	EQ	EQ	EQ	EQ	EQ	EQ
8,200 pF	822	F	G	J	K	M	CJ	CJ	CJ					DR	DR	DR	DR	DR	DG	DG	ER	ER	EQ	EQ	EQ	ER	ER
9,100 pF	912	F	G	J	K	M	CJ	CJ	CJ					DR	DR	DR	DR	DR			ER	ER	EQ	EQ	EQ	ER	ER
10,000 pF	103	F	G	J	K	M	CJ	CJ	CJ					DR	DR	DR	DR	DD			EQ	EQ	EQ	EQ	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
18,000 pF	183	F	G	J	K	M								DR	DR	DR	DD				EQ	EQ	EQ	EQ	EQ	EH	EH
22,000 pF	223	F	G	J	K	M								DD	DD	DD	DF				EQ	EQ	EQ	EQ	ER	EH	EH
27,000 pF	273	F	G	J	K	M								DF	DF	DF					EQ	EQ	EQ	EQ	ET		
33,000 pF	333	F	G	J	K	M								DG	DG	DG					EQ	EQ	EQ	EQ	ET		
39,000 pF	393	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	F	G	J	K	M															ES	ES	ES	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			
100,000 pF	104	F	G	J	K	M															EH	EH	EH				
Capacitance	Cap Code	Rated Voltage (VDC)					10	16	25	50	100	200	250	10	16	25	50	100	200	250	10	16	25	50	100	200	250
		Voltage Code					8	4	3	5	1	2	A	8	4	3	5	1	2	A	8	4	3	5	1	2	A
		Case Size/Series					C0603C							C0805C							C1206C						

Table 1D – Flexible Termination Capacitance Range/Selection Waterfall (1210 – 2220 Case Sizes)

Capacitance	Cap Code	Case Size/Series								C1210C							C1812C				C2220C		
		Voltage Code								8	4	3	5	1	2	A	5	1	2	A	5	1	2
		Rated Voltage (VDC)								10	16	25	50	100	200	250	50	100	200	250	50	100	200
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions													
1.0 - 9.1 pF*	109 - 919*	B	C	D						FN	FN	FN	FN	FN	FN	FN							
1.1 pF	119	B	C	D						FN	FN	FN	FN	FN	FN	FN							
1.2 pF	129	B	C	D						FN	FN	FN	FN	FN	FN	FN							
1.3 pF	139	B	C	D						FN	FN	FN	FN	FN	FN	FN							
1.5 pF	159	B	C	D						FN	FN	FN	FN	FN	FN	FN							
1.6 pF	169	B	C	D						FN	FN	FN	FN	FN	FN	FN							
1.8 pF	189	B	C	D						FN	FN	FN	FN	FN	FN	FN							
2.0 pF	209	B	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	279	B	C	D						FN	FN	FN	FN	FN	FN	FN							
3.0 pF	309	B	C	D						FN	FN	FN	FN	FN	FN	FN							
3.3 pF	339	B	C	D						FN	FN	FN	FN	FN	FN	FN							
3.6 pF	369	B	C	D						FN	FN	FN	FN	FN	FN	FN							
3.9 pF	399	B	C	D						FN	FN	FN	FN	FN	FN	FN							
4.3 pF	439	B	C	D						FN	FN	FN	FN	FN	FN	FN							
4.7 pF	479	B	C	D						FN	FN	FN	FN	FN	FN	FN							
5.1 pF	519	B	C	D						FN	FN	FN	FN	FN	FN	FN							
5.6 pF	569	B	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						FN	FN	FN	FN	FN	FN	FN							
7.5 pF	759	B	C	D						FN	FN	FN	FN	FN	FN	FN							
8.2 pF	829	B	C	D						FN	FN	FN	FN	FN	FN	FN							
9.1 pF	919	B	C	D						FN	FN	FN	FN	FN	FN	FN							
10 pF	100				F	G	J	K	M	FN	FN	FN	FN	FN	FN	FN							
11 pF	110				F	G	J	K	M	FN	FN	FN	FN	FN	FN	FN							
12 pF	120				F	G	J	K	M	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	M	FN	FN	FN	FN	FN	FN	FN							
18 pF	180				F	G	J	K	M	FN	FN	FN	FN	FN	FN	FN							
20 pF	200				F	G	J	K	M	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	270				F	G	J	K	M	FN	FN	FN	FN	FN	FN	FN							
30 pF	300				F	G	J	K	M	FN	FN	FN	FN	FN	FN	FN							
33 pF	330				F	G	J	K	M	FN	FN	FN	FN	FN	FN	FN							
36 pF	360				F	G	J	K	M	FN	FN	FN	FN	FN	FN	FN							
39 pF	390				F	G	J	K	M	FN	FN	FN	FN	FN	FN	FN							
43 pF	430				F	G	J	K	M	FN	FN	FN	FN	FN	FN	FN							
47 pF	470				F	G	J	K	M	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	M	FN	FN	FN	FN	FN	FN	FN							
Capacitance	Cap Code	Rated Voltage (VDC)								10	16	25	50	100	200	250	50	100	200	250	50	100	200
		Voltage Code								8	4	3	5	1	2	A	5	1	2	A	5	1	2
		Case Size/Series								C1210C							C1812C				C2220C		

Table 1D – Flexible Termination Capacitance Range/Selection Waterfall (1210 – 2220 Case Sizes) cont.

Capacitance	Cap Code	Case Size/Series					C1210C							C1812C				C2220C		
		Voltage Code					8	4	3	5	1	2	A	5	1	2	A	5	1	2
		Rated Voltage (VDC)					10	16	25	50	100	200	250	50	100	200	250	50	100	200
		Capacitance Tolerance					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions													
62 pF	620	F	G	J	K	M	FN	FN	FN	FN	FN	FN	FN							
68 pF	680	F	G	J	K	M	FN	FN	FN	FN	FN	FN	FN							
75 pF	750	F	G	J	K	M	FN	FN	FN	FN	FN	FN	FN							
82 pF	820	F	G	J	K	M	FN	FN	FN	FN	FN	FN	FN							
91 pF	910	F	G	J	K	M	FN	FN	FN	FN	FN	FN	FN							
100 pF	101	F	G	J	K	M	FN	FN	FN	FN	FN	FN	FN							
110 pF	111	F	G	J	K	M	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	K	M	FN	FN	FN	FN	FN	FN	FN							
160 pF	161	F	G	J	K	M	FN	FN	FN	FN	FN	FN	FN							
180 pF	181	F	G	J	K	M	FN	FN	FN	FN	FN	FN	FN							
200 pF	201	F	G	J	K	M	FN	FN	FN	FN	FN	FN	FN							
220 pF	221	F	G	J	K	M	FN	FN	FN	FN	FN	FN	FN							
240 pF	241	F	G	J	K	M	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	M	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	M	FN	FN	FN	FN	FN	FN	FN							
390 pF	391	F	G	J	K	M	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	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	M	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	F	G	J	K	M	FN	FN	FN	FN	FN	FE	FE	GB	GB	GB	GB			
2,000 pF	202	F	G	J	K	M	FN	FN	FN	FN	FQ	FE	FE	GB	GB	GB	GB			
2,200 pF	222	F	G	J	K	M	FN	FN	FN	FN	FQ	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	M	FN	FN	FN	FN	FQ	FQ	FQ	GB	GB	GB	GB			
3,000 pF	302	F	G	J	K	M	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			
Capacitance	Cap Code	Rated Voltage (VDC)					10	16	25	50	100	200	250	50	100	200	250	50	100	200
		Voltage Code					8	4	3	5	1	2	A	5	1	2	A	5	1	2
		Case Size/Series					C1210C							C1812C				C2220C		

Table 1D – Flexible Termination Capacitance Range/Selection Waterfall (1210 – 2220 Case Sizes) cont.

Capacitance	Cap Code	Case Size/Series								C1210C							C1812C				C2220C		
		Voltage Code								8	4	3	5	1	2	A	5	1	2	A	5	1	2
		Rated Voltage (VDC)								10	16	25	50	100	200	250	50	100	200	250	50	100	200
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions													
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			
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			
5,100 pF	512				F	G	J	K	M	FN	FN	FN	FN	FZ	FZ	FZ							
5,600 pF	562				F	G	J	K	M	FN	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							
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	752				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				F	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	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	JB	JB	JB
100,000 pF	104				F	G	J	K	M	FE	FE	FE	FZ	FM			GB	GD	GM	GM	JB	JB	JD
120,000 pF	124				F	G	J	K	M	FZ	FZ	FZ	FU				GB	GH			JB	JB	JD
150,000 pF	154				F	G	J	K	M	FU	FU	FU	FM				GD	GN			JB	JB	JG
180,000 pF	184				F	G	J	K	M	FJ	FJ	FJ					GH				JB	JD	JG
220,000 pF	224				F	G	J	K	M								GK				JB	JD	JL
270,000 pF	274				F	G	J	K	M												JB	JF	
330,000 pF	334				F	G	J	K	M												JD	JG	
390,000 pF	394				F	G	J	K	M												JG		
470,000 pF	474				F	G	J	K	M												JG		
Capacitance	Cap Code	Rated Voltage (VDC)								10	16	25	50	100	200	250	50	100	200	250	50	100	200
		Voltage Code								8	4	3	5	1	2	A	5	1	2	A	5	1	2
		Case Size/Series								C1210C							C1812C				C2220C		

Performance and Reliability: Test Methods and Conditions

<table>
<tr><th>Test</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Visual and Mechanical</td><td>KEMET Internal</td><td>No defects that may affect performance (10X)</td><td>Dimensions according KEMET Spec Sheet</td></tr>
<tr><td>Capacitance (Cap)</td><td>KEMET Internal</td><td>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</td><td>Within Tolerance</td></tr>
<tr><td>Dissipation Factor (DF)</td><td>KEMET Internal</td><td>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”</td><td>Within Specification
Dissipation factor (DF) maximum limit at 25°C = 0.1%</td></tr>
<tr><td>Insulation Resistance (IR)</td><td>KEMET Internal</td><td>Rated voltage applied for 120 ±5 seconds at 25°C</td><td>Within Specification

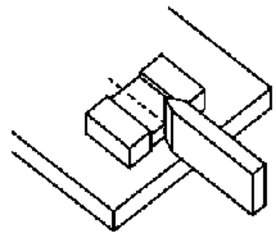
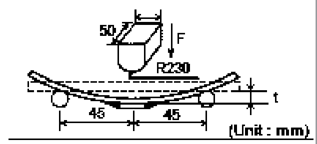
To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ limit. Select the lower of the two limits.

1,000 megaohm microfarads or 100 GΩ.</td></tr>
<tr><td>Temperature Coefficient of Capacitance (TCC)</td><td>KEMET Internal</td><td>Capacitance change with reference to +25°C and 0 VDC applied.
* See part number specification sheet for voltage
<table><tr><th>Step</th><th>Temperature (°C)</th></tr><tr><td>1</td><td>+25°C</td></tr><tr><td>2</td><td>-55°C</td></tr><tr><td>3</td><td>+25°C (Reference)</td></tr><tr><td>4</td><td>+150°C</td></tr></table></td><td>Within Specfcation ±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:
±60 ppm/°C from +125°C to +150°C</td></tr>
<tr><td>Dielectric Withstanding Voltage (DWV)</td><td>KEMET Internal</td><td>250% of rated voltage
(5 ±1 seconds and charge/discharge not exceeding 50 mA)</td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit

Withstand test voltage without insulation breakdown or damage.</td></tr>
<tr><td>Aging Rate (Maximum % Capacitance Loss/Decade Hour)</td><td>KEMET Internal</td><td>Maximum % capacitance loss/decade hour</td><td>0% Loss/Decade Hour</td></tr>
</table>

Performance and Reliability: Test Methods and Conditions cont.

<table>
<tr><th>Test</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Terminal Strength</td><td>KEMET Internal</td><td>Shear stress test per specific case size, Time: 60±1 seconds
<table>
<tr><th>Case Size</th><th>Force</th></tr>
<tr><td>0402</td><td>3N</td></tr>
<tr><td>0603</td><td>5N</td></tr>
<tr><td>0805</td><td>9N</td></tr>
<tr><td>≥1206</td><td>18N</td></tr>
</table>
</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Board Flex</td><td>AEC-Q200-005</td><td>3.0 mm minimum
Test time: 60± 5 seconds
Ramp time: 1 mm/second

</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Solderability</td><td>J-STD-002</td><td>Condition: 4 hours ± 15 minimum at 155°C dry bake apply all methods
Test 245 ± 5°C (SnPb & Pb-Free)</td><td>Visual Inspection.
95% coverage on termination.
No leaching</td></tr>
<tr><td>Temperature Cycling</td><td>JESD22 Method JA-104</td><td>1,000 cycles (−55°C to +150°C)
2 – 3 cycles per hour
Soak Time 1 or 5 minutes</td><td>Measurement at 24 hours ±4 hours after test conclusion.
Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit</td></tr>
<tr><td>Biased Humidity</td><td>MIL-STD-202 Method 103</td><td>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.</td><td>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%</td></tr>
<tr><td>Moisture Resistance</td><td>MIL-STD-202 Method 106</td><td>Number of cycles required 10, 24 hours per cycle.
Steps 7a and 7b not required</td><td>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%</td></tr>
<tr><td>Thermal Shock</td><td>MIL-STD-202 Method 107</td><td>Number of cycles required 5, (−55°C to 150°C)
Dwell time 15 minutes.</td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit</td></tr>
<tr><td>High Temperature Life</td><td rowspan="2">MIL-STD-202 Method 108</td><td>1,000 hours at 150°C with 2 X rated voltage applied</td><td rowspan="2">Within Post Environmental Limits
Cap: ±0.3% or ±0.25 pF shift
IR: 10% of Initial Limit
DF: 0.5%</td></tr>
<tr><td>Storage Life</td><td>1,000 hours at 150°C, Unpowered</td></tr>
</table>

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 Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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	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 Code	**Case Size[1]**	**Thickness ± Range (mm)**	**7" Reel**	**13" Reel**	**7" Reel**	**13" Reel**
			Paper Quantity[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 – Flexible Termination Chip Thickness/Tape & Reel Packaging Quantities

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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 Code	**Case Size[1]**	**Thickness ± Range (mm)**	**7" Reel**	**13" Reel**	**7" Reel**	**13" Reel**
			Paper Quantity[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

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		Packaging Quantities (pieces/unit packaging)	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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 3 – Standard Termination 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)				
		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 ≥ 22 µF.*
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.

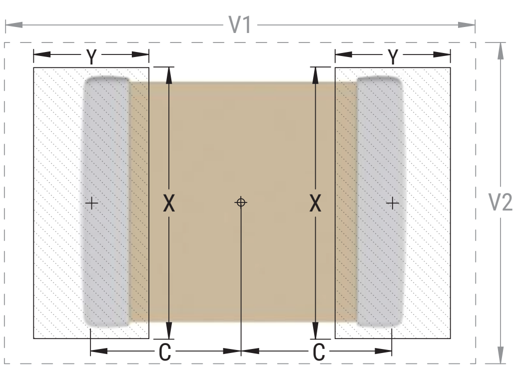
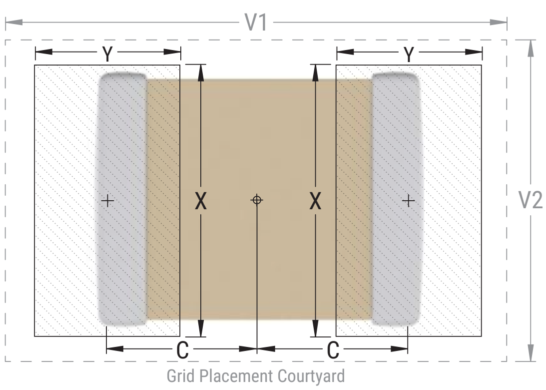


Table 4 – Flexible Termination Chip Capacitor Land Pattern Design Recommendations per IPC–7351 (mm)

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)				
		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:

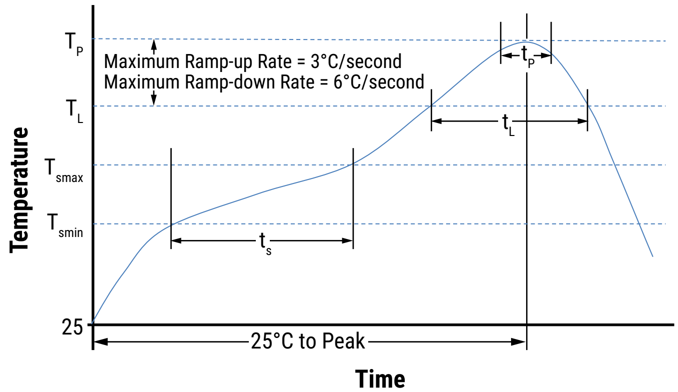
- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- All other EIA case sizes are limited to solder reflow only

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	
	SnPb	100% Matte Sn
Preheat/Soak Temperature Minimum (T_{Smin}) Temperature Maximum (T_{Smax}) Time (t_S) from T_{Smin} to T_{Smax}	 100°C 150°C 60 – 120 seconds	 150°C 200°C 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.

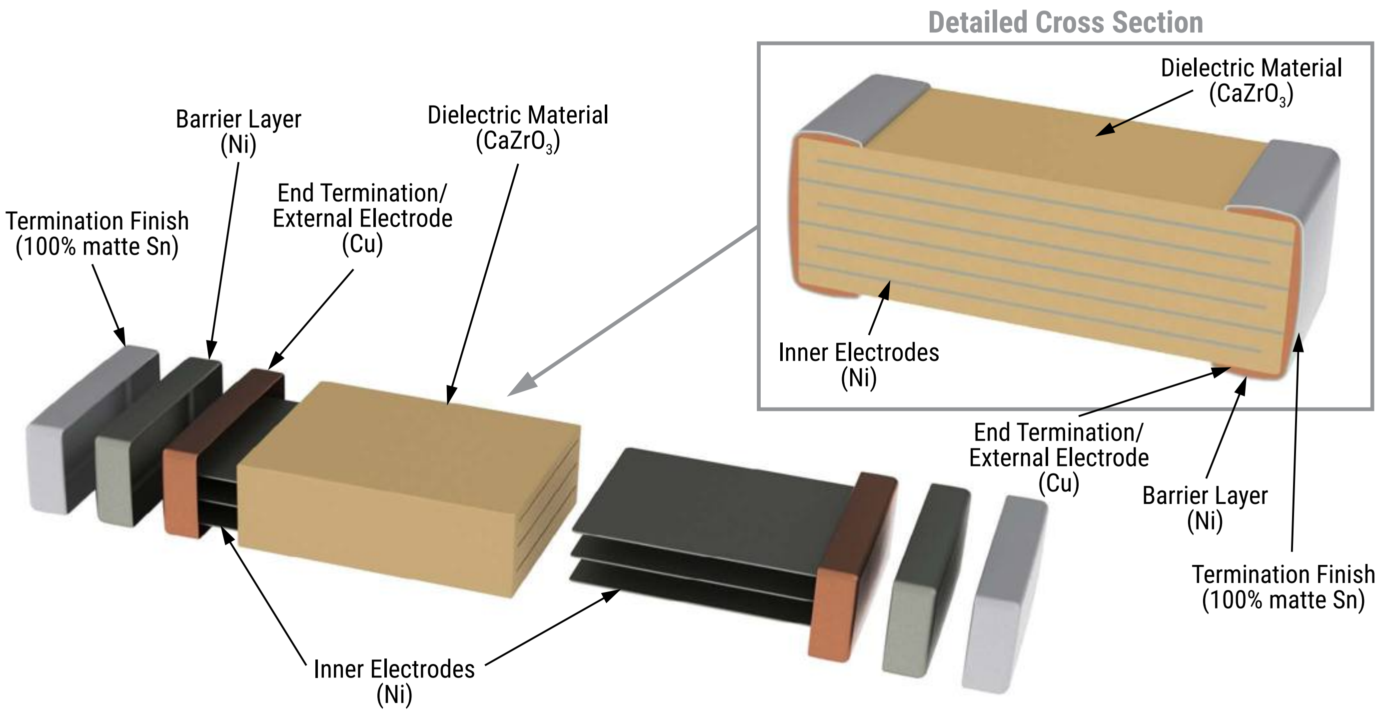


Storage and Handling

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.

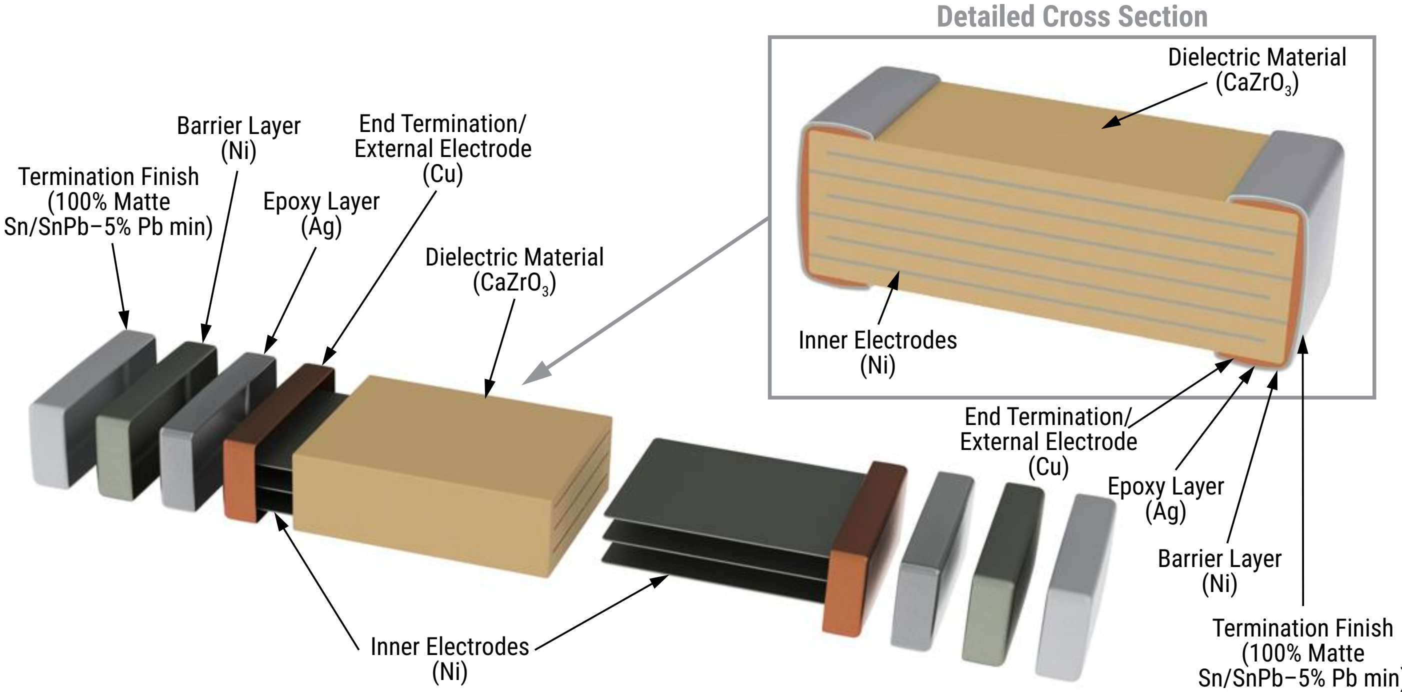
Construction

Standard Termination



Construction cont.

Flex Termination



Capacitor Marking (Optional)

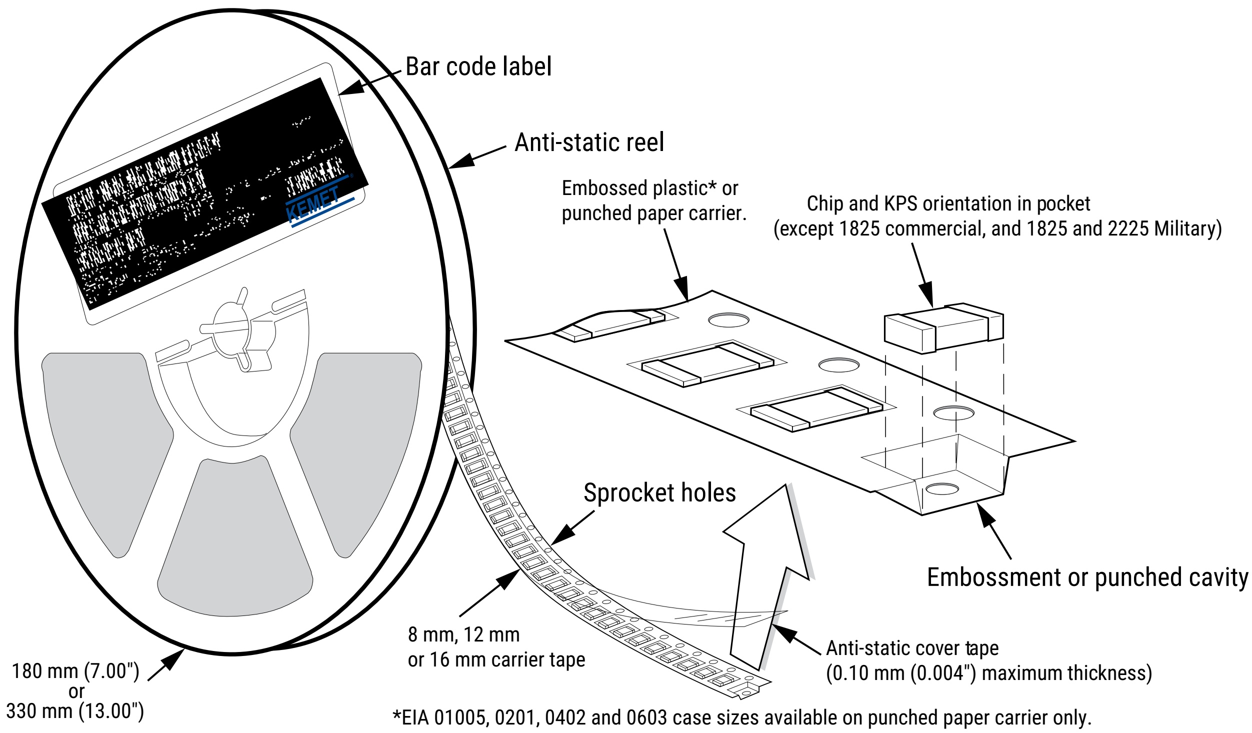
Laser marking option is not available on:

- C0G, 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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

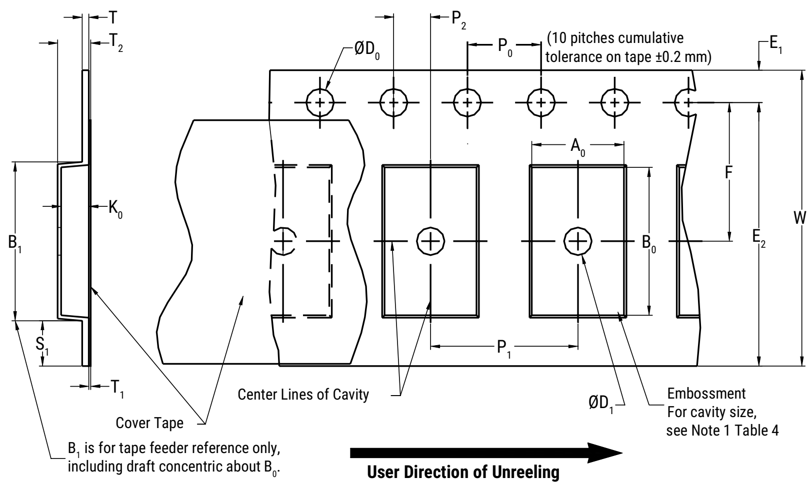


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

<table>
<tr><th colspan="10">Constant Dimensions — Millimeters (Inches)</th></tr>
<tr><th>Tape Size</th><th>D_0</th><th>D_1 Minimum
Note 1</th><th>E_1</th><th>P_0</th><th>P_2</th><th>R Reference
Note 2</th><th>S_1 Minimum
Note 3</th><th>T
Maximum</th><th>T_1
Maximum</th></tr>
<tr><td>8 mm</td><td rowspan="3">1.5 +0.10/−0.0
(0.059 +0.004/−0.0)</td><td>1.0
(0.039)</td><td rowspan="3">1.75 ±0.10
(0.069 ±0.004)</td><td rowspan="3">4.0 ±0.10
(0.157 ±0.004)</td><td rowspan="3">2.0 ±0.05
(0.079 ±0.002)</td><td>25.0
(0.984)</td><td rowspan="3">0.600
(0.024)</td><td rowspan="3">0.600
(0.024)</td><td rowspan="3">0.100
(0.004)</td></tr>
<tr><td>12 mm</td><td rowspan="2">1.5
(0.059)</td><td rowspan="2">30
(1.181)</td></tr>
<tr><td>16 mm</td></tr>
<tr><th colspan="10">Variable Dimensions — Millimeters (Inches)</th></tr>
<tr><th>Tape Size</th><th>Pitch</th><th>B_1 Maximum
Note 4</th><th>E_2
Minimum</th><th>F</th><th>P_1</th><th>T_2
Maximum</th><th>W
Maximum</th><th colspan="2">A_0,B_0 & K_0</th></tr>
<tr><td>8 mm</td><td>Single (4 mm)</td><td>4.35
(0.171)</td><td>6.25
(0.246)</td><td>3.5 ±0.05
(0.138 ±0.002)</td><td>4.0 ±0.10
(0.157 ±0.004)</td><td>2.5
(0.098)</td><td>8.3
(0.327)</td><td colspan="2" rowspan="3">Note 5</td></tr>
<tr><td>12 mm</td><td>Single (4 mm)
and double (8 mm)</td><td>8.2
(0.323)</td><td>10.25
(0.404)</td><td>5.5 ±0.05
(0.217 ±0.002)</td><td>8.0 ±0.10
(0.315 ±0.004)</td><td>4.6
(0.181)</td><td>12.3
(0.484)</td></tr>
<tr><td>16 mm</td><td>Triple (12 mm)</td><td>12.1
(0.476)</td><td>14.25
(0.561)</td><td>7.5 ±0.05
(0.138 ±0.002)</td><td>12.0 ±0.10
(0.157 ±0.004)</td><td>4.6
(0.181)</td><td>16.3
(0.642)</td></tr>
</table>

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 < 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_0, B_0 and K_0 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

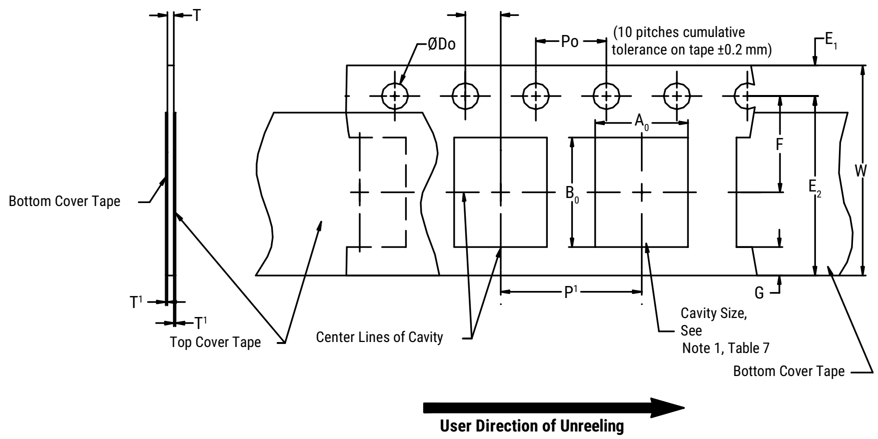


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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

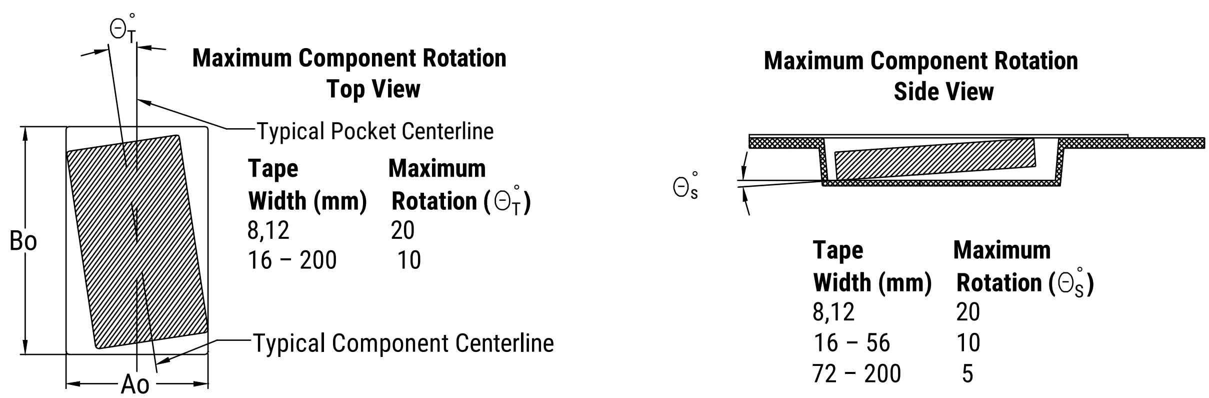


Figure 4 – Maximum Lateral Movement

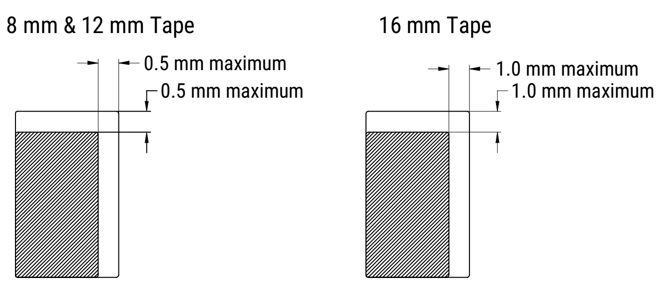


Figure 5 – Bending Radius

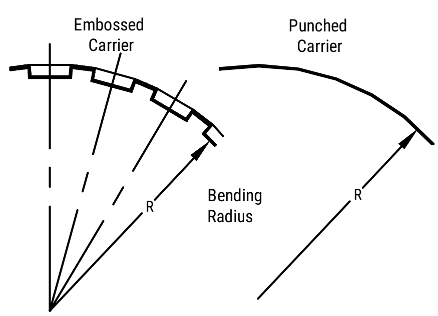
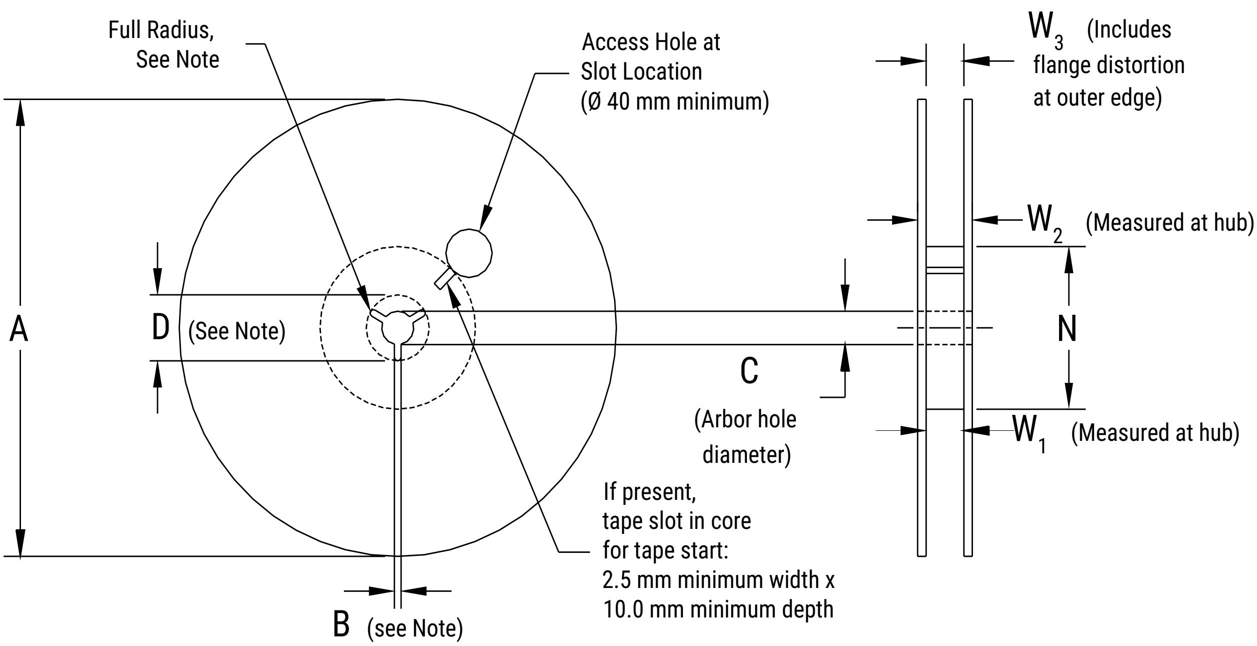


Figure 6 – Reel Dimensions



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	A	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

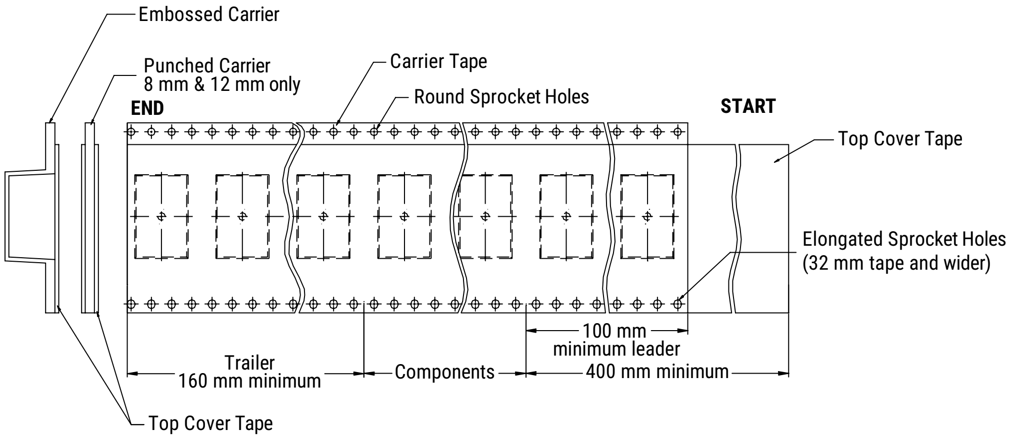
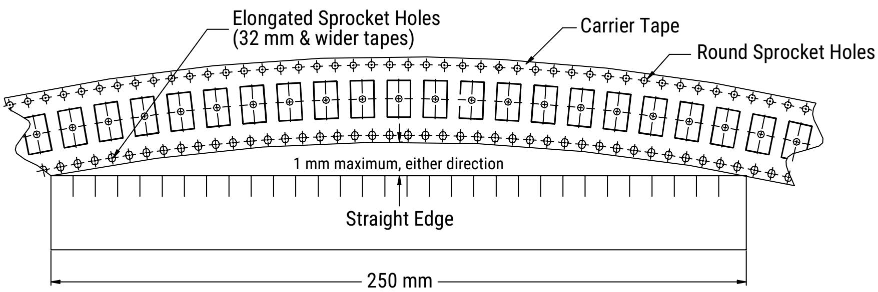


Figure 8 – Maximum Camber



High Voltage Surface Mount Series, MIL-PRF-49467 Screened, 500 - 5,000 VDC (Industrial Grade)

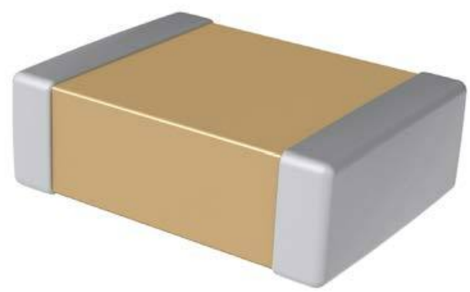
Overview

KKEMET's High Voltage Surface Mount MIL-PRF-49467 Screened ceramic capacitors are designed with C0G 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

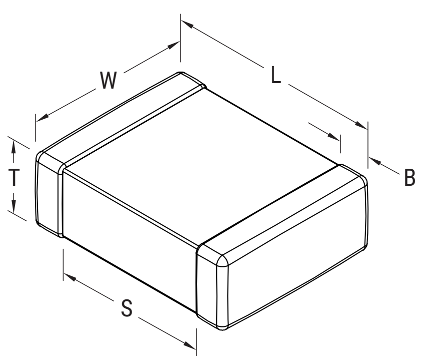
- Downhole exploration and mining
- Aerospace engine compartments
- Switch mode power supplies
- DC/DC Converters
- Measuring equipment
- Inverters
- High voltage coupling

Ordering Information

4540		B	472	M	202	P	M	
Case 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% (C0G 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
HV	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

Case Size		1515			1812			1825				2020				2225				2520				3333				3530				
		Voltage																														
Capacitance (pF)	Capacitance Code	500	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	X	X																												
390 pF	391	X	X	X																												
470 pF	471	X	X	X				X	X	X	X																					
560 pF	561	X	X	X				X	X	X	X	X	X	X	X																	
680 pF	681	X	X	X				X	X	X	X	X	X	X	X					X	X	X	X									
820 pF	821	X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X									
1,000 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
1,200 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
1,500 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
1,800 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	X	X
2,200 pF	222	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	X	X	X
2,700 pF	272	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	X	X	X
3,300 pF	332	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	X	X
3,900 pF	392	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	X
4,700 pF	472	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
5,000 pF	502	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
5,600 pF	562	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
6,800 pF	682	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
8,200 pF	822	X	X		X	X		X	X	X		X	X	X		X	X	X		X	X	X		X	X	X	X	X	X	X	X	
10,000 pF	103	X	X		X	X		X	X	X		X	X	X		X	X	X		X	X	X		X	X	X	X	X	X	X	X	
12,000 pF	123	X	X		X	X		X	X	X		X	X	X		X	X	X		X	X	X		X	X	X	X	X	X	X	X	
15,000 pF	153	X	X		X	X		X	X			X	X	X		X	X	X		X	X	X		X	X	X	X	X	X	X	X	
18,000 pF	183	X	X		X	X		X	X			X	X			X	X			X	X			X	X	X		X	X	X	X	
22,000 pF	223	X	X		X			X	X			X	X			X	X			X	X			X	X	X		X	X	X		
27,000 pF	273	X			X			X	X			X	X			X	X			X	X			X	X	X		X	X	X		
33,000 pF	333	X			X			X	X			X	X			X	X			X	X			X	X	X		X	X	X		
39,000 pF	393	X			X			X	X			X	X			X	X			X	X			X	X	X		X	X	X		
47,000 pF	473	X			X			X	X			X	X			X	X			X	X			X	X			X	X			
56,000 pF	563	X			X			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	X						X				X	X			X	X			X	X			X	X			X	X			
0.10 µF	104	X						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			
0.18 µF	184							X				X				X				X				X	X			X	X			
0.22 µF	224							X				X				X				X				X	X			X	X			
0.27 µF	274											X				X				X				X				X	X			
0.33 µF	334															X								X				X				
0.39 µF	394															X								X				X				
0.47 µF	474																							X				X				
0.56 µF	564																							X				X				
0.68 µF	684																							X				X				
0.82 µF	824																							X								
Capacitance (pF)	Capacitance Code	500	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
Case Size		Voltage																														
		1515			1812			1825				2020				2225				2520				3333				3530				

Table 1A – HV X7R Waterfall cont.

Case Size		4040					4540						5440					5550						6560					
		Voltage																											
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	X	X	X	X	X	X	X	X	X	X						X	X	X	X	X	X						
1,200 pF	122	X	X	X	X	X	X	X	X	X	X	X						X	X	X	X	X	X						
1,500 pF	152	X	X	X	X	X	X	X	X	X	X	X						X	X	X	X	X	X						
1,800 pF	182	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
2,200 pF	222	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
2,700 pF	272	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
3,300 pF	332	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
3,900 pF	392	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
4,700 pF	472	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
5,000 pF	502	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
5,600 pF	562	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
6,800 pF	682	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
8,200 pF	822	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
10,000 pF	103	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
12,000 pF	123	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
15,000 pF	153	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
18,000 pF	183	X	X	X	X		X	X	X	X			X	X	X	X		X	X	X	X	X		X	X	X	X	X	
22,000 pF	223	X	X	X	X		X	X	X	X			X	X	X	X		X	X	X	X	X		X	X	X	X	X	
27,000 pF	273	X	X	X	X		X	X	X	X			X	X	X	X		X	X	X	X	X		X	X	X	X	X	
33,000 pF	333	X	X	X			X	X	X	X			X	X	X	X		X	X	X	X			X	X	X	X	X	
39,000 pF	393	X	X	X			X	X	X	X			X	X	X			X	X	X	X			X	X	X	X	X	
47,000 pF	473	X	X	X			X	X	X				X	X	X			X	X	X	X			X	X	X	X		
56,000 pF	563	X	X	X			X	X	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	X			X	X	X	X		
82,000 pF	823	X	X	X			X	X	X				X	X	X			X	X	X				X	X	X	X		
0.10 µF	104	X	X				X	X	X				X	X				X	X	X				X	X	X	X		
0.12 µF	124	X	X				X	X					X	X				X	X	X				X	X	X			
0.15 µF	154	X	X				X	X					X	X				X	X					X	X	X			
0.18 µF	184	X	X				X	X					X	X				X	X					X	X	X			
0.22 µF	224	X	X				X	X					X	X				X	X					X	X				
0.27 µF	274	X	X				X	X					X	X				X	X					X	X				
0.33 µF	334	X	X				X	X					X	X				X	X					X	X				
0.39 µF	394	X	X				X	X					X	X				X	X					X	X				
0.45 µF	454	X					X	X					X	X				X	X					X	X				
0.47 µF	474	X					X	X					X	X				X	X					X	X				
0.56 µF	564	X					X						X	X				X	X					X	X				
0.68 µF	684	X					X						X					X	X					X	X				
0.82 µF	824	X					X						X					X	X					X	X				
1.0 µF	105	X					X						X					X						X	X				
1.2 µF	125						X						X					X						X					
1.5 µF	155						X						X					X						X					
1.8 µF	185																	X						X					
2.2 µF	225																							X					
2.7 µF	275																							X					
2.9 µF	295																							X					
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
Case Size		Voltage																											
		4040					4540						5440					5550						6560					

Table 1B – HV C0G Waterfall

Case Size		1515				1812				1825				2020				2225				2520				3333					3530				
		Voltage																																	
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	X	X	X	X	X	X	X	X																										
15 pF	150	X	X	X	X	X	X	X	X																										
18 pF	180	X	X	X	X	X	X	X	X																										
22 pF	220	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																		
27 pF	270	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	X	X	X	X	X	X
33 pF	330	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	X	X	X	X	X	X
39 pF	390	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	X	X	X	X	X	X
47 pF	470	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	X	X	X	X	X	X
56 pF	560	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	X	X	X	X	X	X
68 pF	680	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	X	X	X	X	X	X
82 pF	820	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	X	X	X	X	X	X
100 pF	101	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	X	X	X	X	X	X
120 pF	121	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	X	X	X	X	X	X
150 pF	151	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	X	X	X	X	X	X
180 pF	181	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	X	X	X	X	X	X
220 pF	221	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	X	X	X	X	X	X
270 pF	271	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	X	X	X	X	X
330 pF	331	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	X	X	X	X
390 pF	391	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	X	X	X	X
470 pF	471	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	X	X	X	X
560 pF	561	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	X	X	X
680 pF	681	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	X	X	X
820 pF	821	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	
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	
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	
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	
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	
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		
4700 pF	472									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		
6800 pF	682									X				X				X	X			X	X			X	X	X			X	X			
7500 pF	752									X				X				X	X			X				X	X	X			X	X			
8200 pF	822									X				X				X	X			X				X	X	X			X	X			
10000 pF	103									X				X				X				X				X	X	X			X	X			
12000 pF	123																	X				X				X	X	X			X	X			
15000 pF	153																	X				X				X					X	X			
18000 pF	183																	X				X				X					X	X			
22000 pF	223																									X					X				
27000 pF	273																									X					X				
33000 pF	333																														X				
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
Case Size		Voltage																																	
		1515				1812				1825				2020				2225				2520				3333					3530				

Table 1B – HV C0G Waterfall cont.

Case Size		4040					4540						5440					5550						6560					
		Voltage																											
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	X	X	X	X																							
22 pF	220	X	X	X	X	X																							
27 pF	270	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X												
33 pF	330	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X												
39 pF	390	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X												
47 pF	470	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
56 pF	560	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
68 pF	680	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
82 pF	820	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
100 pF	101	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
120 pF	121	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
150 pF	151	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
180 pF	181	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
220 pF	221	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
270 pF	271	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
330 pF	331	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
390 pF	391	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
470 pF	471	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
560 pF	561	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
680 pF	681	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
820 pF	821	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
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	X		X	X	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	X			X	X	X	X	X	X
4700 pF	472	X	X	X	X		X	X	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	X			X	X	X	X		
6800 pF	682	X	X	X			X	X	X				X	X	X	X		X	X	X				X	X	X	X		
7500 pF	752	X	X				X	X	X				X	X	X			X	X	X				X	X	X	X		
8200 pF	822	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						X	X					X	X				X	X					X	X				
33000 pF	333						X	X					X	X				X	X					X	X				
39000 pF	393						X	X					X					X	X					X	X				
47000 pF	473						X	X					X					X	X					X	X				
56000 pF	563						X						X											X	X				
68000 pF	683						X						X											X	X				
82000 pF	823												X											X					
0.10 µF	104																							X					
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
Case Size		Voltage																											
		4040					4540						5440					5550						6560					

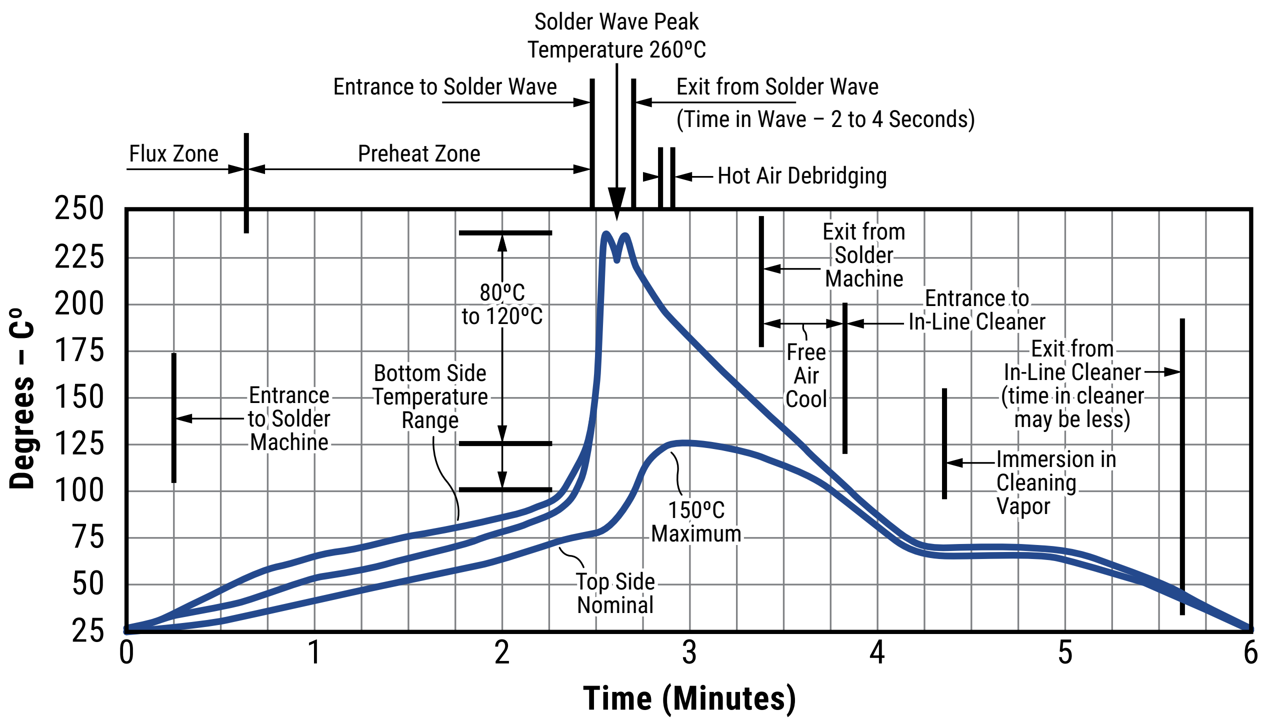
Soldering Process

Recommended Soldering Technique:

- Solder Wave
- Hand Soldering (Manual)

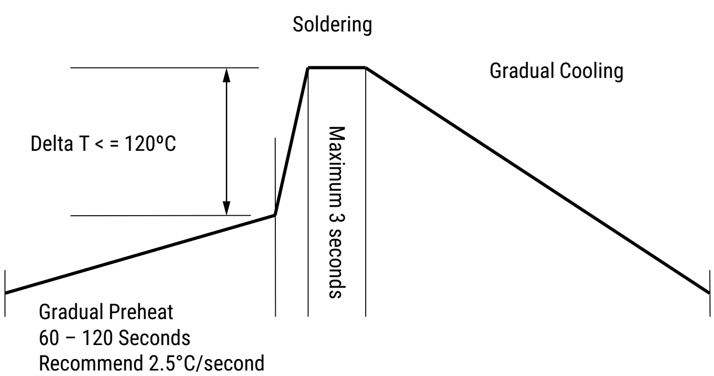
Recommended Soldering Profile:

- 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	C0G (P): 0 ppm/°C ±30 ppm/°C X7R (R or Z): ±15%	Within Specification
Temperature Coefficient of Capacitance at Applied Voltage (TCVC)	KEMET Internal	C0G (P): 0 ppm/°C ±30 ppm/°C X7R (R or Z): +15%/-70%	C0G: 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: C0G: ±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 specified
Storage Life		1,000 hours at 125°C, Unpowered	
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.

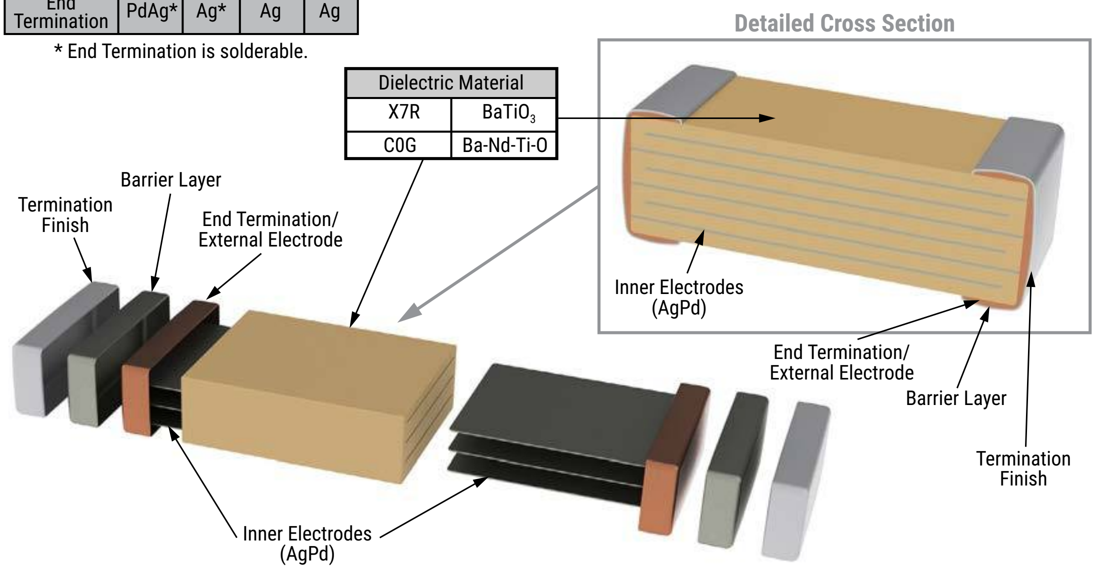
KEMET recommends storing the un-mounted capacitors in their original packaging, in a location away from direct sunlight, and where the temperature and relative humidity do not exceed 40 degrees centigrade and 70% respectively. For optimum solderability, capacitor stock should be used promptly, preferably 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

	P	S	E	C
Termination Finish	N/A	N/A	SnPb	Sn
Barrier Layer	N/A	N/A	Ni	Ni
End Termination	PdAg*	Ag*	Ag	Ag

* End Termination is solderable.

Dielectric Material	
X7R	$BaTiO_3$
C0G	Ba-Nd-Ti-O



Environmental Compliance

Industrial PME (precious metal electrode) part types are not RoHS compliant.

Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs)

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.

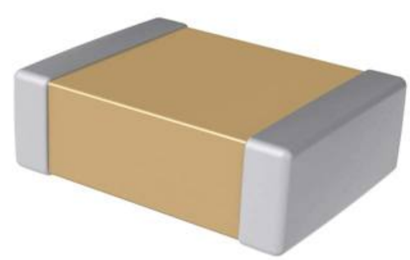
In addition to commercial grade, automotive grade devices are available and meet Automotive Electronics Council's AEC-Q200 qualification requirements. Also available with flexible termination technology which inhibits the transfer of board stress to the rigid ceramic body, therefore mitigating flex cracks 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

C	2220	C	104	K	B	T	A	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 = ±0.10 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	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)
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	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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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.*

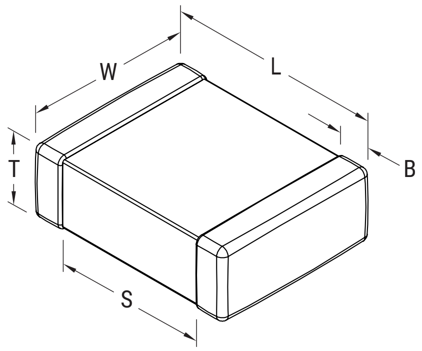
Production Part Approval Process (PPAP)
The purpose of the Production Part Approval Process is:
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements 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			○		

[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)	See Table 2 for Thickness	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)		
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)	See Table 2 for Thickness	0.45 (0.018) ±0.15 (0.006)	0.58 (0.023)	Solder Wave or Solder Reflow
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)	
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	
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
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)		
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)

<table>
<tr><th>EIA Case Size</th><th>500V</th><th>630V</th><th>≥ 1000V</th></tr>
<tr><td>0603</td><td rowspan="9">150% of rated voltage</td><td>130% of rated voltage</td><td rowspan="9">120% of rated voltage</td></tr>
<tr><td>0805</td><td>< 620pF 150% of rated voltage
≥ 620pF 130% of rated voltage</td></tr>
<tr><td>1206</td><td>< 5.1nF 150% of rated voltage
≥ 5.1nF 130% of rated voltage</td></tr>
<tr><td>1210</td><td>< 7.5nF 150% of rated voltage
≥ 7.5nF 130% of rated voltage</td></tr>
<tr><td>1808</td><td>< 5.1nF 150% of rated voltage
≥ 5.1nF 130% of rated voltage</td></tr>
<tr><td>1812</td><td>< 12nF 150% of rated voltage
≥ 12nF 130% of rated voltage</td></tr>
<tr><td>1825</td><td>< 22nF 150% of rated voltage
≥ 22nF 130% of rated voltage</td></tr>
<tr><td>2220</td><td>< 27nF 150% of rated voltage
≥ 27nF 130% of rated voltage</td></tr>
<tr><td>2225</td><td>< 33nF 150% of rated voltage
≥ 33nF 130% of rated voltage</td></tr>
</table>

KEMET YAGEO

Table 1A – Standard Termination Capacitance Range/Selection Waterfall (0603 – 2220 Case Sizes)

Capacitance	Cap Code	Case Size/Series								C0603C			C0805C			C1206C					C1210C					C1812C					C2220C				
		Voltage Code								C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Rated Voltage (VDC)								500	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
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																									
1.0 - 9.1 pF*	109 - 919*	B	C	D									DG	DG	DG																				
10 pF - 47pF*	100 - 470*				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
11 pF	110				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
12 pF	120				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
13 pF	130				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
15 pF	150				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
16 pF	160				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
18 pF	180				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
20 pF	200				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
22 pF	220				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
24 pF	240				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
27 pF	270				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
30 pF	300				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
33 pF	330				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
36 pF	360				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
39 pF	390				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
43 pF	430				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
47 pF	470				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
51 pF	510				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
56 pF	560				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
62 pF	620				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
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	820				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
91 pF	910				F	G	J	K	M				DG	DG	DG	ED	ED	ED	ED	EF	FM	FM	FM	FM	FM	GD	GD	GD	GD	GD	JK	JK	JK	JK	JK
100 pF	101				F	G	J	K	M	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	111				F	G	J	K	M	CG	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	M	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
130 pF	131				F	G	J	K	M	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	K	M	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	M	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	K	M	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	K	M	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	221				F	G	J	K	M	CG	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	M	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
270 pF	271				F	G	J	K	M	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	K	M	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	M	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	K	M	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	K	M	CG	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	431				F	G	J	K	M	CG	CG		DG	DG	DP	ED	ED	EF	EG		FG	FM	FM	FS	FS	GB	GB	GB	GB	GD	JE	JE	JE	JE	JE
470 pF	471				F	G	J	K	M	CG	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	M	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	K	M	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	K	M	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	K	M	CG	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				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
910 pF	911				F	G	J	K	M				DN	DN		ED	EF	EG			FM	FM	FM	FY		GB	GB	GB	GH	GM	JE	JK	JK	JK	JK
1,000 pF	102				F	G	J	K	M				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	K	M				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	K	M				DN	DN		EF	EG	ED			FM	FK	FK	FS		GB	GB	GB	GH	GO	JE	JK	JK	JK	JK
Capacitance	Cap Code	Rated Voltage (VDC)								500	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
		Voltage Code								C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Case Size/Series								C0603C			C0805C			C1206C					C1210C					C1812C					C2220C				

Table 1A – Standard Termination Capacitance Range/Selection Waterfall (0603 – 2220 Case Sizes) cont.

Capacitance	Cap Code	Case Size/Series	C0603C			C0805C			C1206C					C1210C					C1812C					C2220C				
		Voltage Code	C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Rated Voltage (VDC)	500	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
		Capacitance Tolerance	Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																									
1,300 pF	132	F G J K M				DN	DN		EF	EG	ED			FM	FS	FS			GB	GB	GB	GH	GO	JE	JK	JK	JK	JE
1,500 pF	152	F G J K M				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 M				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 M				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	F G J K M				DG	DG		EG	EB	EG			FS	FL	FS			GB	GH	GK	GO		JK	JK	JK	JE	JL
2,700 pF	272	F G J K M				DG	DG		EG	EB	EG			FS	FL	FS			GB	GH	GK	GO		JK	JK	JK	JE	JL
3,000 pF	302	F G J K M							EB	EB				FS	FL	FF			GB	GH	GK			JK	JK	JK	JE	JL
3,300 pF	332	F G J K M							EB	EB				FS	FM	FG			GB	GH	GK			JK	JK	JK	JK	JN
3,600 pF	362	F G J K M							EC	EC				FL	FM	FG			GB	GH	GM			JK	JK	JK	JK	JN
3,900 pF	392	F G J K M							EC	EC				FL	FY	FL			GB	GH	GM			JK	JK	JK	JK	JN
4,300 pF	432	F G J K M							ED	ED				FM	FY	FL			GH	GH	GO			JK	JK	JK	JK	
4,700 pF	472	F G J K M							ED	ED				FM	FY	FM			GH	GH	GO			JK	JK	JK	JL	
5,100 pF	512	F G J K M							EE	EE				FY	FS	FM			GH	GK	GO			JK	JK	JK	JL	
5,600 pF	562	F G J K M							EF	EF				FY	FS	FM			GH	GK	GO			JK	JK	JK	JN	
6,200pF	622	F G J K M							EF	EF				FY	FE	FY			GH	GK	GH			JK	JE	JE	JN	
6,800pF	682	F G J K M							EG	EG				FY	FE	FY			GH	GM	GH			JK	JE	JK	JN	
7,500pF	752	F G J K M							EG	EG				FS	FF	FS			GH	GM	GK			JK	JE	JK		
8,200 pF	822	F G J K M							EG	EG				FS	FF	FS			GK	GO	GK			JK	JE	JL		
9,100 pF	912	F G J K M							EG	EG				FF	FF	FS			GM	GO	GM			JE	JE	JL		
10,000 pF	103	F G J K M							EH	EH				FG	FG	FS			GM	GO	GM			JE	JE	JL		
12,000 pF	123	F G J K M												FG	FG				GO	GH	GO			JE	JK	JN		
15,000 pF	153	F G J K M												FM	FM				GO	GH	GO			JE	JL	JE		
18,000 pF	183	F G J K M												FM	FM				GH	GH				JE	JL	JE		
22,000 pF	223	F G J K M												FY	FY				GH	GH				JK	JN	JK		
27,000 pF	273	F G J K M												FS	FS				GK	GK				JL	JN	JL		
33,000 pF	333	F G J K M												FS	FS				GM	GM				JN	JE	JN		
39,000 pF	393	F G J K M																	GO	GO				JE	JE			
47,000 pF	473	F G J K M																	GO	GO				JE	JE			
56,000 pF	563	F G J K M																						JK	JK			
68,000 pF	683	F G J K M																						JL	JL			
82,000 pF	823	F G J K M																						JL	JL			
0.1 µF	104	F G J K M																						JN	JN			
Capacitance	Cap Code	Rated Voltage (VDC)	500	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
		Voltage Code	C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Case Size/Series	C0603C			C0805C			C1206C					C1210C					C1812C					C2220C				

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Table 1B – Flexible Termination Capacitance Range/Selection Waterfall (0603 – 2220 Case Sizes)

Capacitance	Cap Code	Case Size/Series								C0603X			C0805X			C1206X					C1210X					C1812X					C2220X				
		Voltage Code								C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Rated Voltage (VDC)								500	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
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																									
1.0 - 9.1 pF*	109 - 169*	B	C	D									DG	DG	DG																				
10 pF	100				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
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	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	130				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
15 pF	150				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
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	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
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 pF	240				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
27 pF	270				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
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	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
36 pF	360				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
39 pF	390				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
43 pF	430				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
47 pF	470				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
51 pF	510				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
56 pF	560				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
62 pF	620				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
68 pF	680				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
75 pF	750				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
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	K	M	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	111				F	G	J	K	M	CJ	CJ	CJ	DG	DG	DG	ES	ES	ES	ES	EU	FM	FM	FM	FM	FM	GD	GD	GD	GD	GD	JK	JK	JK	JK	JK
120 pF	121				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
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	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
200 pF	201				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
220 pF	221				F	G	J	K	M	CJ	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
240 pF	241				F	G	J	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	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	K	M	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	G	J	K	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				F	G	J	K	M	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	391				F	G	J	K	M	CJ	CJ		DG	DG	DC	ES	ES	EF	EU		FZ	FZ	FZ	FK	FS	GB	GB	GB	GB	GD	JE	JE	JE	JE	JE
430 pF	431				F	G	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	J	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	J	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	K	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	J	K	M	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	751				F	G	J	K	M				DG	DG	DG	ES	EF	EU			FZ	FM	FM	FM		GB	GB	GB	GD	GK	JE	JE	JE	JK	JK
820 pF	821				F	G	J	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	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	K	M				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	K	M				DC	DC		EF	EU	ED			FM	FK	FK	FS		GB	GB	GB	GH	GO	JE	JK	JK	JK	JK
1,200 pF	122				F	G	J	K	M				DC	DC		EF	EU	ED			FM	FK	FK	FS		GB	GB	GB	GH	GO	JE	JK	JK	JK	JK
Capacitance	Cap Code	Rated Voltage (VDC)								500	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
		Voltage Code								C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Case Size/Series								C0603X			C0805X			C1206X					C1210X					C1812X					C2220X				

Table 1B – Flexible Termination Capacitance Range/Selection Waterfall (0603 – 2220 Case Sizes) cont.

Capacitance	Cap Code	Case Size/Series	C0603X			C0805X			C1206X					C1210X					C1812X					C2220X				
		Voltage Code	C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Rated Voltage (VDC)	500	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
		Capacitance Tolerance	Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																									
1,300 pF	132	F G J K M				DC	DC		EF	EU	ED			FM	FS	FS			GB	GB	GB	GH	GO	JE	JK	JK	JK	JE
1,500 pF	152	F G J K M				DD	DD		EF	EU	ED			FK	FS	FS			GB	GB	GB	GK	GO	JE	JK	JK	JK	JE
1,600 pF	162	F G J K M				DD	DD		EF	EU	ED			FK	FS	FS			GB	GD	GD	GK		JE	JK	JK	JK	JE
1,800 pF	182	F G J K M				DG	DG		EF	EU	EF			FK	FS	FS			GB	GD	GD	GM		JE	JK	JK	JK	JE
2,000 pF	202	F G J K M				DG	DG		EU	EQ	EF			FK	FL	FS			GB	GH	GH	GM		JE	JK	JK	JE	JK
2,200 pF	222	F G J K M				DG	DG		EU	EQ	EF			FK	FL	FS			GB	GH	GH	GO		JE	JK	JK	JE	JK
2,400 pF	242	F G J K M				DG	DG		EU	EQ	EU			FS	FL	FS			GB	GH	GK	GO		JK	JK	JK	JE	JL
2,700 pF	272	F G J K M				DG	DG		EU	EQ	EU			FS	FL	FS			GB	GH	GK	GO		JK	JK	JK	JE	JL
3,000 pF	302	F G J K M							EQ	EQ				FS	FL	FF			GB	GH	GK			JK	JK	JK	JE	JL
3,300 pF	332	F G J K M							EQ	EQ				FS	FM	FG			GB	GH	GK			JK	JK	JK	JK	JN
3,600 pF	362	F G J K M							ER	ER				FL	FM	FG			GB	GH	GM			JK	JK	JK	JK	JN
3,900 pF	392	F G J K M							ER	ER				FL	FY	FL			GB	GH	GM			JK	JK	JK	JK	JN
4,300 pF	432	F G J K M							ES	ES				FM	FY	FL			GH	GH	GO			JK	JK	JK	JK	
4,700 pF	472	F G J K M							ES	ES				FM	FY	FM			GH	GH	GO			JK	JK	JK	JL	
5,100 pF	512	F G J K M							EE	EE				FY	FS	FM			GH	GK	GO			JK	JK	JK	JL	
5,200 pF	562	F G J K M							EF	EF				FY	FS	FM			GH	GK	GO			JK	JK	JK	JN	
6,200pF	622	F G J K M							EF	EF				FY	FE	FY			GH	GK	GH			JK	JE	JE	JN	
6,800pF	682	F G J K M							EU	EU				FY	FE	FY			GH	GM	GH			JK	JE	JK	JN	
7,500pF	752	F G J K M							EU	EU				FS	FF	FS			GH	GM	GK			JK	JE	JK		
8,200pF	822	F G J K M							EU	EU				FS	FF	FS			GK	GO	GK			JK	JE	JL		
9,100 pF	912	F G J K M							EU	EU				FF	FF	FS			GM	GO	GM			JE	JE	JL		
10,000 pF	103	F G J K M							EU	EU				FG	FG	FS			GM	GO	GM			JE	JE	JL		
12,000 pF	123	F G J K M												FG	FG				GO	GH	GO			JE	JK	JN		
15,000 pF	153	F G J K M												FM	FM				GO	GH	GO			JE	JL	JE		
18,000 pF	183	F G J K M												FM	FM				GH	GH				JE	JL	JE		
22,000 pF	223	F G J K M												FY	FY				GH	GH				JK	JN	JK		
27,000 pF	273	F G J K M												FS	FS				GK	GK				JL	JN	JL		
33,000 pF	333	F G J K M												FS	FS				GM	GM				JN	JE	JN		
39,000 pF	393	F G J K M																	GO	GO				JE	JE			
47,000 pF	473	F G J K M																	GO	GO				JE	JE			
56,000 pF	563	F G J K M																						JK	JK			
68,000 pF	683	F G J K M																						JL	JL			
82,000 pF	823	F G J K M																						JL	JL			
0.1 µF	104	F G J K M																						JN	JN			
Capacitance	Cap Code	Rated Voltage (VDC)	500	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
		Voltage Code	C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Case Size/Series	C0603X			C0805X			C1206X					C1210X					C1812X					C2220X				

Table 1C – Automotive Standard Termination Capacitance Range/Selection Waterfall (0603 – 2220 Case Sizes)

Capacitance	Cap Code	Case Size/Series								C0603C			C0805C			C1206C					C1210C					C1812C					C2220C				
		Voltage Code								C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Rated Voltage (VDC)								500	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
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																									
1.0 - 9.1 pF*	109 - 919*	B	C	D									DG	DG	DG																				
10 pF - 47pF*	100 - 470*				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
51 pF	510				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
56 pF	560				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
62 pF	620				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
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	820				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
91 pF	910				F	G	J	K	M				DG	DG	DG	ED	ED	ED	ED	EF	FM	FM	FM	FM	FM	GD	GD	GD	GD	GD	JK	JK	JK	JK	JK
100 pF	101				F	G	J	K	M	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	111				F	G	J	K	M	CG	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	M	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
130 pF	131				F	G	J	K	M	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	K	M	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	M	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	K	M	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	K	M	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	221				F	G	J	K	M	CG	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	M	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
270 pF	271				F	G	J	K	M	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	K	M	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	M	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	K	M	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	K	M	CG	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	431				F	G	J	K	M	CG	CG		DG	DG	DP	ED	ED	EF	EG		FG	FM	FM	FS	FS	GB	GB	GB	GB	GD	JE	JE	JE	JE	JE
470 pF	471				F	G	J	K	M	CG	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	M	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	K	M	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	K	M	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	K	M	CG	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				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
910 pF	911				F	G	J	K	M				DN	DN		ED	EF	EG			FM	FM	FM	FY		GB	GB	GB	GH	GM	JE	JK	JK	JK	JK
1,000 pF	102				F	G	J	K	M				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	K	M				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	K	M				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	M				DN	DN		EF	EG	ED			FM	FS	FS			GB	GB	GB	GH	GO	JE	JK	JK	JK	JE
1,500 pF	152				F	G	J	K	M				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	M				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	M				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				F	G	J	K	M				DG	DG		EG	EB	EG			FS	FL	FS			GB	GH	GK	GO		JK	JK	JK	JE	JL
2,700 pF	272				F	G	J	K	M				DG	DG		EG	EB	EG			FS	FL	FS			GB	GH	GK	GO		JK	JK	JK	JE	JL
3,000 pF	302				F	G	J	K	M							EB	EB				FS	FL	FF			GB	GH	GK			JK	JK	JK	JE	JL
3,300 pF	332				F	G	J	K	M							EB	EB				FS	FM	FG			GB	GH	GK			JK	JK	JK	JK	JN
3,600 pF	362				F	G	J	K	M							EC	EC				FL	FM	FG			GB	GH	GM			JK	JK	JK	JK	JN
3,900 pF	392				F	G	J	K	M							EC	EC				FL	FY	FL			GB	GH	GM			JK	JK	JK	JK	JN
4,300 pF	432				F	G	J	K	M							ED	ED				FM	FY	FL			GH	GH	GO			JK	JK	JK	JK	
4,700 pF	472				F	G	J	K	M							ED	ED				FM	FY	FM			GH	GH	GO			JK	JK	JK	JL	
5,100 pF	512				F	G	J	K	M							EE	EE				FY	FS	FM			GH	GK	GO			JK	JK	JK	JL	
5,600 pF	562				F	G	J	K	M							EF	EF				FY	FS	FM			GH	GK	GO			JK	JK	JK	JN	
Capacitance	Cap Code	Rated Voltage (VDC)								500	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
		Voltage Code								C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Case Size/Series								C0603C			C0805C			C1206C					C1210C					C1812C					C2220C				

Table 1C – Automotive Standard Termination Capacitance Range/Selection Waterfall (0603 – 2220 Case Sizes) cont.

Capacitance	Cap Code	Case Size/Series								C0603C			C0805C			C1206C					C1210C					C1812C					C2220C				
		Voltage Code								C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Rated Voltage (VDC)								500	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
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																									
6,200pF	622				F	G	J	K	M							EF	EF				FY	FE	FY			GH	GK	GH			JK	JE	JE	JN	
6,800pF	682				F	G	J	K	M							EG	EG				FY	FE	FY			GH	GM	GH			JK	JE	JK	JN	
7,500pF	752				F	G	J	K	M							EG	EG				FS	FF	FS			GH	GM	GK			JK	JE	JK		
8,200 pF	822				F	G	J	K	M							EG	EG				FS	FF	FS			GK	GO	GK			JK	JE	JL		
9,100 pF	912				F	G	J	K	M							EG	EG				FF	FF	FS			GM	GO	GM			JE	JE	JL		
10,000 pF	103				F	G	J	K	M							EH	EH				FG	FG	FS			GM	GO	GM			JE	JE	JL		
12,000 pF	123				F	G	J	K	M												FG	FG				GO	GH	GO			JE	JK	JN		
15,000 pF	153				F	G	J	K	M												FM	FM				GO	GH	GO			JE	JL	JE		
18,000 pF	183				F	G	J	K	M												FM	FM				GH	GH				JE	JL	JE		
22,000 pF	223				F	G	J	K	M												FY	FY				GH	GH				JK	JN	JK		
27,000 pF	273				F	G	J	K	M												FS	FS				GK	GK				JL	JN	JL		
33,000 pF	333				F	G	J	K	M												FS	FS				GM	GM				JN	JE	JN		
39,000 pF	393				F	G	J	K	M																	GO	GO				JE	JE			
47,000 pF	473				F	G	J	K	M																	GO	GO				JE	JE			
56,000 pF	563				F	G	J	K	M																						JK	JK			
68,000 pF	683				F	G	J	K	M																						JL	JL			
82,000 pF	823				F	G	J	K	M																						JL	JL			
0.1 µF	104				F	G	J	K	M																						JN	JN			
Capacitance	Cap Code	Rated Voltage (VDC)								500	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
		Voltage Code								C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Case Size/Series								C0603C			C0805C			C1206C					C1210C					C1812C					C2220C				

Table 1D – Automotive Flexible Termination Capacitance Range/Selection Waterfall (0603 – 2220 Case Sizes)

Capacitance	Cap Code	Case Size/Series								C0603X			C0805X			C1206X					C1210X					C1812X					C2220X				
		Voltage Code								C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Rated Voltage (VDC)								500	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
		Capacitance Tolerance								Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																									
1.0 - 9.1 pF*	109 - 169*	B	C	D									DG	DG	DG																				
10 pF	100				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
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	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	130				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
15 pF	150				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
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	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
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 pF	240				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
27 pF	270				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
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	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
36 pF	360				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
39 pF	390				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
43 pF	430				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
47 pF	470				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
51 pF	510				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
56 pF	560				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
62 pF	620				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
68 pF	680				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
75 pF	750				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
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	K	M	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	111				F	G	J	K	M	CJ	CJ	CJ	DG	DG	DG	ES	ES	ES	ES	EU	FM	FM	FM	FM	FM	GD	GD	GD	GD	GD	JK	JK	JK	JK	JK
120 pF	121				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
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	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
200 pF	201				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
220 pF	221				F	G	J	K	M	CJ	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
240 pF	241				F	G	J	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	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	K	M	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	G	J	K	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				F	G	J	K	M	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	391				F	G	J	K	M	CJ	CJ		DG	DG	DC	ES	ES	EF	EU		FZ	FZ	FZ	FK	FS	GB	GB	GB	GB	GD	JE	JE	JE	JE	JE
430 pF	431				F	G	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	J	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	J	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	K	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	J	K	M	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	751				F	G	J	K	M				DG	DG	DG	ES	EF	EU			FZ	FM	FM	FM		GB	GB	GB	GD	GK	JE	JE	JE	JK	JK
820 pF	821				F	G	J	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	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	K	M				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	K	M				DC	DC		EF	EU	ED			FM	FK	FK	FS		GB	GB	GB	GH	GO	JE	JK	JK	JK	JK
1,200 pF	122				F	G	J	K	M				DC	DC		EF	EU	ED			FM	FK	FK	FS		GB	GB	GB	GH	GO	JE	JK	JK	JK	JK
Capacitance	Cap Code	Rated Voltage (VDC)								500	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
		Voltage Code								C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Case Size/Series								C0603X			C0805X			C1206X					C1210X					C1812X					C2220X				

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Table 1D – Automotive Flexible Termination Capacitance Range/Selection Waterfall (0603 – 2220 Case Sizes) cont.

Capacitance	Cap Code	Case Size/Series					C0603X			C0805X			C1206X					C1210X					C1812X					C2220X				
		Voltage Code					C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Rated Voltage (VDC)					500	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
		Capacitance Tolerance					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																									
1,300 pF	132	F	G	J	K	M				DC	DC		EF	EU	ED			FM	FS	FS			GB	GB	GB	GH	GO	JE	JK	JK	JK	JE
1,500 pF	152	F	G	J	K	M				DD	DD		EF	EU	ED			FK	FS	FS			GB	GB	GB	GK	GO	JE	JK	JK	JK	JE
1,600 pF	162	F	G	J	K	M				DD	DD		EF	EU	ED			FK	FS	FS			GB	GD	GD	GK		JE	JK	JK	JK	JE
1,800 pF	182	F	G	J	K	M				DG	DG		EF	EU	EF			FK	FS	FS			GB	GD	GD	GM		JE	JK	JK	JK	JE
2,000 pF	202	F	G	J	K	M				DG	DG		EU	EQ	EF			FK	FL	FS			GB	GH	GH	GM		JE	JK	JK	JE	JK
2,200 pF	222	F	G	J	K	M				DG	DG		EU	EQ	EF			FK	FL	FS			GB	GH	GH	GO		JE	JK	JK	JE	JK
2,400 pF	242	F	G	J	K	M				DG	DG		EU	EQ	EU			FS	FL	FS			GB	GH	GK	GO		JK	JK	JK	JE	JL
2,700 pF	272	F	G	J	K	M				DG	DG		EU	EQ	EU			FS	FL	FS			GB	GH	GK	GO		JK	JK	JK	JE	JL
3,000 pF	302	F	G	J	K	M							EQ	EQ				FS	FL	FF			GB	GH	GK			JK	JK	JK	JE	JL
3,300 pF	332	F	G	J	K	M							EQ	EQ				FS	FM	FG			GB	GH	GK			JK	JK	JK	JK	JN
3,600 pF	362	F	G	J	K	M							ER	ER				FL	FM	FG			GB	GH	GM			JK	JK	JK	JK	JN
3,900 pF	392	F	G	J	K	M							ER	ER				FL	FY	FL			GB	GH	GM			JK	JK	JK	JK	JN
4,300 pF	432	F	G	J	K	M							ES	ES				FM	FY	FL			GH	GH	GO			JK	JK	JK	JK	
4,700 pF	472	F	G	J	K	M							ES	ES				FM	FY	FM			GH	GH	GO			JK	JK	JK	JL	
5,100 pF	512	F	G	J	K	M							EE	EE				FY	FS	FM			GH	GK	GO			JK	JK	JK	JL	
5,200 pF	562	F	G	J	K	M							EF	EF				FY	FS	FM			GH	GK	GO			JK	JK	JK	JN	
6,200pF	622	F	G	J	K	M							EF	EF				FY	FE	FY			GH	GK	GH			JK	JE	JE	JN	
6,800pF	682	F	G	J	K	M							EU	EU				FY	FE	FY			GH	GM	GH			JK	JE	JK	JN	
7,500pF	752	F	G	J	K	M							EU	EU				FS	FF	FS			GH	GM	GK			JK	JE	JK		
8,200 pF	822	F	G	J	K	M							EU	EU				FS	FF	FS			GK	GO	GK			JK	JE	JL		
9,100 pF	912	F	G	J	K	M							EU	EU				FF	FF	FS			GM	GO	GM			JE	JE	JL		
10,000 pF	103	F	G	J	K	M							EU	EU				FG	FG	FS			GM	GO	GM			JE	JE	JL		
12,000 pF	123	F	G	J	K	M												FG	FG				GO	GH	GO			JE	JK	JN		
15,000 pF	153	F	G	J	K	M												FM	FM				GO	GH	GO			JE	JL	JE		
18,000 pF	183	F	G	J	K	M												FM	FM				GH	GH				JE	JL	JE		
22,000 pF	223	F	G	J	K	M												FY	FY				GH	GH				JK	JN	JK		
27,000 pF	273	F	G	J	K	M												FS	FS				GK	GK				JL	JN	JL		
33,000 pF	333	F	G	J	K	M												FS	FS				GM	GM				JN	JE	JN		
39,000 pF	393	F	G	J	K	M																	GO	GO				JE	JE			
47,000 pF	473	F	G	J	K	M																	GO	GO				JE	JE			
68,000 pF	683	F	G	J	K	M																						JL	JL			
82,000 pF	823	F	G	J	K	M																						JL	JL			
0.1 µF	104	F	G	J	K	M																						JN	JN			
Capacitance	Cap Code	Rated Voltage (VDC)					500	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
		Voltage Code					C	B	D	C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G
		Case Size/Series					C0603X			C0805X			C1206X					C1210X					C1812X					C2220X				

Performance and Reliability: Test Methods and Conditions

<table>
<tr><th>Test</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Visual and Mechanical</td><td>KEMET Internal</td><td>No defects that may affect performance (10X)</td><td>Dimensions according KEMET Spec Sheet</td></tr>
<tr><td>Capacitance (Cap)</td><td>KEMET Internal</td><td>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</td><td>Within Tolerance</td></tr>
<tr><td>Dissipation Factor (DF)</td><td>KEMET Internal</td><td>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</td><td>Within Specification
Dissipation factor (DF) maximum limit at 25°C = 0.1%</td></tr>
<tr><td>Insulation Resistance (IR)</td><td>KEMET Internal</td><td>500 VDC applied for 120 ±5 seconds at 25°C</td><td>Within Specification

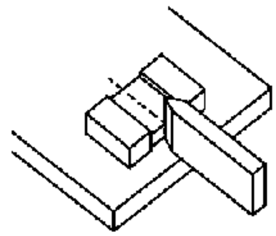
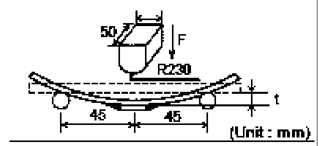
To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ limit. Select the lower of the two limits.

1,000 megaohm microfarads or 100 GΩ.</td></tr>
<tr><td>Temperature Coefficient of Capacitance (TCC)</td><td>KEMET Internal</td><td>Capacitance change with reference to +25°C and 0 VDC applied.
* See part number specification sheet for voltage
<table><tr><th>Step</th><th>Temperature (°C)</th></tr><tr><td>1</td><td>+25°C</td></tr><tr><td>2</td><td>−55°C</td></tr><tr><td>3</td><td>+25°C (Reference)</td></tr><tr><td>4</td><td>+150°C</td></tr></table></td><td>Within Specfcation ±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</td></tr>
<tr><td>Dielectric Withstanding Voltage (DWV)</td><td>KEMET Internal</td><td>See Dielectric Withstanding Voltage (DWV) Table (5 ±1 seconds and charge/discharge not exceeding 50 mA)</td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit

Withstand test voltage without insulation breakdown or damage.</td></tr>
<tr><td>Aging Rate (Maximum % Capacitance Loss/Decade Hour)</td><td>KEMET Internal</td><td>Maximum % capacitance loss/decade hour</td><td>0% Loss/Decade Hour</td></tr>
</table>

Performance and Reliability: Test Methods and Conditions cont.

<table>
<tr><th>Test</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Terminal Strength</td><td>KEMET Internal</td><td>Shear stress test per specific case size, Time: 60±1 seconds
<table><tr><th>Case Size</th><th>Force</th></tr><tr><td>0402</td><td>3N</td></tr><tr><td>0603</td><td>5N</td></tr><tr><td>0805</td><td>9N</td></tr><tr><td>≥1206</td><td>18N</td></tr></table></td><td>No evidence of mechanical damage</td></tr>
<tr><td>Board Flex</td><td>AEC-Q200-005</td><td>3.0 mm minimum
Test time: 60± 5 seconds
Ramp time: 1 mm/second
</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Solderability</td><td>J-STD-002</td><td>Condition: 4 hours ± 15 minimum at 155°C dry bake
apply all methods
Test 245 ± 5°C (SnPb & Pb-Free)</td><td>Visual Inspection.
95% coverage on termination.
No leaching.</td></tr>
<tr><td>Temperature Cycling</td><td>JESD22
Method JA-104</td><td>1,000 cycles (−55°C to +150°C)
2 – 3 cycles per hour
Soak Time 1 or 5 minutes</td><td>Measurement at 24 hours ±4 hours after test conclusion.
Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit</td></tr>
<tr><td>Biased Humidity</td><td>MIL-STD-202
Method 103</td><td>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.</td><td>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%</td></tr>
<tr><td>Moisture Resistance</td><td>MIL-STD-202
Method 106</td><td>Number of cycles required 10, 24 hours per cycle.
Steps 7a and 7b not required</td><td>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%</td></tr>
<tr><td>Thermal Shock</td><td>MIL-STD-202
Method 107</td><td>Number of cycles required 5, (−55°C to 150°C)
Dwell time 15 minutes.</td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit</td></tr>
<tr><td>High Temperature Life</td><td rowspan="2">MIL-STD-202
Method 108</td><td>1,000 hours at 150°C with 1.0 X rated voltage applied</td><td rowspan="2">Within Post Environmental Limits
Cap: ±0.3% or ±0.25 pF shift
IR: 10% of Initial Limit
DF: 0.5%</td></tr>
<tr><td>Storage Life</td><td>1,000 hours at 150°C, Unpowered</td></tr>
</table>

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 Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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 Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[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 – Flexible Termination Chip Thickness/Tape & Reel Packaging Quantities

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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 Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[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 – Automotive Standard Termination Chip Thickness/Tape & Reel Packaging Quantities

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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
HG	1825	1.60 ± 0.20	0	0	1,000	
HJ	1825	2.00 ± 0.20	0	0	500	
HK	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	0	0	500	
JN	2220	2.50 ± 0.20	0	0	500	
KE	2225	1.40 ± 0.15	0	0	1,000	
KF	2225	1.60 ± 0.20	0	0	1,000	
KH	2225	2.00 ± 0.20	0	0	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	3640	1.40 ± 0.15	0	0	250	
MB	3640	2.00 ± 0.20	0	0	250	
MC	3640	2.50 ± 0.20	0	0	250	
SA	4540	1.40 ± 0.15	0	0	200	
SB	4540	2.00 ± 0.20	0	0	200	
SC	4540	2.50 ± 0.20	0	0	200	
Thickness Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[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 2D – Automotive Flexible Termination Chip Thickness/Tape & Reel Packaging Quantities

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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 Code	**Case Size[1]**	**Thickness ± Range (mm)**	**7" Reel**	**13" Reel**	**7" Reel**	**13" Reel**
			Paper Quantity[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 2E – Bulk Packaging Quantities

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		Packaging Quantities (pieces/unit packaging)	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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 3 – Standard Termination 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)				
		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 ≥ 22 µF.*

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.

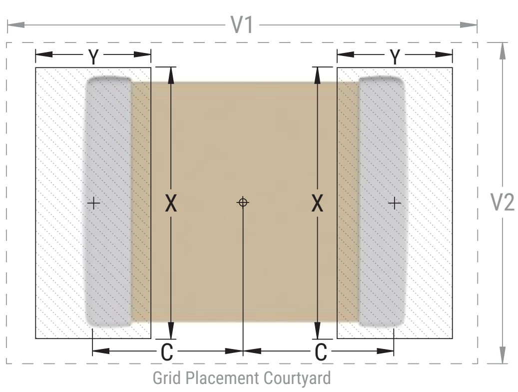
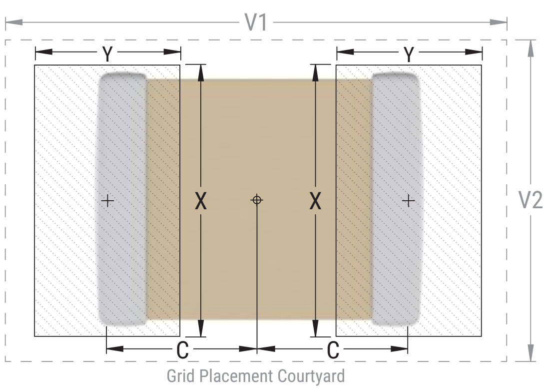


Table 4 – Flexible Termination Chip Capacitor Land Pattern Design Recommendations per IPC–7351 (mm)

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)				
		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:

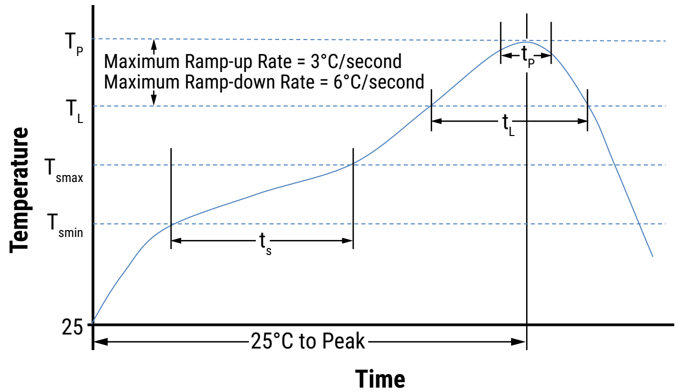
- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- All other EIA case sizes are limited to solder reflow only

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	
	SnPb	100% Matte Sn
Preheat/Soak Temperature Minimum (T_{Smin}) Temperature Maximum (T_{Smax}) Time (t_S) from T_{Smin} to T_{Smax}	 100°C 150°C 60 – 120 seconds	 150°C 200°C 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.

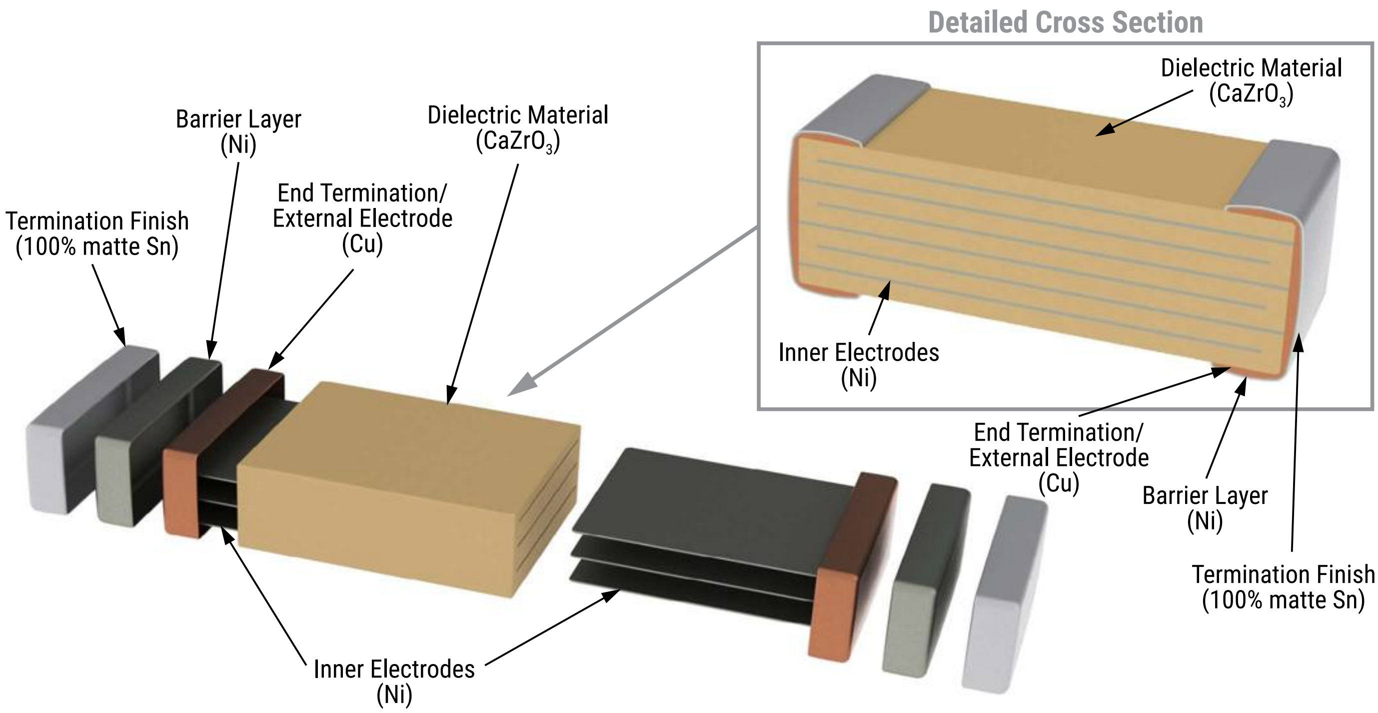


Storage and Handling

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.

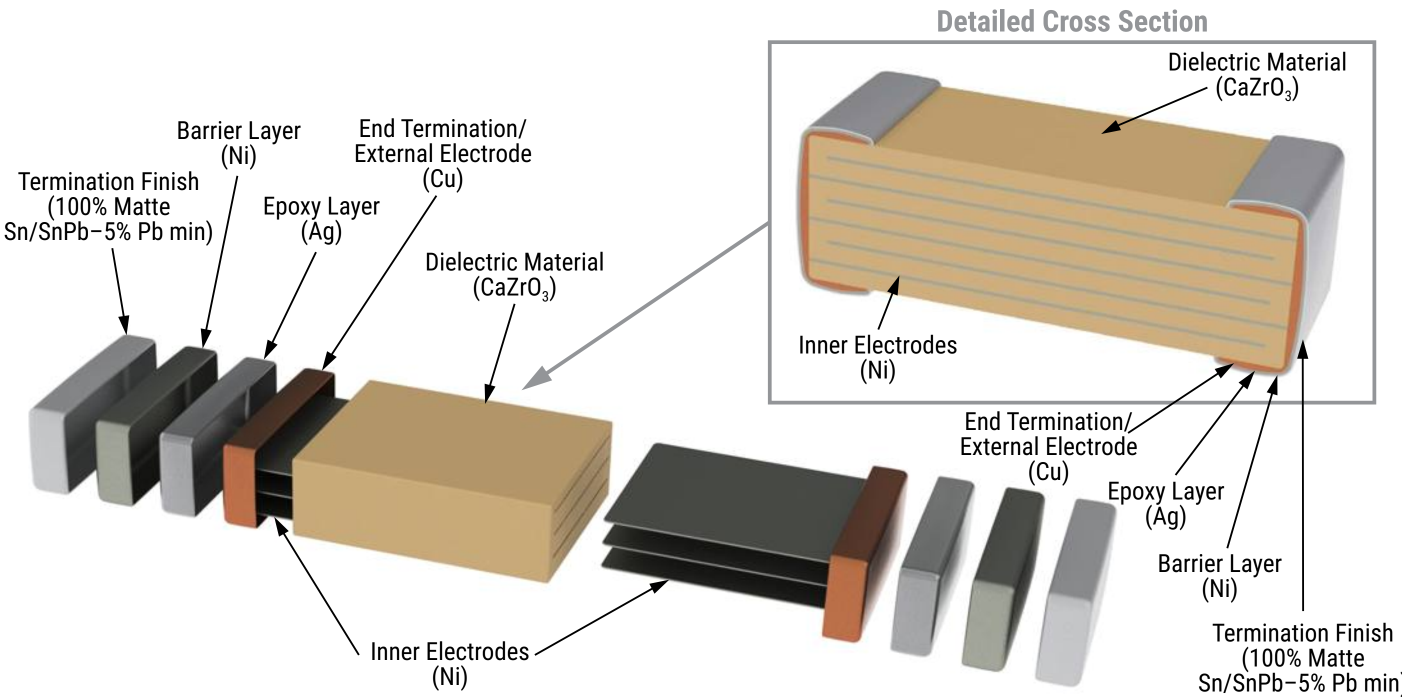
Construction

Standard Termination



Construction cont.

Flex Termination



Capacitor Marking (Optional)

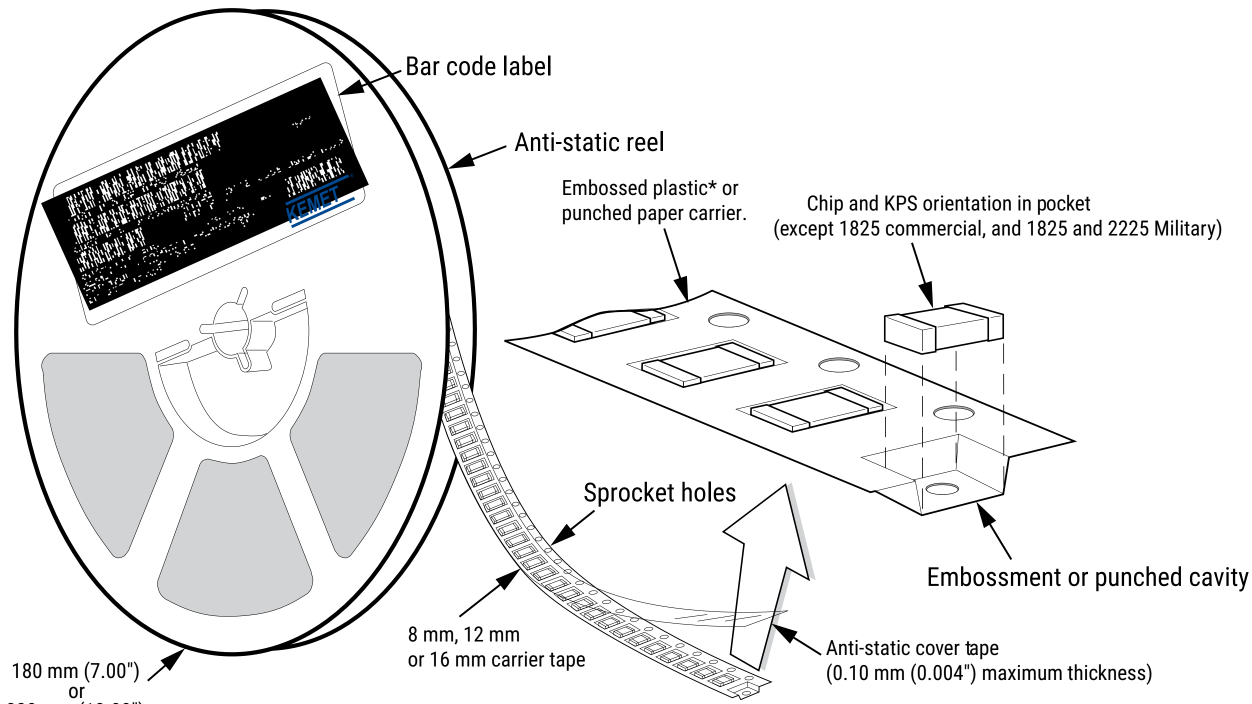
Laser marking option is not available on:

- C0G, 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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

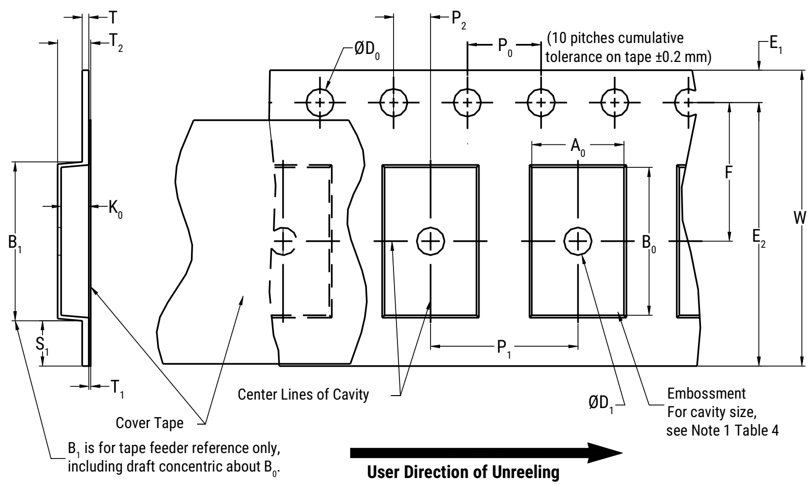


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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 (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)	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 S_1 < 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_0, B_0 and K_0 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

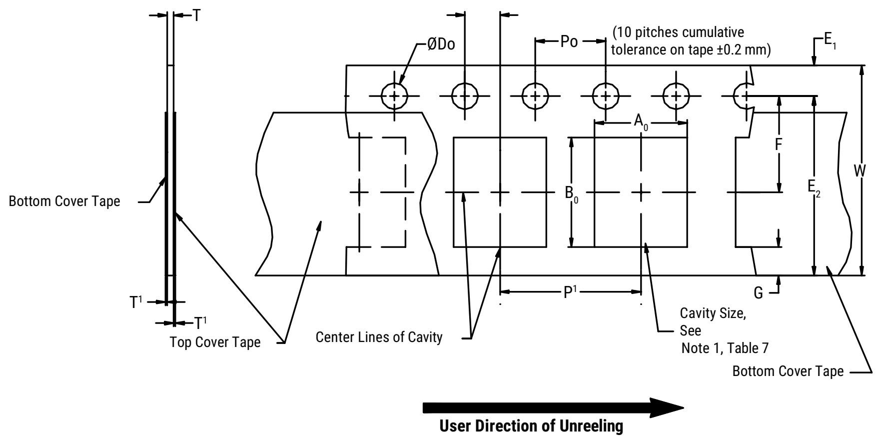


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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.)

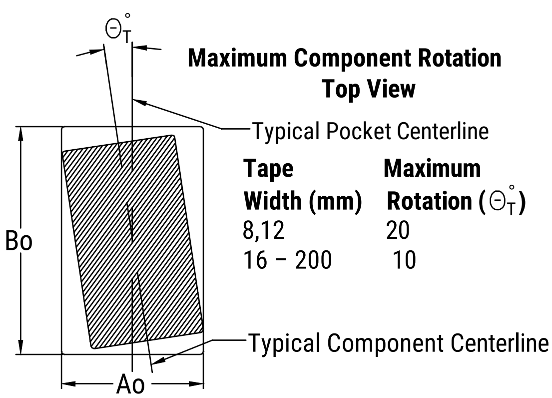
Packaging Information Performance Notes

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:

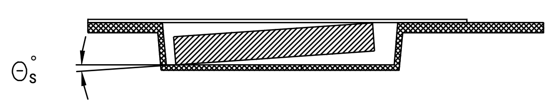
Tape Width	Peel Strength
8 mm	0.1 to 1.0 newton (10 to 100 gf)
12 and 16 mm	0.1 to 1.3 newton (10 to 130 gf)

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



Tape Width (mm)	Maximum Rotation (Θ_T°)
8,12	20
16 – 200	10



Tape Width (mm)	Maximum Rotation (Θ_S°)
8,12	20
16 – 56	10
72 – 200	5

Figure 4 – Maximum Lateral Movement

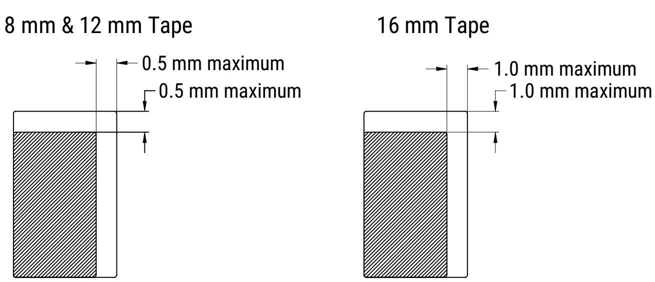


Figure 5 – Bending Radius

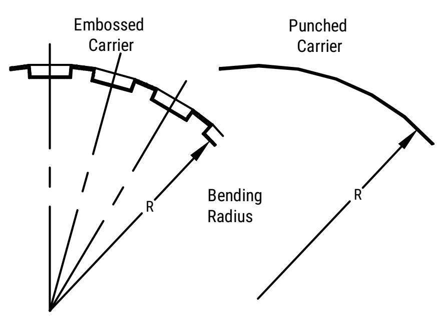
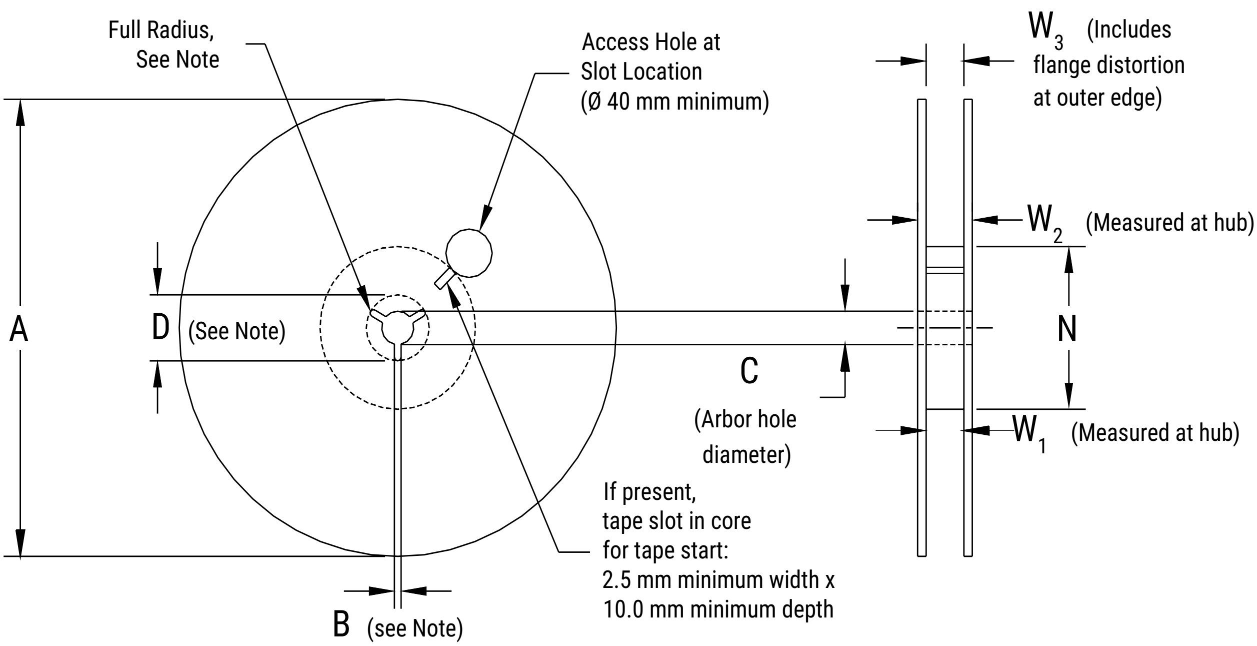


Figure 6 – Reel Dimensions



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	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

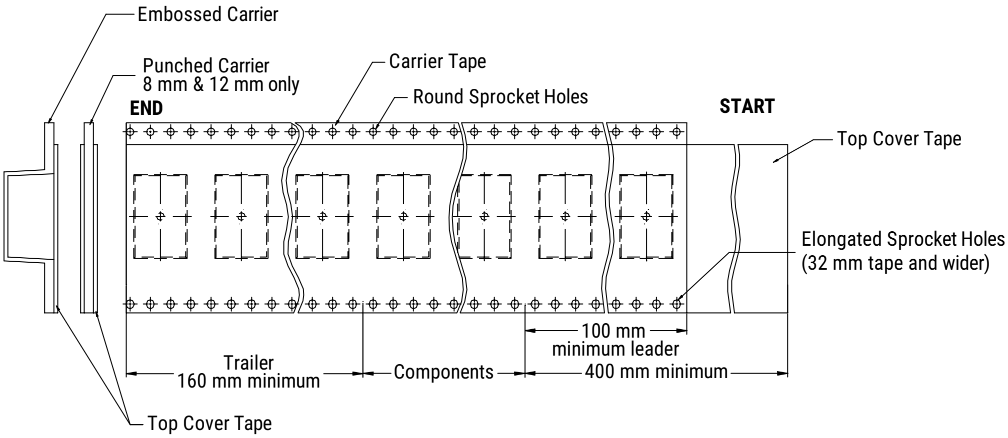
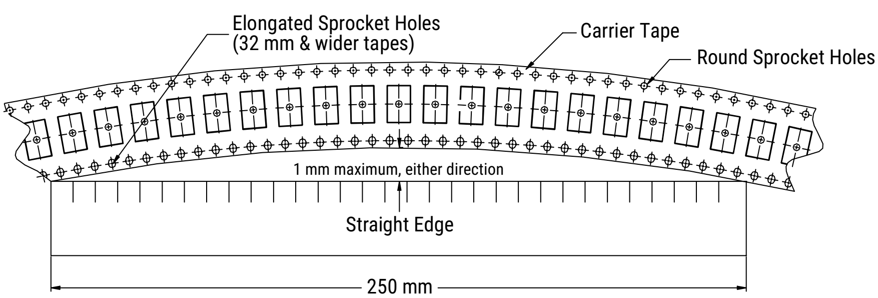


Figure 8 – Maximum Camber



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

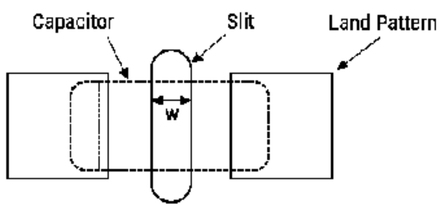
For MLCC ratings ≥1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

Dielectric	CTE (ppm/°C)
Class II $BaTiO_3$	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.



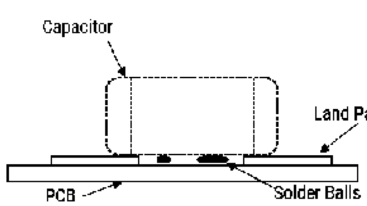
Solder Resist

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)

C0G with KONNEKT™ Technology, 50 – 3,000 VDC (Commercial & Automotive Grade)

Overview

KEMET's C0G 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 multi-chip solution for high density packaging. By utilizing KEMET's robust and proprietary C0G 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 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. C0G 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.

C0G with KONNEKT series compliments the KC-LINK with KONNEKT series by offering a wider voltage range and operating temperature range up to 125°C

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

Applications

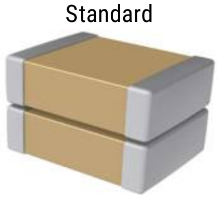
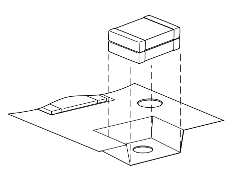
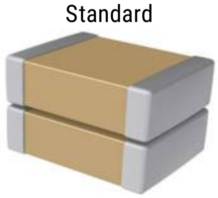
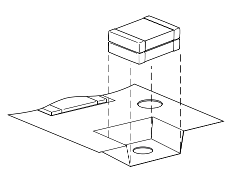
- Wide bandgap (WBG), silicon carbide (SiC) and gallium nitride (GaN) systems
- Data centers
- EV/HEV (drive systems, charging)
- LLC resonant converters
- Switched tank converters
- Wireless charging systems
- Photovoltaic systems
- Power converters
- Inverters
- DC link
- Snubber

Ordering Information

C	1812	C	943	K	C	G	L	C	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 = C0G	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

<table>
<tr><th>Mounting Orientation[1]</th><th>Tape and Reel Illustration</th><th>Packaging Type</th><th>Packaging/Grade Ordering Code (C-Spec)</th></tr>
<tr><td colspan="4">Commercial Grade</td></tr>
<tr><td rowspan="2">Standard
</td><td rowspan="2"></td><td>7" Reel/Unmarked</td><td>TU</td></tr>
<tr><td>13" Reel/Unmarked</td><td>7210</td></tr>
<tr><td colspan="4">Automotive Grade</td></tr>
<tr><td rowspan="2">Standard
</td><td rowspan="2"></td><td>7" Reel/Unmarked</td><td>AUTO</td></tr>
<tr><td>13" Reel/Unmarked</td><td>AUTO7210</td></tr>
</table>

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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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.

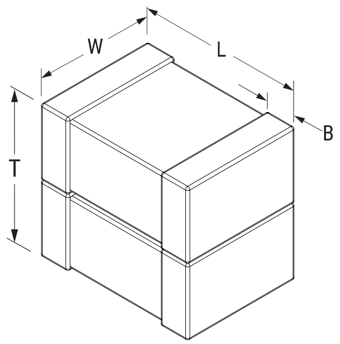
KEMET Automotive C-Spec	PPAP (Product Part Approval Process) Level				
	1	2	3	4	5
KEMET assigned[1]	●	●	●	●	●
AUTO			○		

[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
2 Chips**



<table>
<tr><th>EIA SIZE CODE</th><th>METRIC SIZE CODE</th><th>Number of Chips</th><th>Mounting</th><th>L LENGTH</th><th>W WIDTH</th><th>T THICKNESS</th><th>B BANDWIDTH</th><th>Mounting Technique</th><th>Typical Average Piece Weight (g)</th></tr>
<tr><td>1812</td><td>4532</td><td>2</td><td>Standard</td><td>4.50 (0.177)
±0.30 (0.012)</td><td>3.20 (0.126)
±0.30 (0.012)</td><td rowspan="2">See Table 1A and 1B for Thickness</td><td rowspan="2">0.60 (0.024)
±0.35 (0.014)</td><td rowspan="2">Solder Reflow Only</td><td rowspan="2">See Table 1A and 1B for Weights</td></tr>
<tr><td>2220</td><td>5750</td><td>2</td><td>Standard</td><td>5.70 (0.224)
±0.40 (0.016)</td><td>5.00 (0.197)
±0.40 (0.016</td></tr>
</table>

Table 1A - 1812 Product Ordering Codes, Ratings, and Package Quantities

KEMET Part Number[1]	Capacitance	Cap Code	Voltage	Number of Chips	Thickness mm (inch)	Typical Average Piece Weight (g)	Tape & Reel Quantity	
							7" Tape & Reel	13" Tape & Reel
C1812(a)444(b)5GLC(c)	440 nF	444	50 V	2	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		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

KEMET Part Number[1]	Capacitance	Cap Code	Voltage	Number of Chips	Thickness mm (inch)	Typical Average Piece Weight (g)	Tape & Reel Quantity	
							7" Tape & Reel	13" Tape & Reel
C2220(a)944(b)5GLC(c)	940 nF	944	50 V	2	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		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)

<table>
<tr><th>Test</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Visual and Mechanical</td><td>KEMET Internal</td><td>No defects that may affect performance (10X)</td><td>Dimensions according KEMET Spec Sheet</td></tr>
<tr><td>Capacitance (Cap)</td><td>KEMET Internal</td><td>1 kHz ±50 Hz and 1.0 ±0.2 V_{rms} of capacitance

Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours</td><td>Within Tolerance</td></tr>
<tr><td>Dissipation Factor (DF)</td><td>KEMET Internal</td><td>1 kHz ±50 Hz and 1.0 ±0.2 V_{rms}</td><td>Dissipation factor (DF) maximum limit at 25°C = 0.1%</td></tr>
<tr><td>Insulation Resistance (IR)</td><td>KEMET Internal</td><td>For < 500 VDC:
Rated voltage applied for 120 ±5 seconds at 25°C

For ≥ 500 VDC:
500 V applied for 120 ±5 seconds at 25°C</td><td>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.

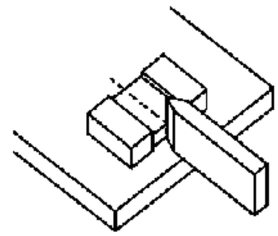
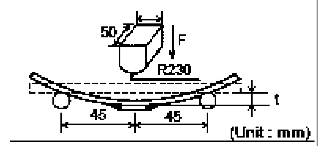
1,000 MΩ-µF or 100 GΩ</td></tr>
<tr><td>Temperature Coefficient of Capacitance (TCC)</td><td>KEMET Internal</td><td>Frequency: 1 kHz ±50 Hz
Capacitance change with reference to +25°C and 0 VDC applied

* See part number specification sheet for voltage

<table><tr><th>Step</th><th>Temperature (°C)</th></tr><tr><td>1</td><td>+25°C</td></tr><tr><td>2</td><td>−55°C</td></tr><tr><td>3</td><td>+25°C
(Reference Temperature)</td></tr><tr><td>4</td><td>+125°C</td></tr></table></td><td>±30 PPM/°C</td></tr>
<tr><td>Dielectric Withstanding Voltage (DWV)</td><td>KEMET Internal</td><td><table><tr><th>Rated DC Voltage</th><th>DWV Voltage (% of Rated)</th></tr><tr><td>< 500</td><td>250%</td></tr><tr><td>500</td><td>150%</td></tr><tr><td>630</td><td>130%</td></tr><tr><td>≥ 1,000</td><td>120%</td></tr></table>(5 ±1 seconds and charge/discharge not exceeding 50 mA)</td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit

Withstand test voltage without insulation breakdown or damage.</td></tr>
<tr><td>Aging Rate (Maximum % Capacitance Loss/Decade Hour)</td><td>KEMET Internal</td><td>Maximum % capacitance loss/decade hour</td><td>0% Loss/Decade Hour</td></tr>
</table>

Table 2 - Performance and Reliability: Test Methods and Conditions (Commercial Only) cont.

<table>
<tr><th>Test</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Terminal Strength</td><td>KEMET Internal</td><td>Shear stress test per specific case size, Time: 60±1 seconds
<table><tr><th>Case Size</th><th>Force</th></tr><tr><td>1812</td><td rowspan="2">18N</td></tr><tr><td>2220</td></tr></table>
</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Board Flex</td><td>AEC-Q200-005</td><td>Standard Termination System 3.0 mm
Test time: 60± 5 seconds
Ramp time: 1 mm/second

</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Solderability</td><td>J-STD-002</td><td>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</td><td>Visual Inspection.
95% coverage on termination.
No leaching</td></tr>
<tr><td>Temperature Cycling</td><td>JESD22 Method JA-104</td><td>1,000 cycles (−55°C to +125°C)
2 – 3 cycles per hour
Soak Time 1 or 5 minutes</td><td>Measurement at 24 hours ±4 hours after test conclusion.
Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit</td></tr>
<tr><td>Biased Humidity</td><td>MIL-STD-202 Method 103</td><td>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.</td><td>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%</td></tr>
<tr><td>Moisture Resistance</td><td>MIL-STD-202 Method 106</td><td>Number of cycles required 10, 24 hours per cycle.
Steps 7a and 7b not required.</td><td>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%</td></tr>
</table>

Table 2 - Performance and Reliability: Test Methods and Conditions (Commercial Only) cont.

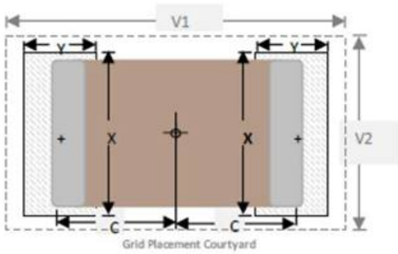
Test	Reference	Test Condition	Limits
Thermal Shock	MIL-STD-202 Method 107	Number of cycles required 5, (−55°C to 125°C) Dwell time 15 minutes.	Cap: Initial Limit DF: Initial Limit IR: Initial Limit
High Temperature Life	MIL-STD-202 Method 108	1,000 hours at 125°C with 1.0 X rated voltage applied	Measurement at 24 hours ±4 hours after test conclusion. Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5%
Storage Life		1,000 hours at 125°C, Unpowered	
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.

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.

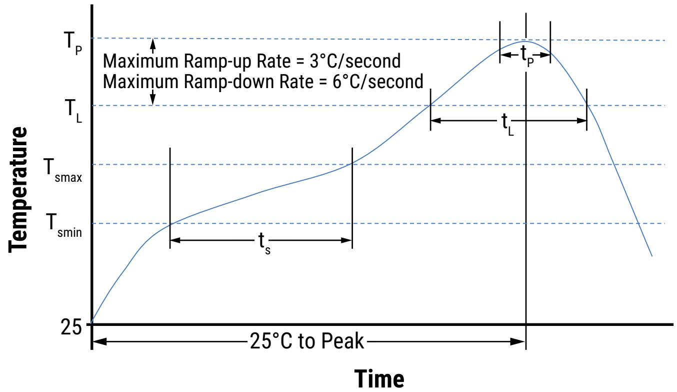
Soldering Process

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
	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.

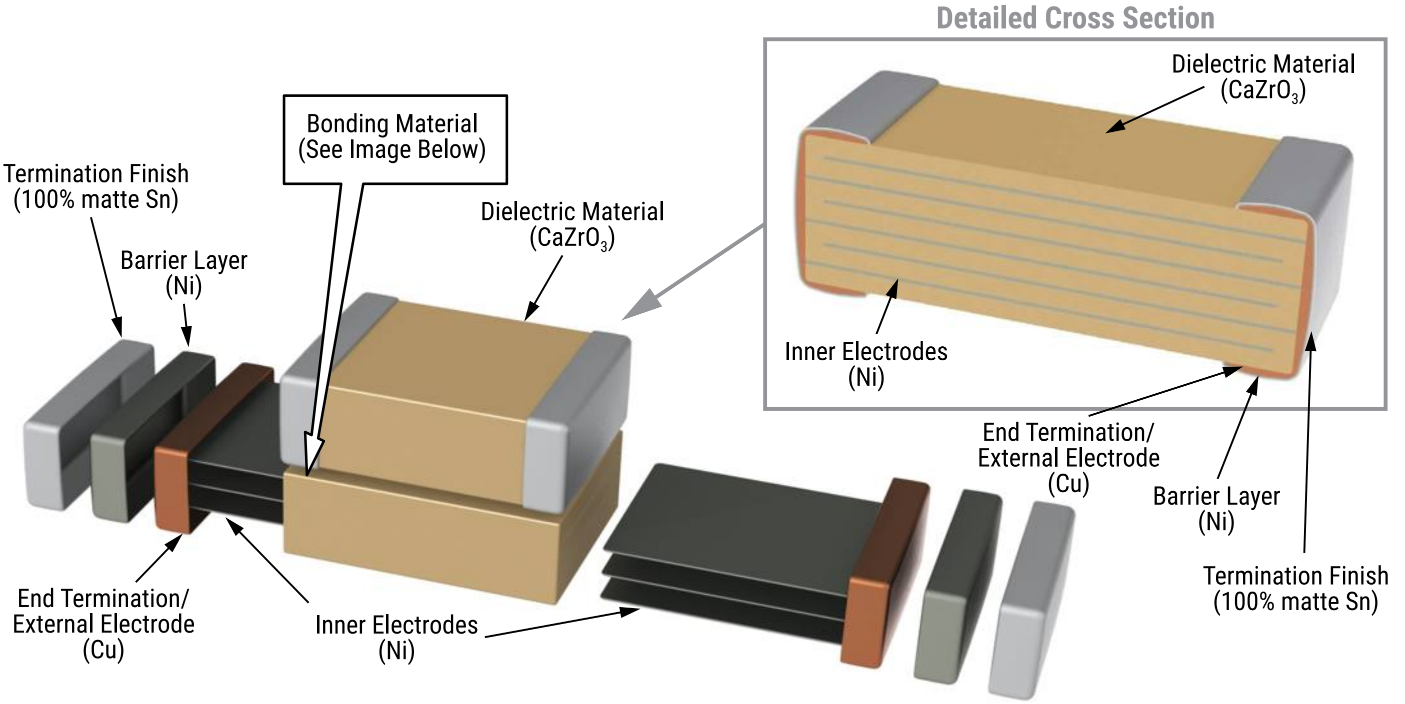


Hand Soldering and Removal of KONNEKT Capacitors

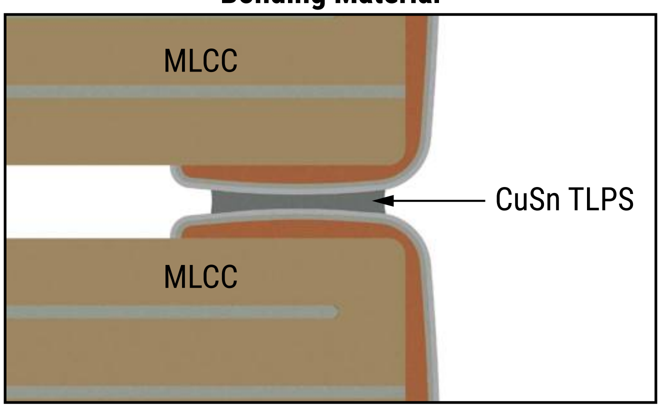
The preferred method of attachment for KEMET's KONNEKT Capacitors is IR or convection reflow where temperature, time and air flow are well controlled.

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



Bonding Material



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.

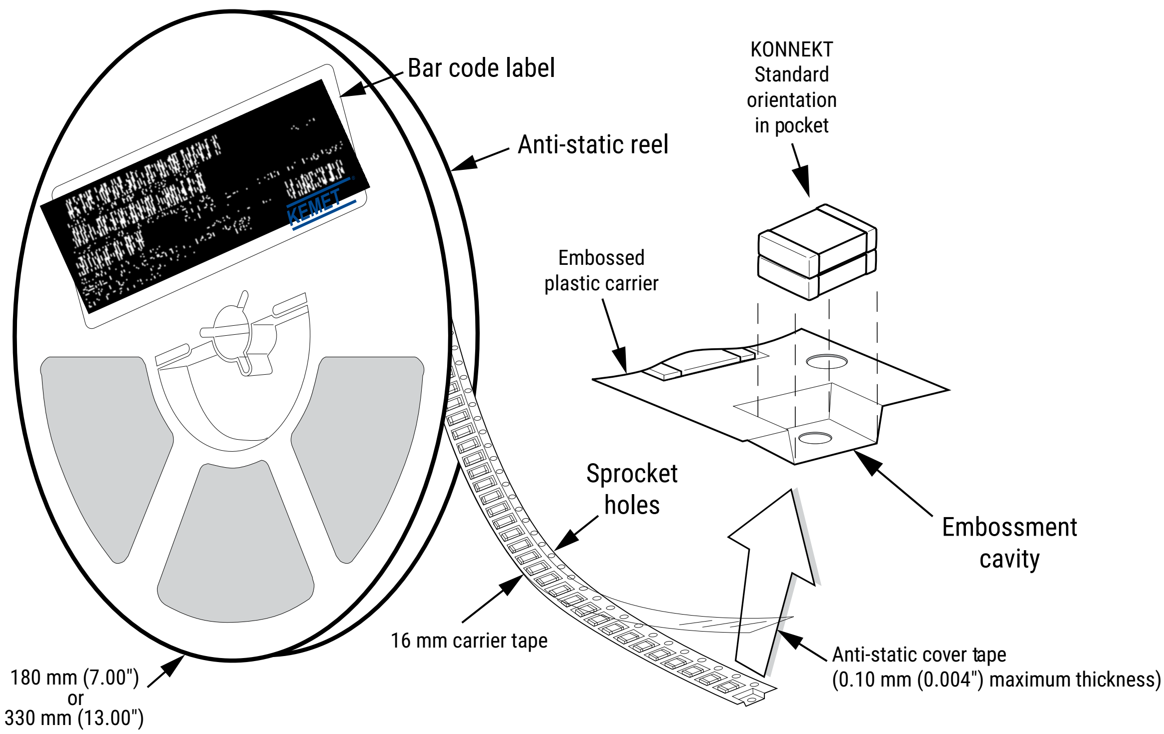


Table 4 – Carrier Tape Configuration, Embossed Plastic (mm)

EIA Case Size	Number of Chips	Chip Thickness	Tape Size (W)[1]	Embossed Plastic	
				7" Reel	13" Reel
				Pitch (P_1)[2]	
KONNEKT 1812	2	≤ 3.5 mm	16	8	8
		> 3.5 mm		12	12
KONNEKT 2220	2	≤ 3.5 mm >5.0 mm & ≤ 5.3 mm	16	8	8
		> 3.5 mm ≤ 5.0		12	12

1. Refer to Figures 1 and 2 for W and P_1 carrier tape reference locations.
2. Refer to Tables 4 and 5 for tolerance specifications.

Figure 1 – Embossed (Plastic) Carrier Tape Dimensions

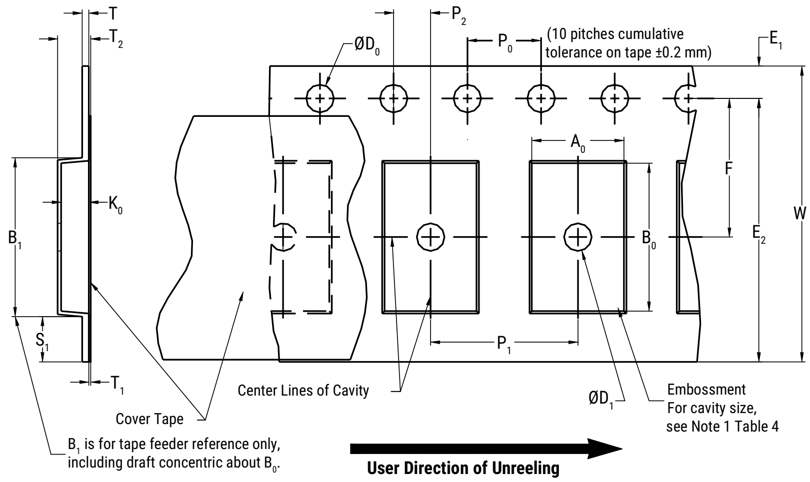


Table 5 – Embossed (Plastic) Carrier Tape Dimensions

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)	7.9 (0.311)	14.25 (0.561)	7.5±0.05 (0.138±0.002)	12.0±0.10 (0.472±0.004)	6.5 (0.256)	16.3 (0.642)	Note 5
			Double (8mm)	7.5 (0.295)			8.0±0.10 (0.315±0.004)			
2220	2	16 mm	Triple (12mm)	8.5 (0.335)	14.25 (0.561)	7.5±0.05 (0.138±0.002)	12.0±0.10 (0.472±0.004)	6.5 (0.256)	16.3 (0.642)	Note 5
			Double (8mm)	9.2 (0.363)			8.0±0.10 (0.315±0.004)			

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 S_1 < 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_0, B_0 and K_0 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_0 and B_0 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	A	B Minimum	C	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

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, ±1%, ±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	A	10	BX	B	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.)

C	0805	Z	101	K	5	G	A	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

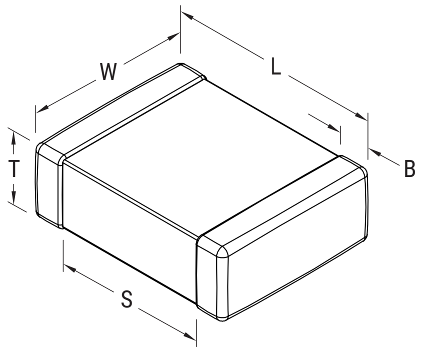
Packaging C-Spec Ordering Options Table

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

[3] To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ 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)

Capacitance	Cap Code (MIL-PRF-123 Part Number)	Cap Code (KEMET Part Number)	Case Size	0805 (CKS51)		1206 (CKS55)		1210 (CKS52)		1808 (CKS53)		1812 (CKS56)		1825 (CKS57)		2225 (CKS54)	
			Voltage Code (MIL)	B	C	B	C	B	C	B	C	B	C	B	C	B	C
			Voltage Code (KEMET)	5	1	5	1	5	1	5	1	5	1	5	1	5	1
			Rated Voltage (VDC)	50	100	50	100	50	100	50	100	50	100	50	100	50	100
				Product Availability													
1.0 pF	1R0	109	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%	(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)										
2.2 pF	2R2	229		(1)	(1)		(4)										
2.4 pF	2R4	249		(1)	(1)		(4)										
2.7 pF	2R7	279		(1)	(1)		(5)										
3.0 pF	3R0	309		(1)	(1)		(5)										
3.3 pF	3R3	339		(1)	(1)		(5)										
3.6 pF	3R6	369		(1)	(1)		(5)										
3.9 pF	3R9	399		(1)	(1)		(5)										
4.3 pF	4R3	439		(1)	(1)		(5)										
4.7 pF	4R7	479		(1)	(1)		(5)										
5.1 pF	5R1	519		(1)	(1)		(5)										
5.6 pF	5R6	569		(1)	(1)		(5)										
6.2 pF	6R2	629		(1)	(1)		(5)										
6.8 pF	6R8	689		(1)	(1)		(5)										
7.5 pF	7R5	759		(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)										
Capacitance	Cap Code (MIL-PRF-123 Par Number)	Cap Code (KEMET Part Number)	Rated Voltage (VDC)	50	100	50	100	50	100	50	100	50	100	50	100	50	100
			Voltage Code (KEMET)	5	1	5	1	5	1	5	1	5	1	5	1	5	1
			Voltage Code (MIL)	B	C	B	C	B	C	B	C	B	C	B	C	B	C
			Case Size	0805 (CKS51)		1206 (CKS55)		1210 (CKS52)		1808 (CKS53)		1812 (CKS56)		1825 (CKS57)		2225 (CKS54)	

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%

Table 1A - Product Ordering Codes & Ratings (BP Dielectric) cont.

Capacitance	Cap Code (MIL-PRF-123 Part Number)	Cap Code (KEMET Part Number)	Case Size	0805 (CKS51)		1206 (CKS55)		1210 (CKS52)		1808 (CKS53)		1812 (CKS56)		1825 (CKS57)		2225 (CKS54)	
			Voltage Code (MIL)	B	C	B	C	B	C	B	C	B	C	B	C	B	C
			Voltage Code (KEMET)	5	1	5	1	5	1	5	1	5	1	5	1	5	1
			Rated Voltage (VDC)	50	100	50	100	50	100	50	100	50	100	50	100	50	100
				Product Availability													
30 pF	300	300	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)												
33 pF	330	330		(3)	(3)		(3)										
36 pF	360	360		(3)	(3)		(3)										
39 pF	390	390		(3)	(3)		(3)										
43 pF	430	430		(3)	(3)		(3)										
47 pF	470	470		(3)	(3)		(3)										
51 pF	510	510		(3)	(3)		(3)										
56 pF	560	560		(3)	(3)		(3)										
62 pF	620	620		(3)	(3)		(3)										
68 pF	680	680		(3)	(3)		(3)										
75 pF	750	750		(3)	(3)		(3)										
82 pF	820	820		(3)	(3)		(3)										
91 pF	910	910		(3)	(3)		(3)										
100 pF	101	101		(3)	(3)		(3)										
110 pF	111	111		(3)	(3)		(3)										
120 pF	121	121		(3)	(3)		(3)										
130 pF	131	131		(3)	(3)		(3)										
150 pF	151	151		(3)	(3)		(3)										
160 pF	161	161		(3)	(3)		(3)										
180 pF	181	181		(3)	(3)		(3)										
200 pF	201	201		(3)	(3)		(3)										
220 pF	221	221		(3)	(3)		(3)										
240 pF	241	241		(3)	(3)		(3)										
270 pF	271	271		(3)	(3)		(3)										
300 pF	301	301		(3)	(3)		(3)	(3)	(3)	(3)	(3)						
330 pF	331	331		(3)	(3)		(3)	(3)	(3)	(3)	(3)						
360 pF	361	361		(3)	(3)		(3)	(3)	(3)	(3)	(3)						
390 pF	391	391		(3)	(3)		(3)	(3)	(3)	(3)	(3)						
430 pF	431	431		(3)	(3)		(3)	(3)	(3)	(3)	(3)						
470 pF	471	471		(3)	(3)		(3)	(3)	(3)	(3)	(3)						
510 pF	511	511		(3)			(3)	(3)	(3)	(3)	(3)						
560 pF	561	561		(3)			(3)	(3)	(3)	(3)	(3)						
620 pF	621	621		(3)			(3)	(3)	(3)	(3)	(3)						
680 pF	681	681		(3)			(3)	(3)	(3)	(3)	(3)						
750 pF	751	751					(3)	(3)	(3)	(3)	(3)						
Capacitance	Cap Code (MIL-PRF-123 Part Number)	Cap Code (KEMET Part Number)	Rated Voltage (VDC)	50	100	50	100	50	100	50	100	50	100	50	100	50	100
			Voltage Code (KEMET)	5	1	5	1	5	1	5	1	5	1	5	1	5	1
			Voltage Code (MIL)	B	C	B	C	B	C	B	C	B	C	B	C	B	C
			Case Size	0805 (CKS51)		1206 (CKS55)		1210 (CKS52)		1808 (CKS53)		1812 (CKS56)		1825 (CKS57)		2225 (CKS54)	

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%

Table 1A - Product Ordering Codes & Ratings (BP Dielectric) cont.

Capacitance	Cap Code (MIL-PRF-123 Part Number)	Cap Code (KEMET Part Number)	Case Size	0805 (CKS51)		1206 (CKS55)		1210 (CKS52)		1808 (CKS53)		1812 (CKS56)		1825 (CKS57)		2225 (CKS54)	
			Voltage Code (MIL)	B	C	B	C	B	C	B	C	B	C	B	C	B	C
			Voltage Code (KEMET)	5	1	5	1	5	1	5	1	5	1	5	1	5	1
			Rated Voltage (VDC)	50	100	50	100	50	100	50	100	50	100	50	100	50	100
				Product Availability													
820 pF	821	821	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)						
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						(3)					(3)			(3)	
2,700 pF	272	272						(3)					(3)			(3)	
3,000 pF	302	302						(3)					(3)			(3)	
3,300 pF	332	332						(3)					(3)			(3)	
3,600 pF	362	362											(3)			(3)	
3,900 pF	392	392											(3)		(3)	(3)	
4,300 pF	432	432											(3)			(3)	
4,700 pF	472	472											(3)		(3)	(3)	
5,100 pF	512	512										(3)			(3)	(3)	
5,600 pF	562	562										(3)			(3)	(3)	
6,200 pF	622	622										(3)			(3)	(3)	
6,800 pF	682	682										(3)			(3)	(3)	
7,500 pF	752	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												(3)			
Capacitance	Cap Code (MIL-PRF-123 Part Number)	Cap Code (KEMET Part Number)	Rated Voltage (VDC)	50	100	50	100	50	100	50	100	50	100	50	100	50	100
			Voltage Code (KEMET)	5	1	5	1	5	1	5	1	5	1	5	1	5	1
			Voltage Code (MIL)	B	C	B	C	B	C	B	C	B	C	B	C	B	C
			Case Size	0805 (CKS51)		1206 (CKS55)		1210 (CKS52)		1808 (CKS53)		1812 (CKS56)		1825 (CKS57)		2225 (CKS54)	

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%

Table 1B - Product Ordering Codes & Ratings (BX Dielectric)

Capacitance	Cap Code (MIL-PRF-123 Part Number)	Cap Code (KEMET Part Number)	Case Size	0805 (CKS51)		1206 (CKS55)		1210 (CKS52)		1808 (CKS53)		1812 (CKS56)		1825 (CKS57)		2225 (CKS54)	
			Voltage Code (MIL)	B	C	B	C	B	C	B	C	B	C	B	C	B	C
			Voltage Code (KEMET)	5	1	5	1	5	1	5	1	5	1	5	1	5	1
			Rated Voltage (VDC)	50	100	50	100	50	100	50	100	50	100	50	100	50	100
				Product Availability													
330 pF	331	331		(7)	(7)												
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)												
1,200 pF	122	122		(7)	(7)												
1,500 pF	152	152		(7)	(7)												
1,800 pF	182	182		(7)	(7)												
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 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%	(7)			(6)	(6)	(6)	(7)	(7)						
8,200 pF	822	822		(7)			(6)	(6)	(6)	(7)	(7)						
10,000 pF	103	103		(7)			(6)	(6)	(6)	(7)	(7)						
12,000 pF	123	123		(7)			(6)	(6)	(6)	(7)	(7)						
15,000 pF	153	153		(7)			(6)	(6)	(6)	(7)	(7)						
18,000 pF	183	183		(7)		(6)		(6)	(6)	(7)	(7)						
22,000 pF	223	223				(6)		(6)	(6)	(7)	(7)						
27,000 pF	273	273				(6)		(6)	(6)	(7)	(7)		(6)				
33,000 pF	333	333				(6)		(6)		(7)	(7)		(6)				
39,000 pF	393	393				(6)		(6)		(7)			(6)				
47,000 pF	473	473						(6)		(7)			(6)				
56,000 pF	563	563						(6)		(7)			(6)		(6)		
68,000 pF	683	683						(6)		(7)		(6)			(6)		
82,000 pF	823	823						(6)		(7)		(6)			(6)		
100,000 pF	104	104						(6)		(7)		(6)			(6)		
120,000 pF	124	124										(6)			(6)	(7)	
150,000 pF	154	154										(6)			(6)	(7)	
180,000 pF	184	184												(6)		(7)	
220,000 pF	224	224												(6)		(7)	
270,000 pF	274	274												(6)		(7)	
330,000 pF	334	334												(6)		(7)	
390,000 pF	394	394												(6)		(7)	
470,000 pF	474	474												(6)		(7)	
1,000,000 pF	105	105														(7)	
Capacitance	Cap Code (MIL-PRF-123 Par Number)	Cap Code (KEMET Part Number)	Rated Voltage (VDC)	50	100	50	100	50	100	50	100	50	100	50	100	50	100
			Voltage Code (KEMET)	5	1	5	1	5	1	5	1	5	1	5	1	5	1
			Voltage Code (MIL)	B	C	B	C	B	C	B	C	B	C	B	C	B	C
			Case Size	0805 (CKS51)		1206 (CKS55)		1210 (CKS52)		1808 (CKS53)		1812 (CKS56)		1825 (CKS57)		2225 (CKS54)	

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%

Legacy Ratings and Part Number Reference

CAP. pF	KEMET PART NUMBER	MIL-PRF-123 PART NUMBER
50/100 VOLT- BP-C0805 SIZE (MILITARY CKS51)		
1.0	C0805Z109(1)(8)GA(9)	M123A10BP(7)1R0(1)(10)
1.1	C0805Z119(1)(8)GA(9)	M123A10BP(7)1R1(1)(10)
1.2	C0805Z129(1)(8)GA(9)	M123A10BP(7)1R2(1)(10)
1.3	C0805Z139(1)(8)GA(9)	M123A10BP(7)1R3(1)(10)
1.5	C0805Z159(1)(8)GA(9)	M123A10BP(7)1R5(1)(10)
1.6	C0805Z169(1)(8)GA(9)	M123A10BP(7)1R6(1)(10)
1.8	C0805Z189(1)(8)GA(9)	M123A10BP(7)1R8(1)(10)
2.0	C0805Z209(1)(8)GA(9)	M123A10BP(7)2R0(1)(10)
2.2	C0805Z229(1)(8)GA(9)	M123A10BP(7)2R2(1)(10)
2.4	C0805Z249(1)(8)GA(9)	M123A10BP(7)2R4(1)(10)
2.7	C0805Z279(1)(8)GA(9)	M123A10BP(7)2R7(1)(10)
3.0	C0805Z309(1)(8)GA(9)	M123A10BP(7)3R0(1)(10)
3.3	C0805Z339(1)(8)GA(9)	M123A10BP(7)3R3(1)(10)
3.6	C0805Z369(1)(8)GA(9)	M123A10BP(7)3R6(1)(10)
3.9	C0805Z399(1)(8)GA(9)	M123A10BP(7)3R9(1)(10)
4.3	C0805Z439(1)(8)GA(9)	M123A10BP(7)4R3(1)(10)
4.7	C0805Z479(1)(8)GA(9)	M123A10BP(7)4R7(1)(10)
5.1	C0805Z519(1)(8)GA(9)	M123A10BP(7)5R1(1)(10)
5.6	C0805Z569(1)(8)GA(9)	M123A10BP(7)5R6(1)(10)
6.2	C0805Z629(1)(8)GA(9)	M123A10BP(7)6R2(1)(10)
6.8	C0805Z689(1)(8)GA(9)	M123A10BP(7)6R8(1)(10)
7.5	C0805Z759(1)(8)GA(9)	M123A10BP(7)7R5(1)(10)
8.2	C0805Z829(1)(8)GA(9)	M123A10BP(7)8R2(1)(10)
9.1	C0805Z919(1)(8)GA(9)	M123A10BP(7)9R1(1)(10)
10.0	C0805Z100(2)(8)GA(9)	M123A10BP(7)100(2)(10)
11.0	C0805Z110(2)(8)GA(9)	M123A10BP(7)110(2)(10)
12.0	C0805Z120(2)(8)GA(9)	M123A10BP(7)120(2)(10)
13.0	C0805Z130(2)(8)GA(9)	M123A10BP(7)130(2)(10)
15.0	C0805Z150(2)(8)GA(9)	M123A10BP(7)150(2)(10)
16.0	C0805Z160(2)(8)GA(9)	M123A10BP(7)160(2)(10)
18.0	C0805Z180(2)(8)GA(9)	M123A10BP(7)180(2)(10)
20.0	C0805Z200(2)(8)GA(9)	M123A10BP(7)200(2)(10)
22.0	C0805Z220(2)(8)GA(9)	M123A10BP(7)220(2)(10)
24.0	C0805Z240(2)(8)GA(9)	M123A10BP(7)240(2)(10)
27.0	C0805Z270(3)(8)GA(9)	M123A10BP(7)270(3)(10)
30.0	C0805Z300(3)(8)GA(9)	M123A10BP(7)300(3)(10)
33.0	C0805Z330(3)(8)GA(9)	M123A10BP(7)330(3)(10)
36.0	C0805Z360(3)(8)GA(9)	M123A10BP(7)360(3)(10)
39.0	C0805Z390(3)(8)GA(9)	M123A10BP(7)390((3)(10)
43.0	C0805Z430(3)(8)GA(9)	M123A10BP(7)430(3)(10)
47.0	C0805Z470(3)(8)GA(9)	M123A10BP(7)470(3)(10)
51.0	C0805Z510(3)(8)GA(9)	M123A10BP(7)510(3)(10)
56.0	C0805Z560(3)(8)GA(9)	M123A10BP(7)560(3)(10)
62.0	C0805Z620(3)(8)GA(9)	M123A10BP(7)620(3)(10)
68.0	C0805Z680(3)(8)GA(9)	M123A10BP(7)680(3)(10)
75.0	C0805Z750(3)(8)GA(9)	M123A10BP(7)750(3)(10)
82.0	C0805Z820(3)(8)GA(9)	M123A10BP(7)820(3)(10)
91.0	C0805Z910(3)(8)GA(9)	M123A10BP(7)910(3)(10)
100.0	C0805Z101(3)(8)GA(9)	M123A10BP(7)101(3)(10)
110.0	C0805Z111(3)(8)GA(9)	M123A10BP(7)111(3)(10)
120.0	C0805Z121(3)(8)GA(9)	M123A10BP(7)121(3)(10)
130.0	C0805Z131(3)(8)GA(9)	M123A10BP(7)131(3)(10)
150.0	C0805Z151(3)(8)GA(9)	M123A10BP(7)151(3)(10)
160.0	C0805Z161(3)(8)GA(9)	M123A10BP(7)161(3)(10)
180.0	C0805Z181(3)(8)GA(9)	M123A10BP(7)181(3)(10)
200.0	C0805Z201(3)(8)GA(9)	M123A10BP(7)201(3)(10)
220.0	C0805Z221(3)(8)GA(9)	M123A10BP(7)221(3)(10)
240.0	C0805Z241(3)(8)GA(9)	M123A10BP(7)241(3)(10)
270.0	C0805Z271(3)(8)GA(9)	M123A10BP(7)271(3)(10)
300.0	C0805Z301(3)(8)GA(9)	M123A10BP(7)301(3)(10)
330.0	C0805Z331(3)(8)GA(9)	M123A10BP(7)331(3)(10)
360.0	C0805Z361(3)(8)GA(9)	M123A10BP(7)361(3)(10)
390.0	C0805Z391(3)(8)GA(9)	M123A10BP(7)391(3)(10)
430.0	C0805Z431(3)(8)GA(9)	M123A10BP(7)431(3)(10)
470.0	C0805Z471(3)(8)GA(9)	M123A10BP(7)471(3)(10)

CAP. pF	KEMET PART NUMBER	MIL-PRF-123 PART NUMBER
50 VOLT-BP-C0805 SIZE (MILITARY CKS51)		
510.0	C0805Z511(3)5GA(9)	M123A10BPB511(3)(10)
560.0	C0805Z561(3)5GA(9)	M123A10BPB561(3)(10)
620.0	C0805Z621(3)5GA(9)	M123A10BPB621(3)(10)
680.0	C0805Z681(3)5GA(9)	M123A10BPB681(3)(10)
50/100 VOLT-BX-C0805 SIZE (MILITARY CKS51)		
330.0	C0805Z331K(8)XA(9)	M123A10BX(7)331K(10)
390.0	C0805Z391K(8)XA(9)	M123A10BX(7)391K(10)
470.0	C0805Z471K(8)XA(9)	M123A10BX(7)471K(10)
560.0	C0805Z561K(8)XA(9)	M123A10BX(7)561K(10)
680.0	C0805Z681K(8)XA(9)	M123A10BX(7)681K(10)
820.0	C0805Z821K(8)XA(9)	M123A10BX(7)821K(10)
1,000.0	C0805Z102K(8)XA(9)	M123A10BX(7)102K(10)
1,200.0	C0805Z122K(8)XA(9)	M123A10BX(7)122K(10)
1,500.0	C0805Z152K(8)XA(9)	M123A10BX(7)152K(10)
1,800.0	C0805Z182K(8)XA(9)	M123A10BX(7)182K(10)
2,200.0	C0805Z222K(8)XA(9)	M123A10BX(7)222K(10)
2,700.0	C0805Z272K(8)XA(9)	M123A10BX(7)272K(10)
3,300.0	C0805Z332K(8)XA(9)	M123A10BX(7)332K(10)
3,900.0	C0805Z392K(8)XA(9)	M123A10BX(7)392K(10)
4,700.0	C0805Z472K(8)XA(9)	M123A10BX(7)472K(10)
50 VOLT-BX-C0805 SIZE (MILITARY CKS51)		
5,600.0	C0805Z562K5XA(9)	M123A10BXB562K(10)
6,800.0	C0805Z682K5XA(9)	M123A10BXB682K(10)
8,200.0	C0805Z822K5XA(9)	M123A10BXB822K(10)
10,000.0	C0805Z103K5XA(9)	M123A10BXB103K(10)
12,000.0	C0805Z123K5XA(9)	M123A10BXB123K(10)
15,000.0	C0805Z153K5XA(9)	M123A10BXB153K(10)
18,000.0	C0805Z183K5XA(9)	M123A10BXB183K(10)
50/100 VOLT-BP-C1210 SIZE (MILITARY CKS52)		
300.0	C1210Z301(3)(8)GA(9)	M123A11BP(7)301(3)(10)
330.0	C1210Z331(3)(8)GA(9)	M123A11BP(7)331(3)(10)
360.0	C1210Z361(3)(8)GA(9)	M123A11BP(7)361(3)(10)
390.0	C1210Z391(3)(8)GA(9)	M123A11BP(7)391(3)(10)
430.0	C1210Z431(3)(8)GA(9)	M123A11BP(7)431(3)(10)
470.0	C1210Z471(3)(8)GA(9)	M123A11BP(7)471(3)(10)
510.0	C1210Z511(3)(8)GA(9)	M123A11BP(7)511(3)(10)
560.0	C1210Z561(3)(8)GA(9)	M123A11BP(7)561(3)(10)
620.0	C1210Z621(3)(8)GA(9)	M123A11BP(7)621(3)(10)
680.0	C1210Z681(3)(8)GA(9)	M123A11BP(7)681(3)(10)
750.0	C1210Z751(3)(8)GA(9)	M123A11BP(7)751(3)(10)
820.0	C1210Z821(3)(8)GA(9)	M123A11BP(7)821(3)(10)
910.0	C1210Z911(3)(8)GA(9)	M123A11BP(7)911(3)(10)
1,000.0	C1210Z102(3)(8)GA(9)	M123A11BP(7)102(3)(10)
1,100.0	C1210Z112(3)(8)GA(9)	M123A11BP(7)112(3)(10)
1,200.0	C1210Z122(3)(8)GA(9)	M123A11BP(7)122(3)(10)
1,300.0	C1210Z132(3)(8)GA(9)	M123A11BP(7)132(3)(10)
1,500.0	C1210Z152(3)(8)GA(9)	M123A11BP(7)152(3)(10)
1,600.0	C1210Z162(3)(8)GA(9)	M123A11BP(7)162(3)(10)
1,800.0	C1210Z182(3)(8)GA(9)	M123A11BP(7)182(3)(10)
2,000.0	C1210Z202(3)(8)GA(9)	M123A11BP(7)202(3)(10)
2,200.0	C1210Z222(3)(8)GA(9)	M123A11BP(7)222(3)(10)
50 VOLT-BP-C1210 SIZE (MILITARY CKS52)		
2,400.0	C1210Z242(3)5GA(9)	M123A11BPB242(3)(10)
2,700.0	C1210Z272(3)5GA(9)	M123A11BPB272(3)(10)
3,000.0	C1210Z302(3)5GA(9)	M123A11BPB302(3)(10)
3,300.0	C1210Z332(3)5GA(9)	M123A11BPB332(3)(10)
50/100 VOLT-BX-C1210 SIZE (MILITARY CKS52)		
5,600.0	C1210Z562(6)(8)XA(9)	M123A11BX(7)562(6)(10)
6,800.0	C1210Z682(6)(8)XA(9)	M123A11BX(7)682(6)(10)
8,200.0	C1210Z822(6)(8)XA(9)	M123A11BX(7)822(6)(10)
10,000.0	C1210Z103(6)(8)XA(9)	M123A11BX(7)103(6)(10)
12,000.0	C1210Z123(6)(8)XA(9)	M123A11BX(7)123(6)(10)
15,000.0	C1210Z153(6)(8)XA(9)	M123A11BX(7)153(6)(10)
18,000.0	C1210Z183(6)(8)XA(9)	M123A11BX(7)183(6)(10)
22,000.0	C1210Z223(6)(8)XA(9)	M123A11BX(7)223(6)(10)
27,000.0	C1210Z273(6)(8)XA(9)	M123A11BX(7)273(6)(10)
50 VOLT-BX-C1210 SIZE (MILITARY CKS52)		
33,000.0	C1210Z333(6)5XA(9)	M123A11BXB333(6)(10)
39,000.0	C1210Z393(6)5XA(9)	M123A11BXB393(6)(10)
47,000.0	C1210Z473(6)5XA(9)	M123A11BXB473(6)(10)
56,000.0	C1210Z563(6)5XA(9)	M123A11BXB563(6)(10)
68,000.0	C1210Z683(6)5XA(9)	M123A11BXB683(6)(10)
82,000.0	C1210Z823(6)5XA(9)	M123A11BXB823(6)(10)
100,000.0	C1210Z104(6)5XA(9)	M123A11BXB104(6)(10)

CAP. pF	KEMET PART NUMBER	MIL-PRF-123 PART NUMBER
50/100 VOLT-BP-C1808 SIZE (MILITARY CKS53)		
300.0	C1808Z301(3)(8)GA(9)	M123A12BP(7)301(3)(10)
330.0	C1808Z331(3)(8)GA(9)	M123A12BP(7)331(3)(10)
360.0	C1808Z361(3)(8)GA(9)	M123A12BP(7)361(3)(10)
390.0	C1808Z391(3)(8)GA(9)	M123A12BP(7)391(3)(10)
430.0	C1808Z431(3)(8)GA(9)	M123A12BP(7)431(3)(10)
470.0	C1808Z471(3)(8)GA(9)	M123A12BP(7)471(3)(10)
510.0	C1808Z511(3)(8)GA(9)	M123A12BP(7)511(3)(10)
560.0	C1808Z561(3)(8)GA(9)	M123A12BP(7)561(3)(10)
620.0	C1808Z621(3)(8)GA(9)	M123A12BP(7)621(3)(10)
680.0	C1808Z681(3)(8)GA(9)	M123A12BP(7)681(3)(10)
750.0	C1808Z751(3)(8)GA(9)	M123A12BP(7)751(3)(10)
820.0	C1808Z821(3)(8)GA(9)	M123A12BP(7)821(3)(10)
910.0	C1808Z911(3)(8)GA(9)	M123A12BP(7)911(3)(10)
1,000.0	C1808Z102(3)(8)GA(9)	M123A12BP(7)102(3)(10)
50/100 VOLT-BX-C1808 SIZE (MILITARY CKS53)		
5,600.0	C1808Z562K(8)XA(9)	M123A12BX(7)562K(10)
6,800.0	C1808Z682K(8)XA(9)	M123A12BX(7)682K(10)
8,200.0	C1808Z822K(8)XA(9)	M123A12BX(7)822K(10)
10,000.0	C1808Z103K(8)XA(9)	M123A12BX(7)103K(10)
12,000.0	C1808Z123K(8)XA(9)	M123A12BX(7)123K(10)
15,000.0	C1808Z153K(8)XA(9)	M123A12BX(7)153K(10)
18,000.0	C1808Z183K(8)XA(9)	M123A12BX(7)183K(10)
22,000.0	C1808Z223K(8)XA(9)	M123A12BX(7)223K(10)
27,000.0	C1808Z273K(8)XA(9)	M123A12BX(7)273K(10)
33,000.0	C1808Z333K(8)XA(9)	M123A12BX(7)333K(10)
50 VOLT-BX-C1808 SIZE (MILITARY CKS53)		
39,000.0	C1808Z393K5XA(9)	M123A12BXB393K(10)
47,000.0	C1808Z473K5XA(9)	M123A12BXB473K(10)
56,000.0	C1808Z563K5XA(9)	M123A12BXB563K(10)
68,000.0	C1808Z683K5XA(9)	M123A12BXB683K(10)
82,000.0	C1808Z823K5XA(9)	M123A12BXB823K(10)
100,000.0	C1808Z104K5XA(9)	M123A12BXB104K(10)
50 VOLT-BP-C2225 SIZE (MILITARY CKS54)		
1,100.0	C2225Z112(3)5GA(9)	M123A13BPB112(3)(10)
1,200.0	C2225Z122(3)5GA(9)	M123A13BPB122(3)(10)
1,300.0	C2225Z132(3)5GA(9)	M123A13BPB132(3)(10)
1,500.0	C2225Z152(3)5GA(9)	M123A13BPB152(3)(10)
1,600.0	C2225Z162(3)5GA(9)	M123A13BPB162(3)(10)
1,800.0	C2225Z182(3)5GA(9)	M123A13BPB182(3)(10)
2,000.0	C2225Z202(3)5GA(9)	M123A13BPB202(3)(10)
2,200.0	C2225Z222(3)5GA(9)	M123A13BPB222(3)(10)
2,400.0	C2225Z242(3)5GA(9)	M123A13BPB242(3)(10)
2,700.0	C2225Z272(3)5GA(9)	M123A13BPB272(3)(10)
3,000.0	C2225Z302(3)5GA(9)	M123A13BPB302(3)(10)
3,300.0	C2225Z332(3)5GA(9)	M123A13BPB332(3)(10)
3,600.0	C2225Z362(3)5GA(9)	M123A13BPB362(3)(10)
3,900.0	C2225Z392(3)5GA(9)	M123A13BPB392(3)(10)
4,300.0	C2225Z432(3)5GA(9)	M123A13BPB432(3)(10)
4,700.0	C2225Z472(3)5GA(9)	M123A13BPB472(3)(10)
5,100.0	C2225Z512(3)5GA(9)	M123A13BPB512(3)(10)
5,600.0	C2225Z562(3)5GA(9)	M123A13BPB562(3)(10)
6,200.0	C2225Z622(3)5GA(9)	M123A13BPB622(3)(10)
6,800.0	C2225Z682(3)5GA(9)	M123A13BPB682(3)(10)
7,500.0	C2225Z752(3)5GA(9)	M123A13BPB752(3)(10)
8,200.0	C2225Z822(3)5GA(9)	M123A13BPB822(3)(10)
9,100.0	C2225Z912(3)5GA(9)	M123A13BPB912(3)(10)
10,000.0	C2225Z103(3)5GA(9)	M123A13BPB103(3)(10)
50 VOLT-BX-C2225 SIZE (MILITARY CKS54)		
120,000.0	C2225Z124K5XA(9)	M123A13BXB124K(10)
150,000.0	C2225Z154K5XA(9)	M123A13BXB154K(10)
180,000.0	C2225Z184K5XA(9)	M123A13BXB184K(10)
220,000.0	C2225Z224K5XA(9)	M123A13BXB224K(10)
270,000.0	C2225Z274K5XA(9)	M123A13BXB274K(10)
330,000.0	C2225Z334K5XA(9)	M123A13BXB334K(10)
390,000.0	C2225Z394K5XA(9)	M123A13BXB394K(10)
470,000.0	C2225Z474K5XA(9)	M123A13BXB474K(10)
560,000.0	C2225Z564K5XA(9)	M123A13BXB564K(10)
680,000.0	C2225Z684K5XA(9)	M123A13BXB684K(10)
820,000.0	C2225Z824K5XA(9)	M123A13BXB824K(10)
1,000,000.0	C2225Z105K5XA(9)	M123A13BXB105K(10)

To complete the KEMET part numbers, insert the following tolerance:
(1) C = ±0.25pF; D = ±0.5pF
(2) C = ±0.25pF; J = ±5%; K = ±10%
(3) F = ±1%; J = ±5%; K = ±10%
(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

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Legacy Ratings and Part Number Reference cont.

CAP. pF	KEMET PART NUMBER	MIL-PRF-123 PART NUMBER
100 VOLT - BP - C1206 SIZE (MILITARY CKS55)		
1.0	C1206Z109(4)1GA(9)	M123A21BPC1R0(4)(10)
1.1	C1206Z119(4)1GA(9)	M123A21BPC1R1(4)(10)
1.2	C1206Z129(4)1GA(9)	M123A21BPC1R2(4)(10)
1.3	C1206Z139(4)1GA(9)	M123A21BPC1R3(4)(10)
1.5	C1206Z159(4)1GA(9)	M123A21BPC1R5(4)(10)
1.6	C1206Z169(4)1GA(9)	M123A21BPC1R6(4)(10)
1.8	C1206Z189(4)1GA(9)	M123A21BPC1R8(4)(10)
2.0	C1206Z209(4)1GA(9)	M123A21BPC2R0(4)(10)
2.2	C1206Z229(4)1GA(9)	M123A21BPC2R2(4)(10)
2.4	C1206Z249(4)1GA(9)	M123A21BPC2R4(4)(10)
2.7	C1206Z279(5)1GA(9)	M123A21BPC2R7(5)(10)
3.0	C1206Z309(5)1GA(9)	M123A21BPC3R0(5)(10)
3.3	C1206Z339(5)1GA(9)	M123A21BPC3R3(5)(10)
3.6	C1206Z369(5)1GA(9)	M123A21BPC3R6(5)(10)
3.9	C1206Z399(5)1GA(9)	M123A21BPC3R9(5)(10)
4.3	C1206Z439(5)1GA(9)+	M123A21BPC4R3(5)(10)
4.7	C1206Z479(5)1GA(9)	M123A21BPC4R7(5)(10)
5.1	C1206Z519(5)1GA(9)	M123A21BPC5R1(5)(10)
5.6	C1206Z569(5)1GA(9)	M123A21BPC5R6(5)(10)
6.2	C1206Z629(5)1GA(9)	M123A21BPC6R2(5)(10)
6.8	C1206Z689(5)1GA(9)	M123A21BPC6R8(5)(10)
7.5	C1206Z759(5)1GA(9)	M123A21BPC7R5(5)(10)
8.2	C1206Z829(5)1GA(9)	M123A21BPC8R2(5)(10)
9.1	C1206Z919(5)1GA(9)	M123A21BPC9R1(5)(10)
10.0	C1206Z100(3)1GA(9)	M123A21BPC100(3)(10)
11.0	C1206Z110(3)1GA(9)	M123A21BPC110(3)(10)
12.0	C1206Z120(3)1GA(9)	M123A21BPC120(3)(10)
13.0	C1206Z130(3)1GA(9)	M123A21BPC130(3)(10)
15.0	C1206Z150(3)1GA(9)	M123A21BPC150(3)(10)
16.0	C1206Z160(3)1GA(9)	M123A21BPC160(3)(10)
18.0	C1206Z180(3)1GA(9)	M123A21BPC180(3)(10)
20.0	C1206Z200(3)1GA(9)	M123A21BPC200(3)(10)
24.0	C1206Z240(3)1GA(9)	M123A21BPC240(3)(10)
27.0	C1206Z270(3)1GA(9)	M123A21BPC270(3)(10)
33.0	C1206Z330(3)1GA(9)	M123A21BPC330(3)(10)
36.0	C1206Z360(3)1GA(9)	M123A21BPC360(3)(10)
39.0	C1206Z390(3)1GA(9)	M123A21BPC390(3)(10)
43.0	C1206Z430(3)1GA(9)	M123A21BPC430(3)(10)
47.0	C1206Z470(3)1GA(9)	M123A21BPC470(3)(10)
51.0	C1206Z510(3)1GA(9)	M123A21BPC510(3)(10)
56.0	C1206Z560(3)1GA(9)	M123A21BPC560(3)(10)
62.0	C1206Z620(3)1GA(9)	M123A21BPC620(3)(10)
68.0	C1206Z680(3)1GA(9)	M123A21BPC680(3)(10)
75.0	C1206Z750(3)1GA(9)	M123A21BPC750(3)(10)
82.0	C1206Z820(3)1GA(9)	M123A21BPC820(3)(10)
91.0	C1206Z910(3)1GA(9)	M123A21BPC910(3)(10)
100.0	C1206Z101(3)1GA(9)	M123A21BPC101(3)(10)
110.0	C1206Z111(3)1GA(9)	M123A21BPC111(3)(10)
120.0	C1206Z121(3)1GA(9)	M123A21BPC121(3)(10)
130.0	C1206Z131(3)1GA(9)	M123A21BPC131(3)(10)
150.0	C1206Z151(3)1GA(9)	M123A21BPC151(3)(10)
160.0	C1206Z161(3)1GA(9)	M123A21BPC161(3)(10)
180.0	C1206Z181(3)1GA(9)	M123A21BPC181(3)(10)
200.0	C1206Z201(3)1GA(9)	M123A21BPC201(3)(10)
220.0	C1206Z221(3)1GA(9)	M123A21BPC221(3)(10)
240.0	C1206Z241(3)1GA(9)	M123A21BPC241(3)(10)
270.0	C1206Z271(3)1GA(9)	M123A21BPC271(3)(10)
300.0	C1206Z301(3)1GA(9)	M123A21BPC301(3)(10)
330.0	C1206Z331(3)1GA(9)	M123A21BPC331(3)(10)
360.0	C1206Z361(3)1GA(9)	M123A21BPC361(3)(10)
390.0	C1206Z391(3)1GA(9)	M123A21BPC391(3)(10)
430.0	C1206Z431(3)1GA(9)	M123A21BPC431(3)(10)
470.0	C1206Z471(3)1GA(9)	M123A21BPC471(3)(10)
510.0	C1206Z511(3)1GA(9)	M123A21BPC511(3)(10)
560.0	C1206Z561(3)1GA(9)	M123A21BPC561(3)(10)
620.0	C1206Z621(3)1GA(9)	M123A21BPC621(3)(10)
680.0	C1206Z681(3)1GA(9)	M123A21BPC681(3)(10)
750.0	C1206Z751(3)1GA(9)	M123A21BPC751(3)(10)
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)

CAP. pF	KEMET PART NUMBER	MIL-PRF-123 PART NUMBER
50 VOLT-BP-C1206 SIZE (MILITARY CKS55)		
1,100.0	C1206Z112(3)5GA(9)	M123A21BPB112(3)(10)
1,200.0	C1206Z122(3)5GA(9)	M123A21BPB122(3)(10)
1,300.0	C1206Z132(3)5GA(9)	M123A21BPB132(3)(10)
1,500.0	C1206Z152(3)5GA(9)	M123A21BPB152(3)(10)
1,600.0	C1206Z162(3)5GA(9)	M123A21BPB162(3)(10)
1,800.0	C1206Z182(3)5GA(9)	M123A21BPB182(3)(10)
2,000.0	C1206Z202(3)5GA(9)	M123A21BPB202(3)(10)
2,200.0	C1206Z222(3)5GA(9)	M123A21BPB222(3)(10)
100 VOLT-BX-C1206 SIZE (MILITARY CKS55)		
4,700.0	C1206Z472(6)1XA(9)	M123A21BXC472(6)(10)
5,600.0	C1206Z562(6)1XA(9)	M123A21BXC562(6)(10)
6,800.0	C1206Z682(6)1XA(9)	M123A21BXC682(6)(10)
8,200.0	C1206Z822(6)1XA(9)	M123A21BXC822(6)(10)
10,000.0	C1206Z103(6)1XA(9)	M123A21BXC103(6)(10)
12,000.0	C1206Z123(6)1XA(9)	M123A21BXC123(6)(10)
15,000.0	C1206Z153(6)1XA(9)	M123A21BXC153(6)(10)
50 VOLT-BX-C1206 SIZE (MILITARY CKS55)		
18,000.0	C1206Z183(6)5XA(9)	M123A21BXB183(6)(10)
22,000.0	C1206Z223(6)5XA(9)	M123A21BXB223(6)(10)
27,000.0	C1206Z273(6)5XA(9)	M123A21BXB273(6)(10)
33,000.0	C1206Z333(6)5XA(9)	M123A21BXB333(6)(10)
39,000.0	C1206Z393(6)5XA(9)	M123A21BXB393(6)(10)
100 VOLT-BP-C1812 SIZE (MILITARY CKS56)		
1,200.0	C1812Z122(3)1GA(9)	M123A22BPC122(3)(10)
2,200.0	C1812Z222(3)1GA(9)	M123A22BPC222(3)(10)
2,400.0	C1812Z242(3)1GA(9)	M123A22BPC242(3)(10)
2,700.0	C1812Z272(3)1GA(9)	M123A22BPC272(3)(10)
3,000.0	C1812Z302(3)1GA(9)	M123A22BPC302(3)(10)
3,300.0	C1812Z332(3)1GA(9)	M123A22BPC332(3)(10)
3,600.0	C1812Z362(3)1GA(9)	M123A22BPC362(3)(10)
3,900.0	C1812Z392(3)1GA(9)	M123A22BPC392(3)(10)
4,300.0	C1812Z432(3)1GA(9)	M123A22BPC432(3)(10)
4,700.0	C1812Z472(3)1GA(9)	M123A22BPC472(3)(10)
50 VOLT-BP-C1812 SIZE (MILITARY CKS56)		
5,100.0	C1812Z512(3)5GA(9)	M123A22BPB512(3)(10)
5,600.0	C1812Z562(3)5GA(9)	M123A22BPB562(3)(10)
6,200.0	C1812Z622(3)5GA(9)	M123A22BPB622(3)(10)
6,800.0	C1812Z682(3)5GA(9)	M123A22BPB682(3)(10)
7,500.0	C1812Z752(3)5GA(9)	M123A22BPB752(3)(10)
8,200.0	C1812Z822(3)5GA(9)	M123A22BPB822(3)(10)
9,100.0	C1812Z912(3)5GA(9)	M123A22BPB912(3)(10)
10,000.0	C1812Z103(3)5GA(9)	M123A22BPB103(3)(10)
100 VOLT-BX-C1812 SIZE (MILITARY CKS56)		
27,000.0	C1812Z273(6)1XA(9)	M123A22BXC273(6)(10)
33,000.0	C1812Z333(6)1XA(9)	M123A22BXC333(6)(10)
39,000.0	C1812Z393(6)1XA(9)	M123A22BXC393(6)(10)
47,000.0	C1812Z473(6)1XA(9)	M123A22BXC473(6)(10)
56,000.0	C1812Z563(6)1XA(9)	M123A22BXC563(6)(10)
50 VOLT-BX-C1812 SIZE (MILITARY CKS56)		
100,000.0	C1812Z104(6)5XA(9)	M123A22BXB104(6)(10)
120,000.0	C1812Z124(6)5XA(9)	M123A22BXB124(6)(10)
150,000.0	C1812Z154(6)5XA(9)	M123A22BXB154(6)(10)
180,000.0	C1812Z184(6)5XA(9)	M123A22BXB184(6)(10)

To complete the KEMET part numbers, insert the following tolerance:
(1) C = ±0.25pF; D = ±0.5pF
(2) C = ±0.25pF; J = ±5%; K = ±10%
(3) F = ±1%; J = ±5%; K = ±10%
(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

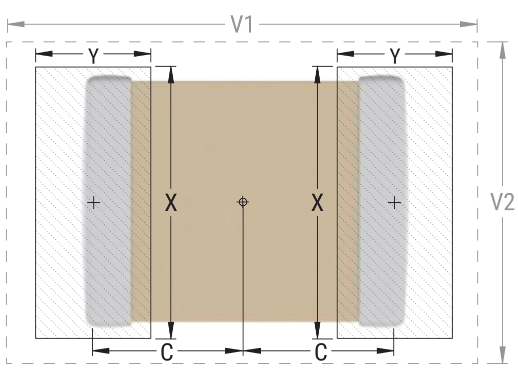
CAP. pF	KEMET PART NUMBER	MIL-PRF-123 PART NUMBER
100 VOLT-BP-C1825 SIZE (MILITARY CKS57)		
3,900.0	C1825Z392(3)1GA(9)	M123A23BPC392(3)(10)
4,700.0	C1825Z472(3)1GA(9)	M123A23BPC472(3)(10)
5,100.0	C1825Z512(3)1GA(9)	M123A23BPC512(3)(10)
5,600.0	C1825Z562(3)1GA(9)	M123A23BPC562(3)(10)
6,200.0	C1825Z622(3)1GA(9)	M123A23BPC622(3)(10)
6,800.0	C1825Z682(3)1GA(9)	M123A23BPC682(3)(10)
7,500.0	C1825Z752(3)1GA(9)	M123A23BPC752(3)(10)
8,200.0	C1825Z822(3)1GA(9)	M123A23BPC822(3)(10)
9,100.0	C1825Z912(3)1GA(9)	M123A23BPC912(3)(10)
10,000.0	C1825Z103(3)1GA(9)	M123A23BPC103(3)(10)
50 VOLT-BP-C1812 SIZE (MILITARY CKS57)		
11,000.0	C1825Z113(3)5GA(9)	M123A23BPB113(3)(10)
12,000.0	C1825Z123(3)5GA(9)	M123A23BPB123(3)(10)
13,000.0	C1825Z133(3)5GA(9)	M123A23BPB133(3)(10)
15,000.0	C1825Z153(3)5GA(9)	M123A23BPB153(3)(10)
16,000.0	C1825Z163(3)5GA(9)	M123A23BPB163(3)(10)
18,000.0	C1825Z183(3)5GA(9)	M123A23BPB183(3)(10)
20,000.0	C1825Z203(3)5GA(9)	M123A23BPB203(3)(10)
22,000.0	C1825Z223(3)5GA(9)	M123A23BPB223(3)(10)
100 VOLT-BX-C1825 SIZE (MILITARY CKS57)		
56,000.0	C1825Z563(6)1XA(9)	M123A23BXC563(6)(10)
68,000.0	C1825Z683(6)1XA(9)	M123A23BXC683(6)(10)
82,000.0	C1825Z823(6)1XA(9)	M123A23BXC823(6)(10)
100,000.0	C1825Z104(6)1XA(9)	M123A23BXC104(6)(10)
120,000.0	C1825Z124(6)1XA(9)	M123A23BXC124(6)(10)
150,000.0	C1825Z154(6)1XA(9)	M123A23BXC154(6)(10)
50 VOLT-BX-C1825 SIZE (MILITARY CKS57)		
180,000.0	C1825Z184(6)5XA(9)	M123A23BXB184(6)(10)
220,000.0	C1825Z224(6)5XA(9)	M123A23BXB224(6)(10)
270,000.0	C1825Z274(6)5XA(9)	M123A23BXB274(6)(10)
330,000.0	C1825Z334(6)5XA(9)	M123A23BXB334(6)(10)
390,000.0	C1825Z394(6)5XA(9)	M123A23BXB394(6)(10)
470,000.0	C1825Z474(6)5XA(9)	M123A23BXB474(6)(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)					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
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	Termination Finish	
	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.

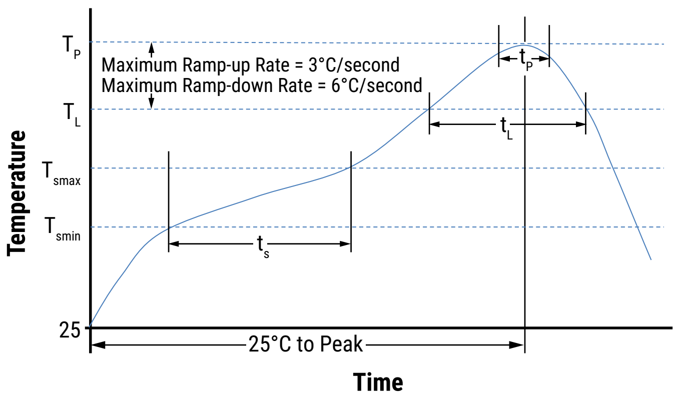


Table 3 – Performance & Reliability: Test Methods and Conditions

Inspection	Test Method	MIL-PRF-123 M-Level	MIL-PRF-123 T-Level
In-Process Inspection			
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 Inspection			
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 Inspection			
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 (Subgroup 2: Chip Devices)			
Terminal Strength	MIL-PRF-123 Method 4.6.12.2.1	Yes (Military Monitoring Program, periodic)	
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		
Bond strength (wire) (termination G only)	MIL-PRF-123 Method 4.6.13.2		
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

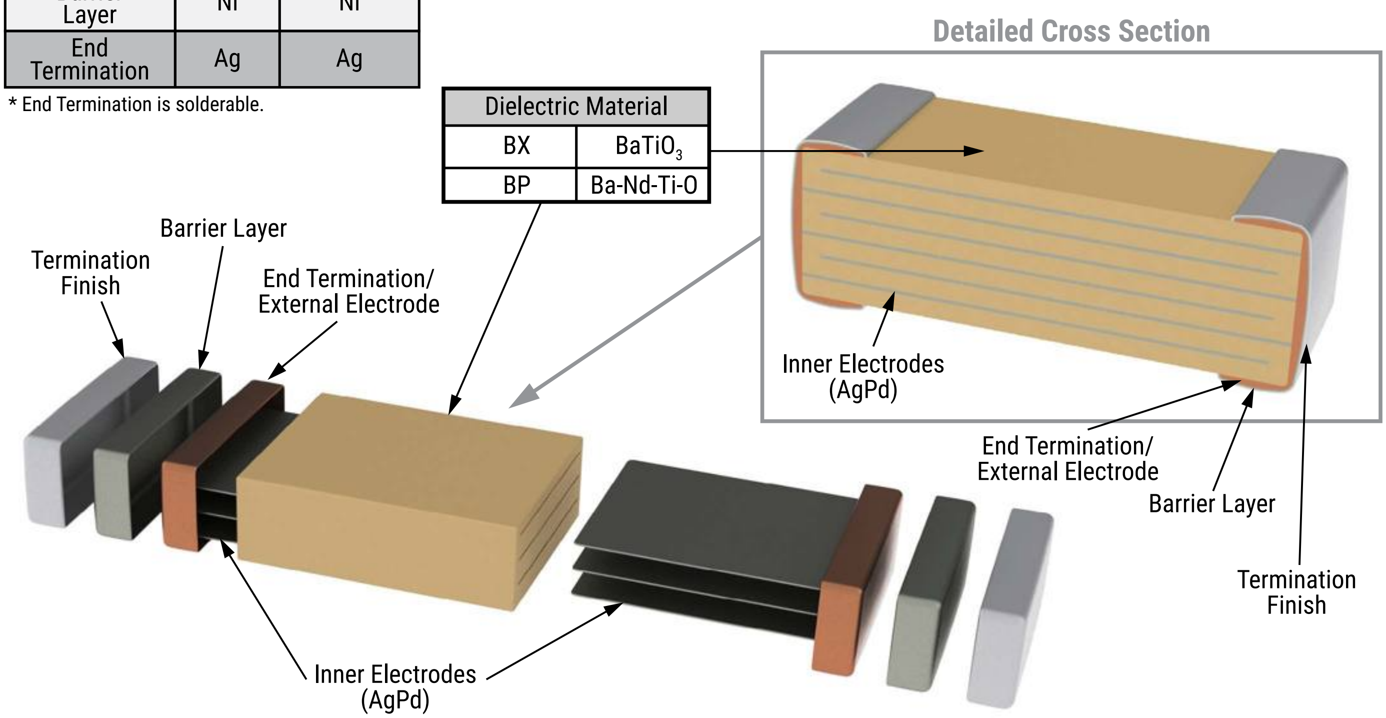
Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will 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.

Construction

MIL Finish	S	Z
KEMET Finish	H	L
Termination Finish	Sn60 (Coated)	70/30 SnPb (Plated)
Barrier Layer	Ni	Ni
End Termination	Ag	Ag

* End Termination is solderable.

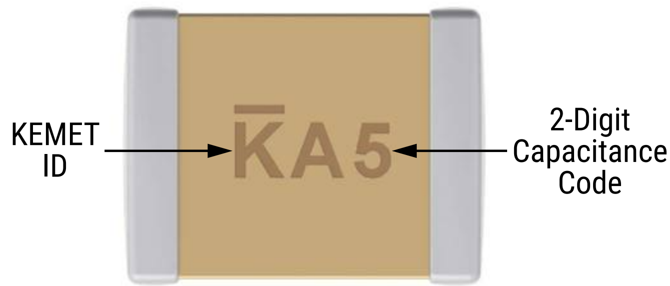
Dielectric Material	
BX	$BaTiO_3$
BP	Ba-Nd-Ti-O



Capacitor Marking

KEMET MIL-PRF-123 ceramic capacitors will be marked in accordance with the military specification on case sizes ≥ 0805. Case sizes below 0805 will not be marked. Two sides of the ceramic body will be laser marked with a "K̄" to identify KEMET, followed by two characters to identify the capacitance value.

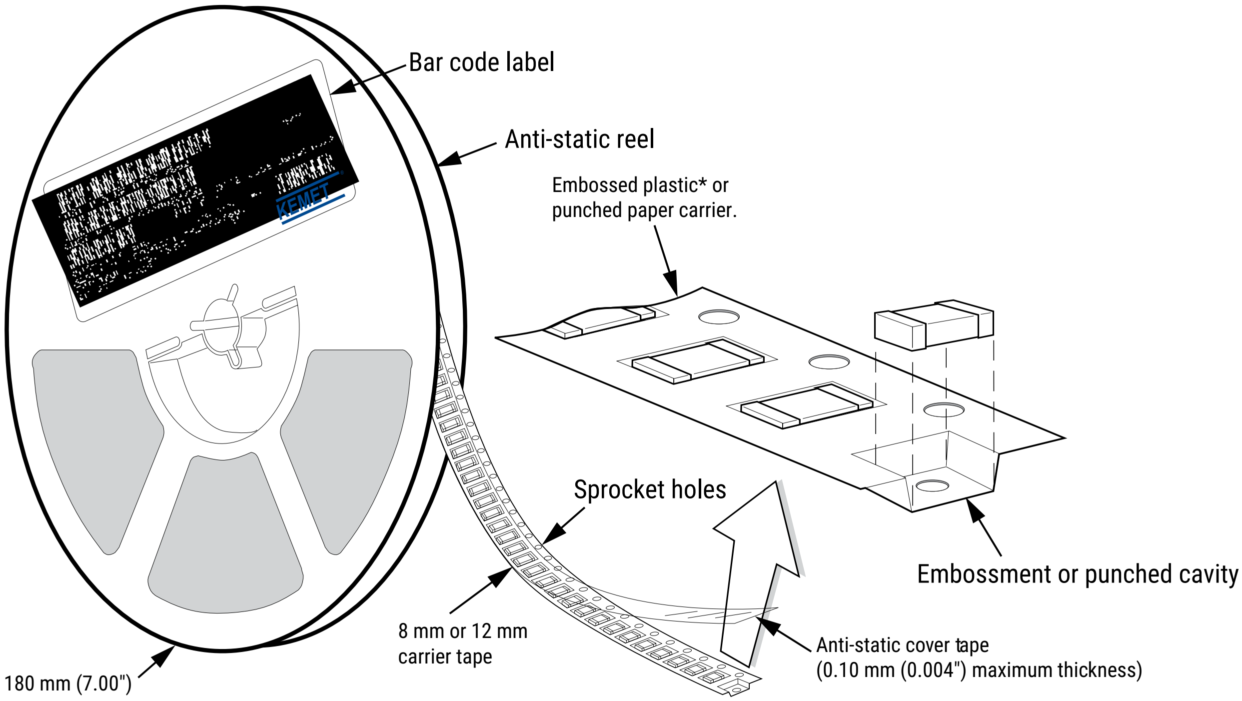
The marking appears in legible contrast. Illustrated below is an example of an MLCC with laser the marking of "K̄A5", which designates a KEMET device with the rated capacitance of 100 nF.



Capacitance (pF) For Various Alpha/Numeral Identifiers								
Alpha Character	Numeral							
	9	0	1	2	3	4	5	6
	Capacitance (pF)							
A	0.1	1.0	10	100	1,000	10,000	100,000	1,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 0402 and 0603 case sizes available on punched paper carrier only.

Table 4 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

EIA Case Size	Tape size (W)*	Embossed Plastic
		7" Reel
		Pitch (P1)*
0805 – 1210	8	4
≥ 1808	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

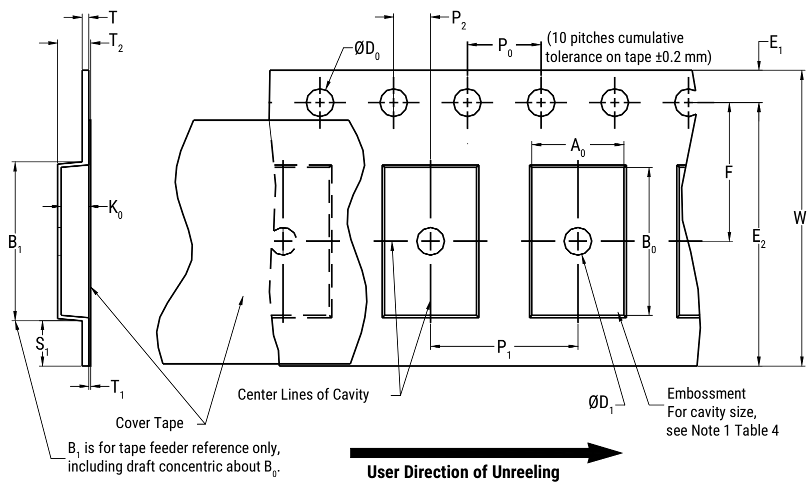


Table 5 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)									
Tape Size	D_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)	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_0, B_0 and K_0 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 ±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

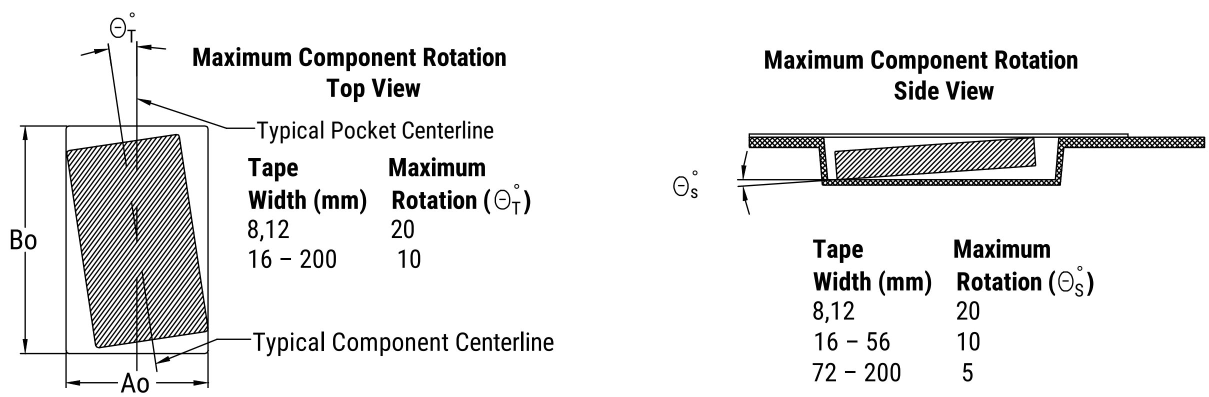


Figure 3 – Maximum Lateral Movement

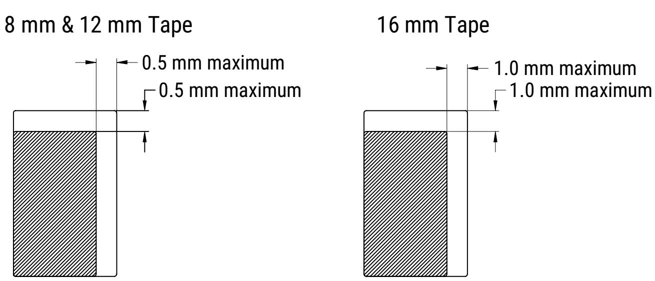


Figure 4 – Bending Radius

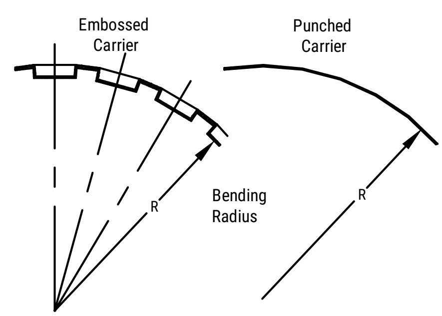
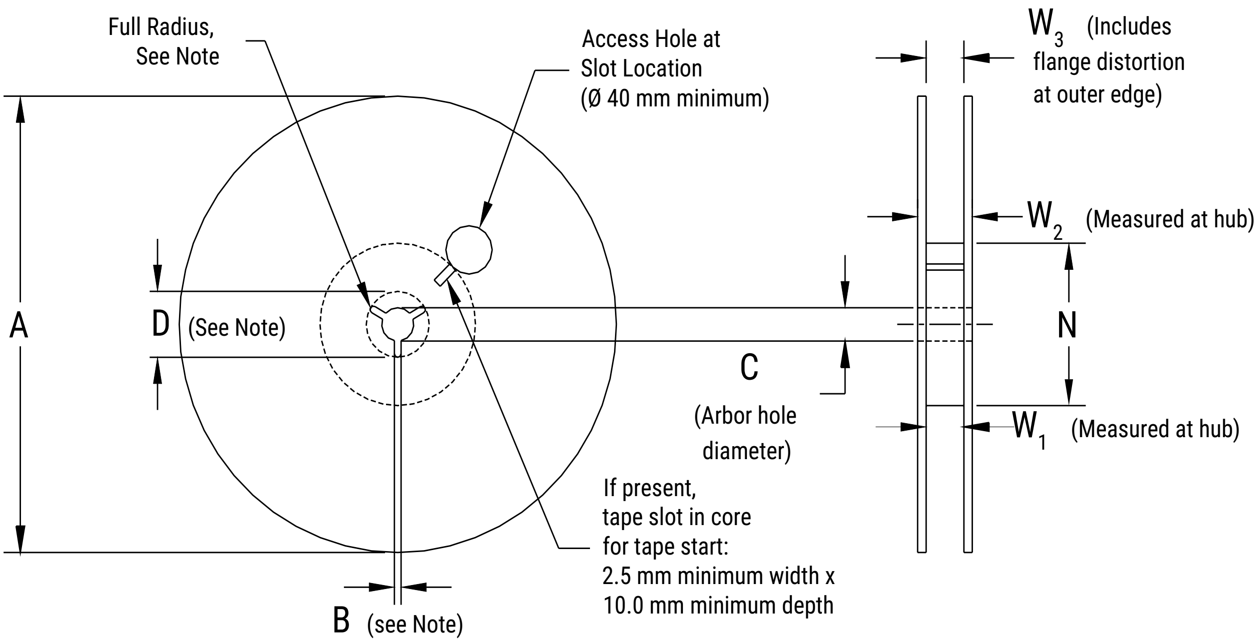


Figure 5 – Reel Dimensions



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	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				
Variable Dimensions — Millimeters (Inches)				
Tape Size	N Minimum See Note 2, Tables 2–3	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 accomadate tape width without interference
12 mm		12.4 + 2.0/−0.0 (0.488 + 0.078/−0.0)	18.4 (0.724)	

Figure 7 – Tape Leader & Trailer Dimensions

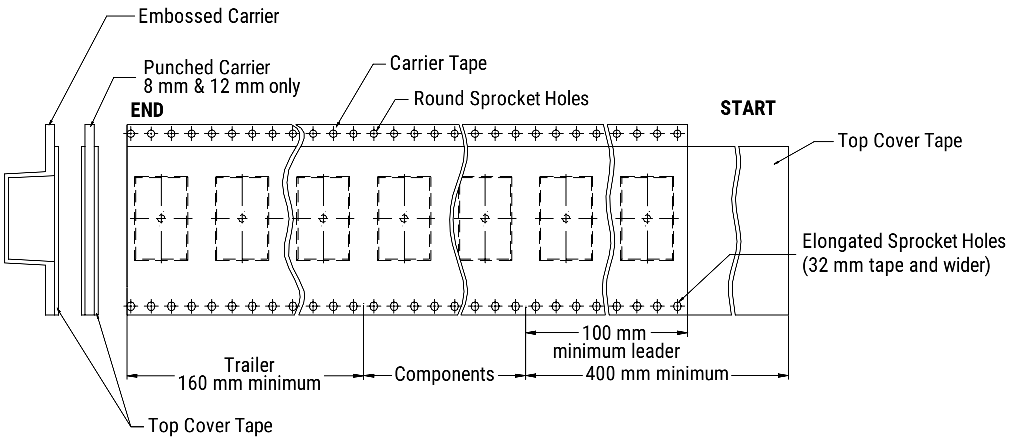
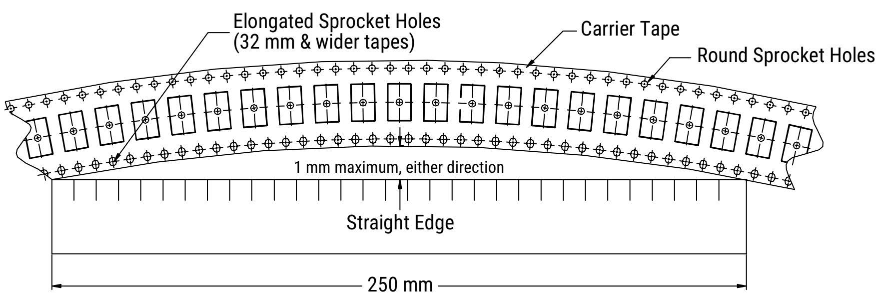


Figure 8 – Maximum Camber



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

Figure 9 – Waffle Tray Dimensions – Inches (Millimeters)

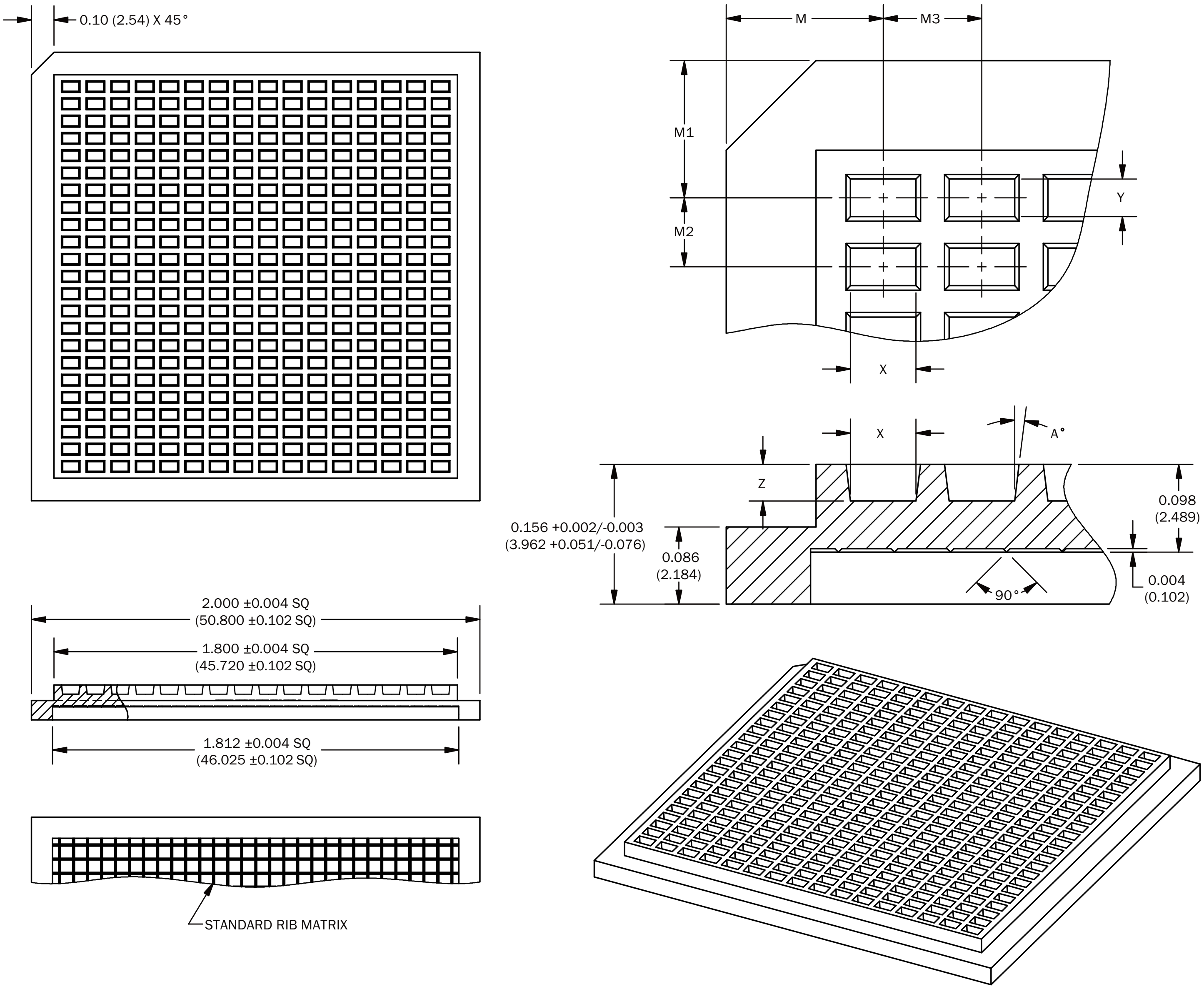


Table 7A – Waffle Tray Dimensions – Inches

Case Size		2" x 2" Waffle Tray Dimensions – Inches									Packaging Quantity (pcs/unit packaging)
		M	M1	M2	M3	X	Y	Z	A°	MATRIX	
EIA (in)	Metric (mm)	±0.003	±0.003	±0.002	±0.002	±0.002	±0.002	±0.003	±1/2°	(X x Y)	
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

Case Size		2" x 2" Waffle Tray Dimensions – Millimeters									Packaging Quantity (pcs/unit packaging)
		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)	
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, C0G 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 C0G/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 C0G 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

Ordering Information

CHT	13	C	124	J	5	G	A	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)
CHT	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 = ±0.10 pF C = ±0.25 pF D = ±0.5 pF F = ±1% G = ±2% J = ±5% K = ±10% M = ±20%	8 = 10 V 4 = 16 V 3 = 25 V 5 = 50 V 1 = 100 V	G =C0G	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.

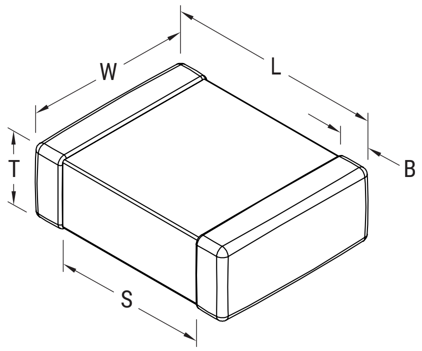
Packaging C-Spec Ordering Options Table

Packaging Type/Options[1]	Packaging Ordering Code (C-Spec)[2]
7" Reel	TU
13" Reel	7411 (EIA 0603 and smaller case sizes)
	7210 (EIA 0805 and larger case sizes)
7" Reel - 50 pcs	T050
7" Reel - 100 pcs	T100
7" Reel - 250 pcs	T250
7" Reel - 500 pcs	T500
7" Reel - 1,000 pcs	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.*

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)	See Table 2 for Thickness	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)
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)	

Environmental Compliance

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

Table 1 – Capacitance Range/Selection Waterfall (0603 – 1210 Case Sizes)

Capacitance	Cap Code	Case Size/ Series	CHT06					CHT08					CHT12					CHT13				
			0603					0805					1206					1210				
		Voltage Code	8	4	3	5	1	8	4	3	5	1	8	4	3	5	1	8	4	3	5	1
		Rated Voltage (VDC)	10	16	25	50	100	10	16	25	50	100	10	16	25	50	100	10	16	25	50	100
		Capacitance Tolerance	Product Availability and Chip Thickness Codes See Packaging Specs for Chip Thickness Dimensions																			
0.5 & 0.75 pF	508 & 758	B C D	CF	CF	CF	CF	CF	DN	DN	DN	DN	DN										
1.0 - 9.0 pF*	109 - 919*	B C D	CF	CF	CF	CF	CF	DN	DN	DN	DN	DN	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB
9.1 pF	919	B C D	CF	CF	CF	CF	CF	DN	DN	DN	DN	DN	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB
10 - 91 pF*	100 - 910*	F G J K M	CF	CF	CF	CF	CF	DN	DN	DN	DN	DN	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB
100 - 180 pF*	101 - 181*	F G J K M	CF	CF	CF	CF	CF	DN	DN	DN	DN	DN	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB
200 - 430 pF*	201 - 431*	F G J K M	CF	CF	CF	CF		DN	DN	DN	DN	DN	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB
470 pF	471	F G J K M	CF	CF	CF			DP	DP	DP	DP	DP	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB
510 pF	511	F G J K M	CF	CF	CF			DN	DN	DN	DN	DN	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB
560 pF	561	F G J K M	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 M	CF	CF	CF			DN	DN	DN	DN	DN	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB
680 pF	681	F G J K M	CF	CF	CF			DN	DN	DN	DN	DN	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB
750 pF	751	F G J K M	CF	CF	CF			DN	DN	DN	DN	DN	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB
820 pF	821	F G J K M	CF	CF	CF			DN	DN	DN	DN	DN	EB	EB	EB	EB	EB	FB	FB	FB	FB	FB
910 pF	911	F G J K M	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 M	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 K M	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 M	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 M	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 M	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 M						DP	DP	DP	DP		ED	ED	ED	ED	ED	FE	FE	FE	FE	FE
1,800 pF	182	F G J K M						DP	DP	DP	DP		ED	ED	ED	ED	ED	FE	FE	FE	FE	FE
2,000 pF	202	F G J K M						DN	DN	DN			ED	ED	ED	ED	ED	FE	FE	FE	FE	FE
2,200 pF	222	F G J K M						DN	DN	DN			EE	EE	EE	EE	EE	FG	FG	FG	FG	FG
2,400 pF	242	F G J K M						DN	DN	DN			EC	EC	EC	EC	EC	FC	FC	FC	FC	FC
2,700 pF	272	F G J K M						DN	DN	DN			EC	EC	EC	EC	EC	FC	FC	FC	FC	FC
3,000 pF	302	F G J K M						DP	DP	DP			EC	EC	EC	EC		FF	FF	FF	FF	FF
3,300 pF	332	F G J K M						DP	DP	DP			EE	EE	EE	EE		FF	FF	FF	FF	FF
3,600 pF	362	F G J K M						DP	DP	DP			EE	EE	EE	EE		FF	FF	FF	FF	FF
3,900 pF	392	F G J K M						DE	DE	DE			EF	EF	EF	EF		FF	FF	FF	FF	FF
4,300 pF	432	F G J K M						DE	DE	DE			EC	EC	EC	EC		FF	FF	FF	FF	FF
4,700 pF	472	F G J K M						DE	DE	DE			EC	EC	EC	EC		FG	FG	FG	FG	FG
5,100 pF	512	F G J K M						DE	DE	DE			ED	ED	ED	ED		FG	FG	FG	FG	FG
5,600 pF	562	F G J K M											ED	ED	ED	ED		FG	FG	FG	FG	FG
6,200 pF	622	F G J K M											EB	EB	EB			FG	FG	FG	FG	
6,800 pF	682	F G J K M											EB	EB	EB			FG	FG	FG	FG	
7,500 pF	752	F G J K M											EB	EB	EB			FC	FC	FC	FC	
8,200 pF	822	F G J K M											EC	EC	EC			FC	FC	FC	FC	
9,100 pF	912	F G J K M											EC	EC	EC			FE	FE	FE	FE	
10,000 pF	103	F G J K M											ED	ED	ED			FF	FF	FF	FF	
12,000 pF	123	F G J K M																FG	FG	FG		
15,000 pF	153	F G J K M																FG	FG	FG		
Capacitance	Cap Code	Rated Voltage (VDC)	10	16	25	50	100	10	16	25	50	100	10	16	25	50	100	10	16	25	50	100
		Voltage Code	8	4	3	5	1	8	4	3	5	1	8	4	3	5	1	8	4	3	5	1
		Case Size/Series	CHT06/0603					CHT08/0805					CHT12/1206					CHT13/1210				

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.

Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

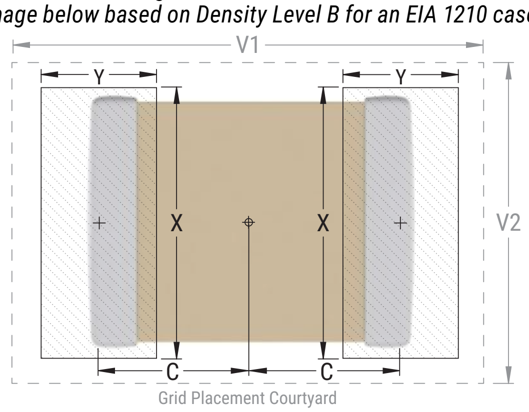
Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
CF	0603	0.80 ± 0.07	4,000	15,000	0	0
DN	0805	0.78 ± 0.10	4,000	15,000	0	0
DP	0805	0.90 ± 0.10	4,000	15,000	0	0
DE	0805	1.00 ± 0.10	0	0	2,500	10,000
EB	1206	0.78 ± 0.10	0	0	4,000	10,000
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 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 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)				
		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

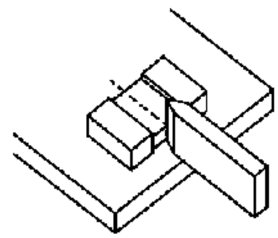
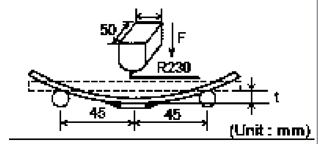
Density Level A: *For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.*
Density Level B: *For products with a moderate level of component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



C0G 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 ≤ 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 voltage Step / Temperature (°C): 1: +25°C 2: −55°C 3: +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

C0G HT 260°C Performance and Reliability: SMD Test Methods and Conditions cont.

<table>
<tr><th>Test</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Terminal Strength</td><td>KEMET Internal</td><td>Shear stress test per specific case size, Time: 60±1 seconds
<table><tr><th>Case Size</th><th>Force</th></tr><tr><td>0603</td><td>5N</td></tr><tr><td>0805</td><td>9N</td></tr><tr><td>≥1206</td><td>18N</td></tr></table></td><td>No evidence of mechanical damage</td></tr>
<tr><td>Board Flex</td><td>AEC-Q200-005</td><td>3.0 mm minimum
Test time: 60 ±5 seconds
Ramp time: 1 mm / second
</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Temperature Cycling</td><td>JESD22 Method JA-104</td><td>50 cycles (−55°C to +260°C)
2 – 3 cycles per hour
Soak Time: 1 or 5 minutes</td><td>Measurement at 24 hours ±4 hours after test conclusion.
Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit</td></tr>
<tr><td>Biased Humidity</td><td>MIL-STD-202 Method 103</td><td>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.</td><td>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%</td></tr>
<tr><td>High Temperature Life</td><td>MIL-STD-202 Method 108</td><td>1,000 hours at 260°C with rated voltage applied</td><td>Within Post Environmental Limits

Cap: ±0.3% or ±0.25 pF shift
IR: 10% of Initial Limit
DF: 0.5%</td></tr>
</table>

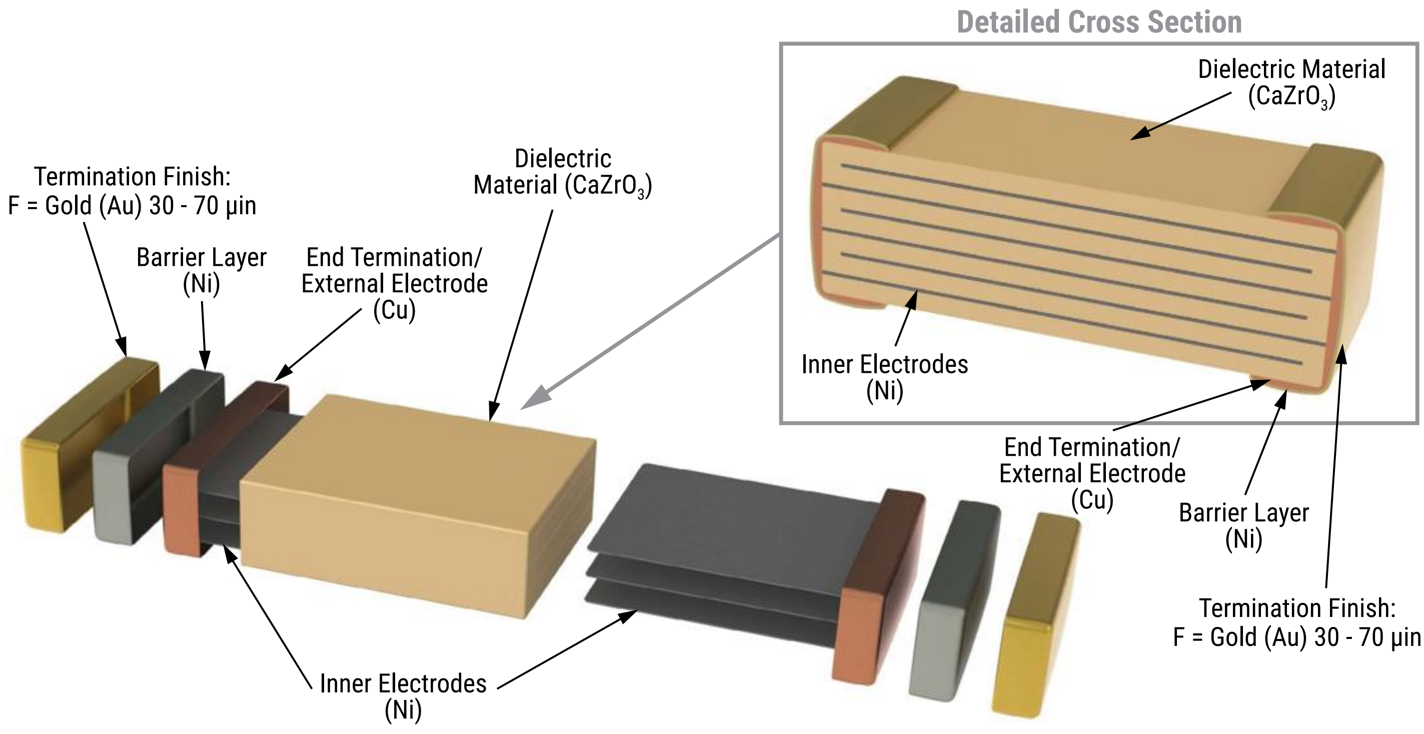
C0G HT 260°C Performance and Reliability: SMD Test Methods and Conditions cont.

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	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):

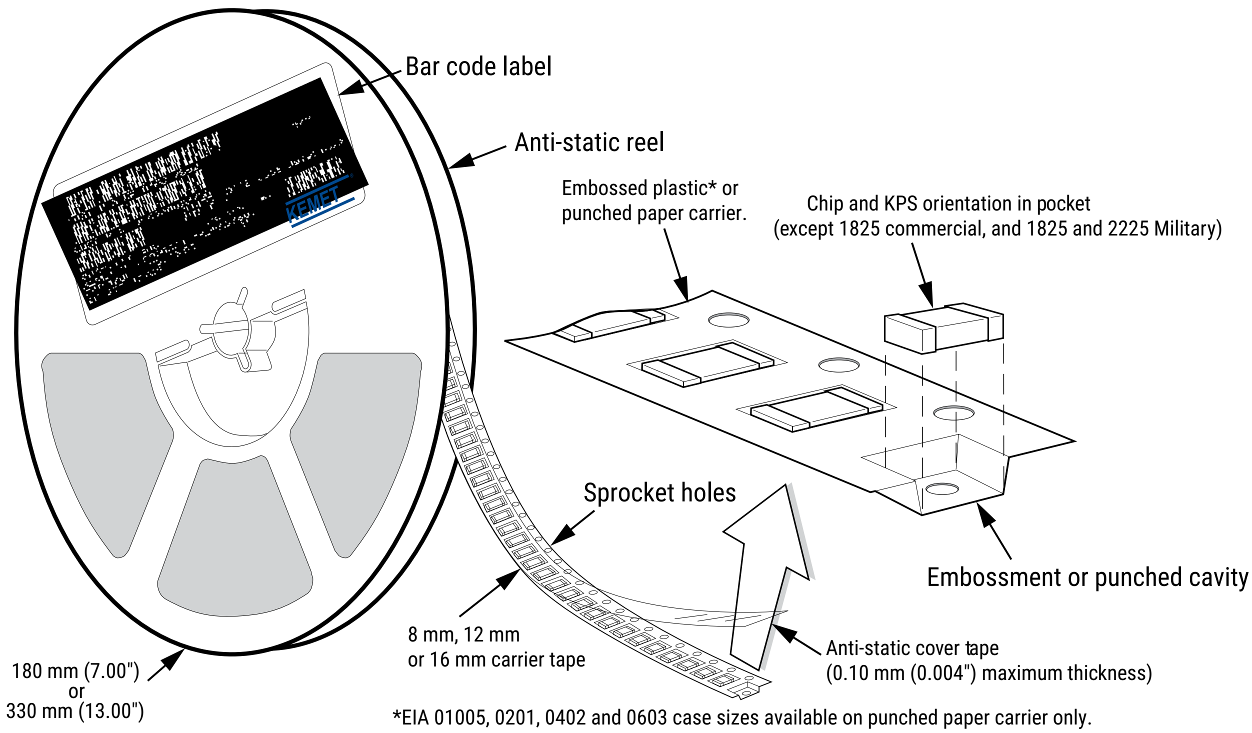
Laser marking option is not available on:

- C0G, 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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

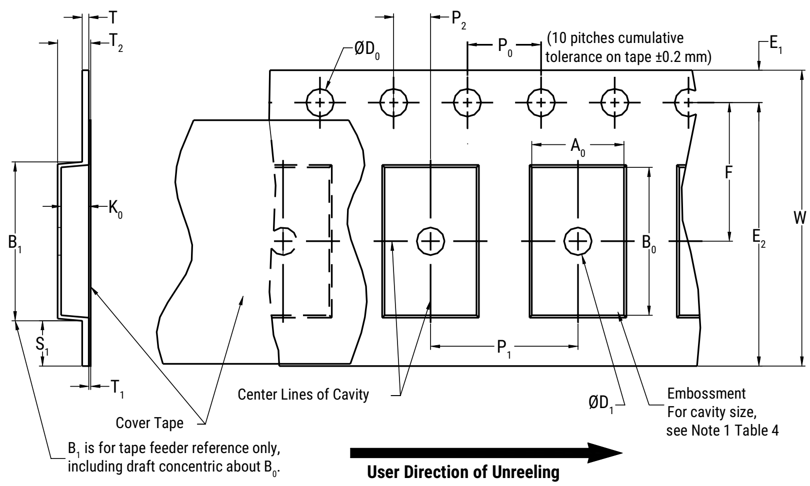


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +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)			
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)	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 S_1 < 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_0, B_0 and K_0 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

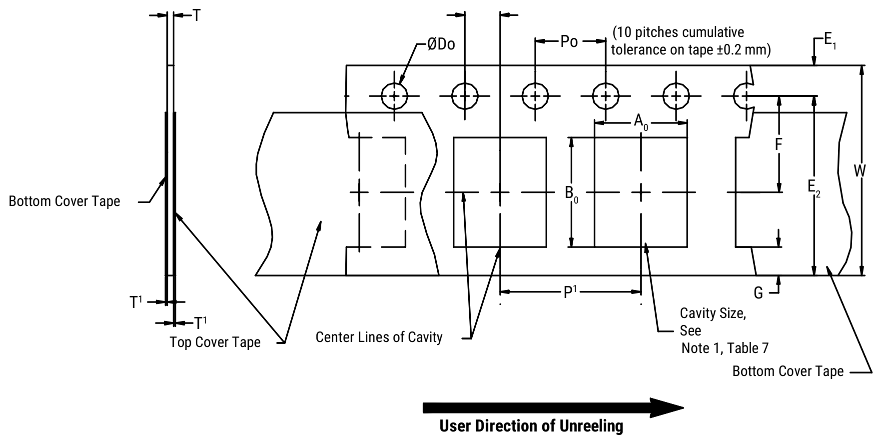


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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.)

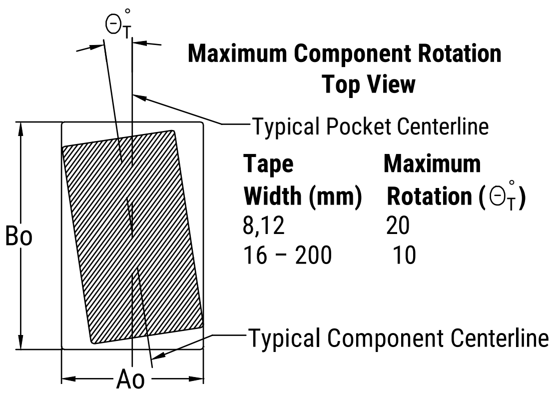
Packaging Information Performance Notes

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



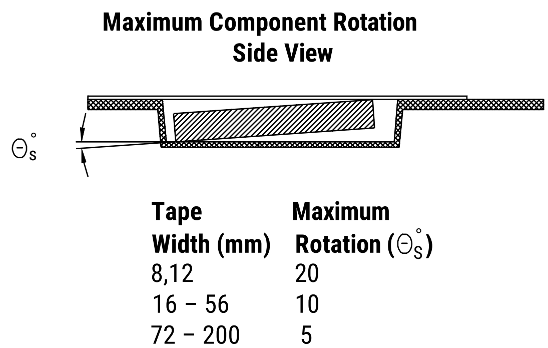


Figure 4 – Maximum Lateral Movement

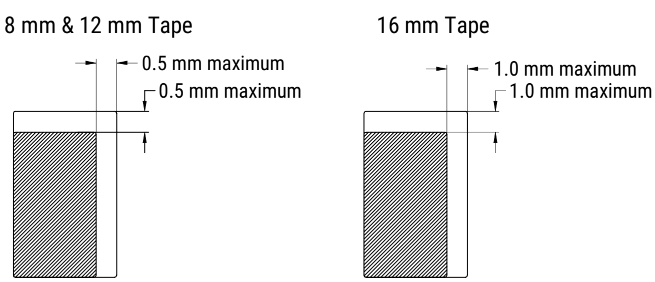


Figure 5 – Bending Radius

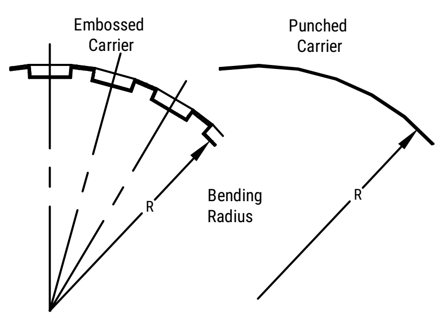
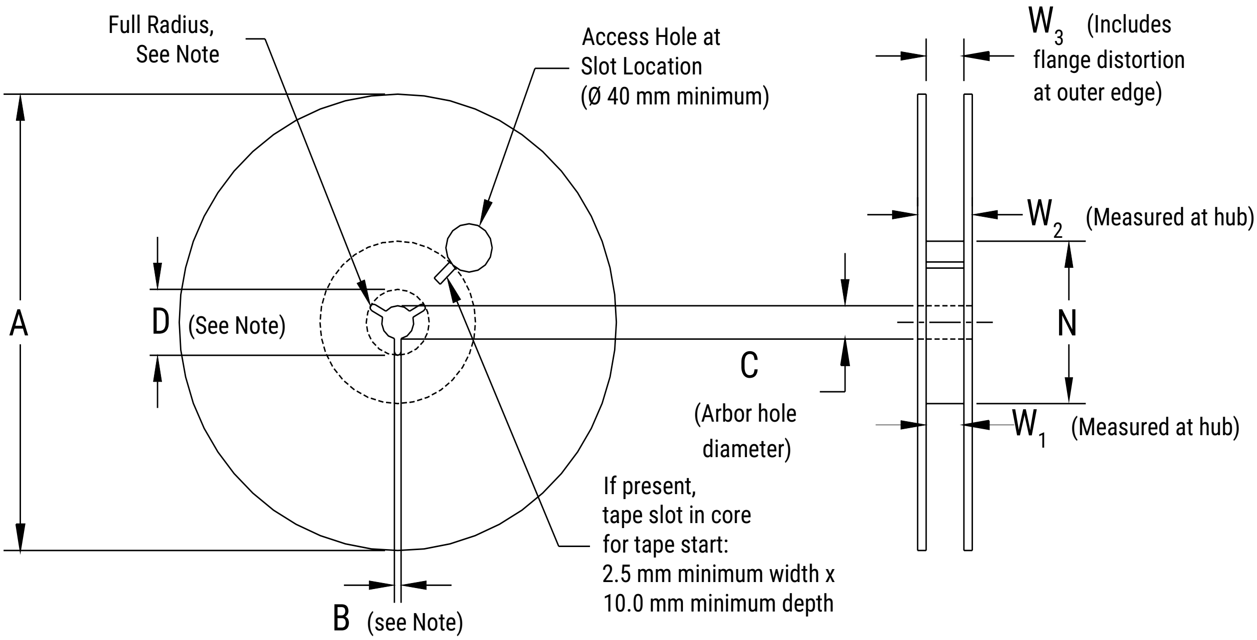


Figure 6 – Reel Dimensions



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	A	B Minimum	C	D Minimum
8 mm 12 mm 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	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

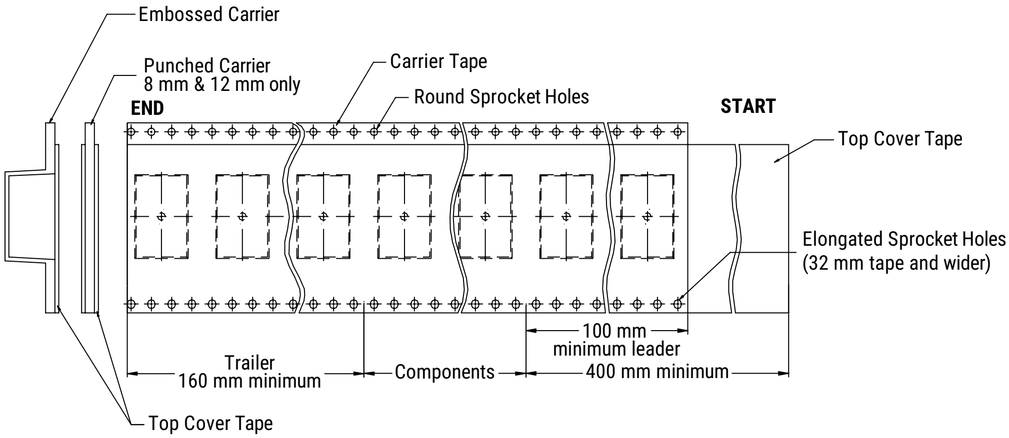
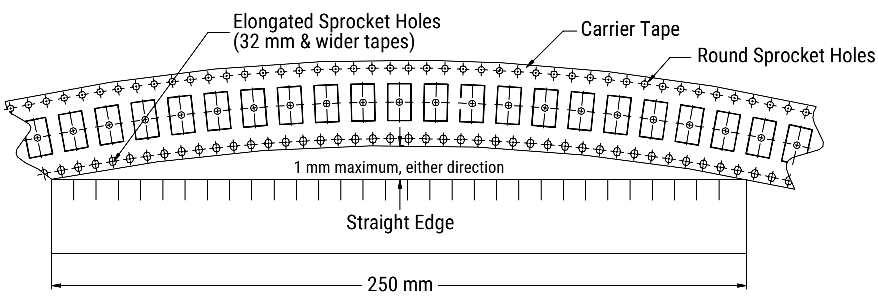


Figure 8 – Maximum Camber



KEMET
a YAGEO company

HiQ-CBR Automotive Series, C0G Dielectric, Low ESR, 50 VDC, 1 MHz – 50 GHz (RF & Microwave)

Overview

HiQ-CBR
RF & MICROWAVE

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.

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°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, ±1%, ±2%, and ±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	A	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 = ±0.05 pF B = ±0.1 pF C = ±0.25 pF D = ±0.5 pF F = ±1% G = ±2% J = ±5%	5 = 50 V	G = C0G	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	AUTO7411

Environmental Compliance

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

Lead-free RoHS REACH COMPLIANT

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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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.*

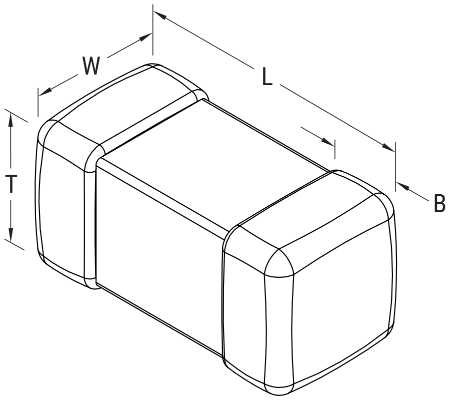
Production Part Approval Process (PPAP)
The purpose of the Production Part Approval Process is:
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements 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			○		

[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 or Solder Reflow
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)	

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 GΩ 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_{rms}

Table 1 – CBR AUTO Series, Capacitance Range Waterfall

Case Size – Inches (mm)		0402 (1005)	0603 (1608)
Rated Voltage (VDC)		50	50
Voltage Code		5	5
Capacitance	Capacitance Tolerance	Capacitance Code (Available Capacitance)	
0.1 pF	B = ±0.1pF	108	
0.2 pF	A = ±0.05 pF B = ±0.1 pF C = ±0.25 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		109	109
1.1 pF		119	119
1.2 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	A = ±0.05 pF B = ±0.1 pF C = ±0.25 pF D = ±0.5 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		349	349
3.5 pF		359	359
3.6 pF		369	369
3.7 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 Voltage (VDC)		50	50
Voltage Code		5	5

Table 1 – CBR AUTO Series, Capacitance Range Waterfall cont.

Case Size – Inches (mm)		0402 (1005)	0603 (1608)
Rated Voltage (VDC)		50	50
Voltage Code		5	5
Capacitance	Capacitance Tolerance	Capacitance Code (Available Capacitance)	
5.1 pF	B = ±0.1 pF C = ±0.25 pF D = ±0.5 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		749	749
7.5 pF		759	759
7.6 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		879	879
8.8 pF		889	889
8.9 pF		899	899
9.0 pF		909	909
9.1 pF		919	919
9.2 pF		929	929
9.3 pF		939	939
9.4 pF		949	949
9.5 pF		959	959
9.6 pF		969	969
9.7 pF		979	979
9.8 pF		989	989
9.9 pF		999	999
Rated Voltage (VDC)		50	50
Voltage Code		5	5

Table 1 – CBR AUTO Series, Capacitance Range Waterfall cont.

Case Size – Inches (mm)		0402 (1005)	0603 (1608)
Rated Voltage (VDC)		50	50
Voltage Code		5	5
Capacitance	Capacitance Tolerance	Capacitance Code (Available Capacitance)	
10 pF	F = ±1% G = ±2% J = ±5%	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		300	300
33 pF		330	330
36 pF		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 Voltage (VDC)		50	50
Voltage Code		5	5

Table 2 – Chip Thickness/Reeling Quantities

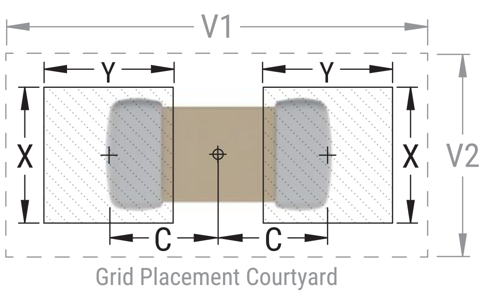
Chip Size Inches (mm)	Chip Thickness (mm)	Reel Quantity	
		7" Paper	13" Paper
0402 (1005)	0.50 ±0.05	10,000	50,000
0603 (1608)	0.80 ±0.10	4,000	15,000

Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC–7351 (mm)

Case Size (Inches)	Case Size (mm)	Density Level A: Maximum (Most) Land Protrusion					Density Level B: Median (Nominal) Land Protrusion					Density Level C: Minimum (Least) Land Protrusion				
		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:

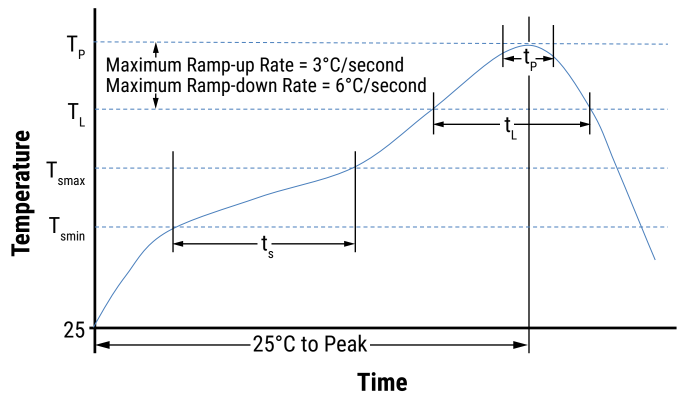
- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- All other EIA case sizes are limited to solder reflow only

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.

Profile Feature	Termination Finish	
	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

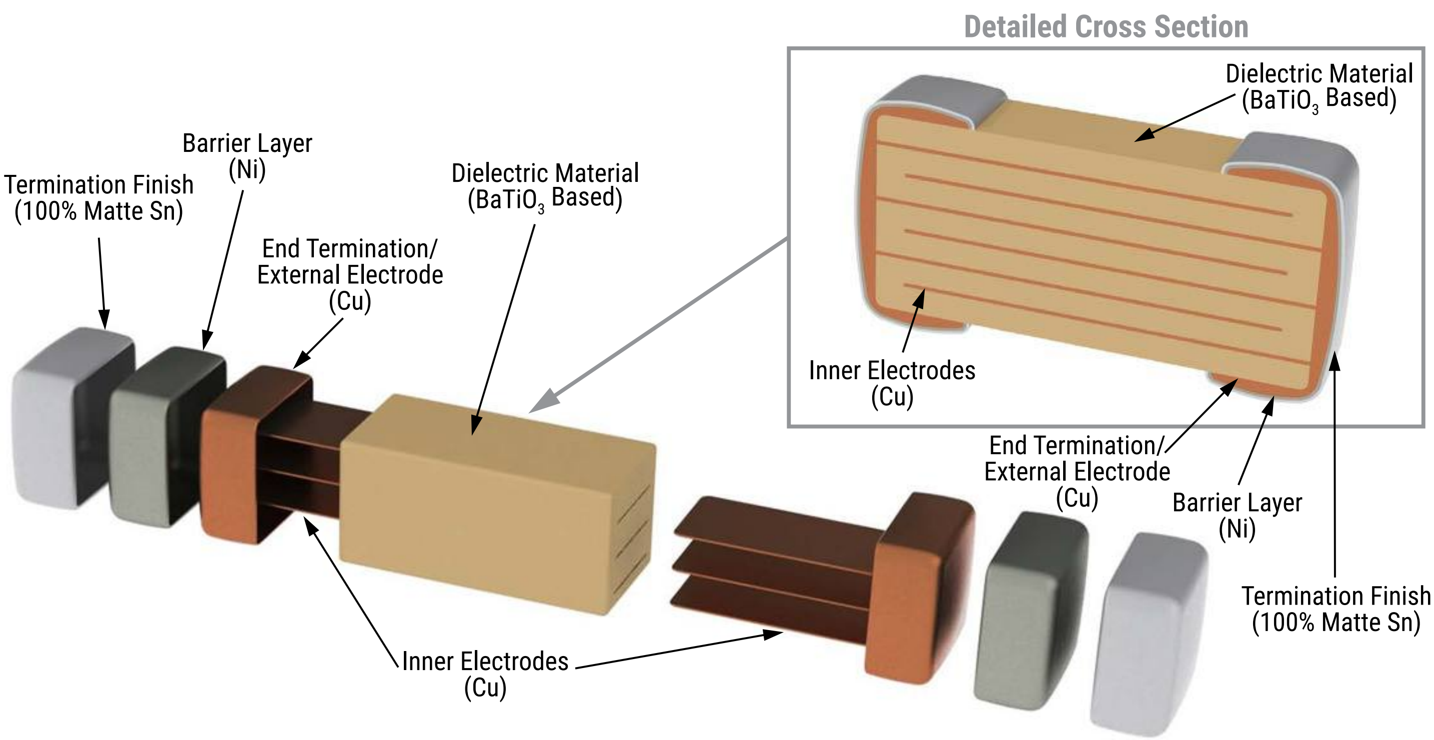
Note 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.



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.

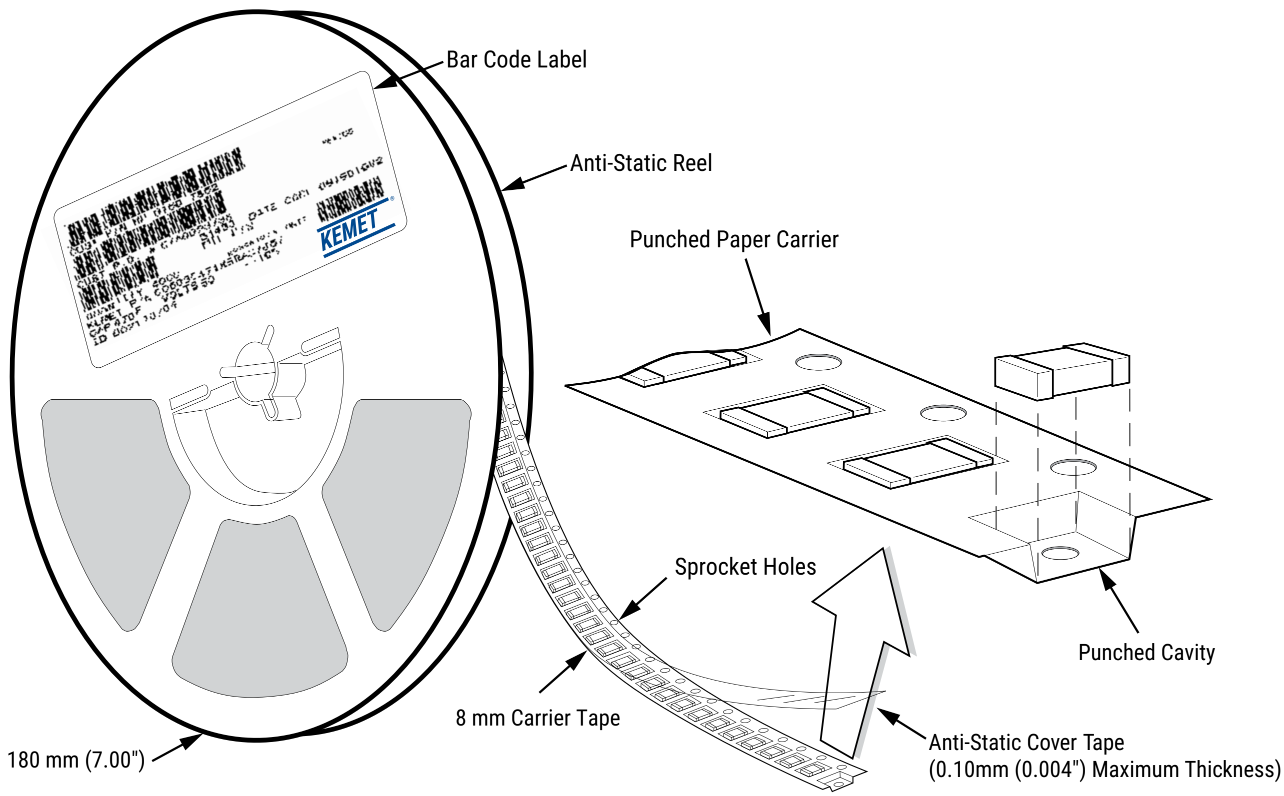


Table 4 – Carrier Tape Configuration (mm)

EIA Case Size	Tape Size (W)*	Lead Space (P_1)*
0402	8	2
0603	8	4

**Refer to Figure 1 for W and P_1 carrier tape reference locations.*
**Refer to Table 6 for tolerance specifications.*

Figure 1 – Punched (Paper) Carrier Tape Dimensions

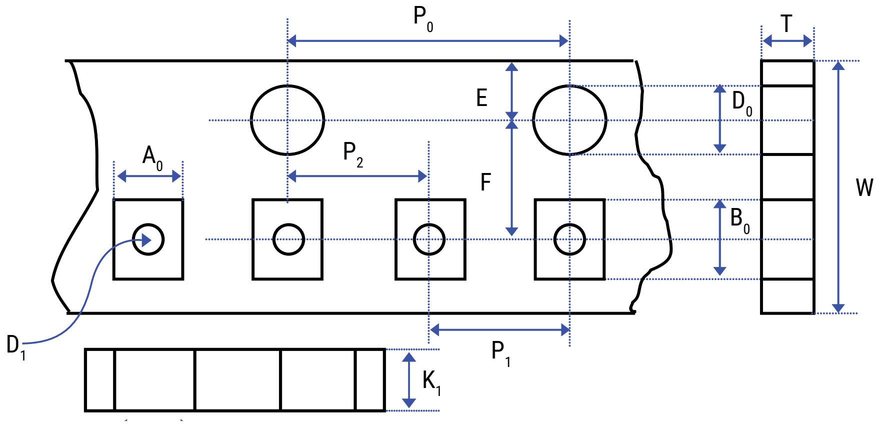


Table 5 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

<table>
<tr><th colspan="9">Constant Dimensions — Millimeters (Inches)</th></tr>
<tr><th>Tape Size</th><th>D_0</th><th>E_1</th><th>P_0</th><th>P_2</th><th>R Reference Note 2</th><th colspan="3">K_0</th></tr>
<tr><td>8 mm</td><td>1.55+0.05 (0.061+0.002)</td><td>1.55±0.05 (0.061±0.002)</td><td>4.0±0.10 (0.157±0.004)</td><td>2.0±0.05 (0.079±0.002)</td><td>25.0 (0.984)</td><td colspan="3">-</td></tr>
<tr><th colspan="9">Variable Dimensions — Millimeters (Inches)</th></tr>
<tr><th>Tape Size</th><th>Pitch</th><th>A_0</th><th>B_0</th><th>F</th><th>P_1</th><th>T</th><th>W</th><th>D_1</th></tr>
<tr><td rowspan="2">8 mm</td><td rowspan="2">Half (2 mm)</td><td>0.37±0.03 (0.015±0.001)</td><td>0.67±0.03 (0.03±0.001)</td><td rowspan="4">3.5±0.05 (0.138±0.002)</td><td rowspan="2">2.0±0.05 (0.079±0.002)</td><td>0.42±0.03 (0.017±0.001)</td><td rowspan="4">8.0±0.10 (0.315±0.004)</td><td rowspan="4">-</td></tr>
<tr><td>0.62±0.05 (0.025±0.002)</td><td>1.12±0.05 (0.04±0.002)</td><td>0.60±0.05 (0.024±0.002)</td></tr>
<tr><td rowspan="2">8 mm</td><td rowspan="2">Single (4 mm)</td><td>1.00±0.10 (0.040±0.004)</td><td>1.80±0.10 (0.07±0.004)</td><td rowspan="2">4.0±0.10 (0.157±0.004)</td><td>0.95±0.05 (0.037±0.002)</td></tr>
<tr><td>1.50±0.10 (0.06±0.004)</td><td>2.30±0.10 (0.09±0.004)</td><td>0.95±0.05 (0.037±0.002)</td></tr>
</table>

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 ±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 – Bending Radius

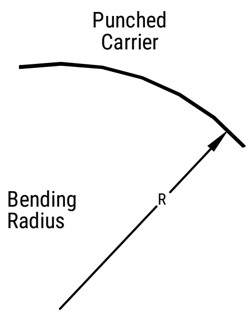


Figure 3 – Tape Leader & Trailer Dimensions

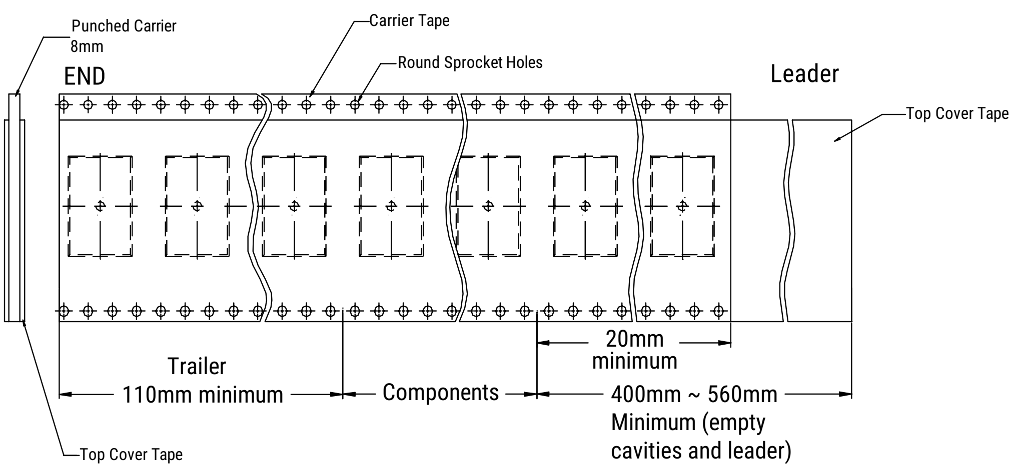


Figure 4 – Maximum Camber

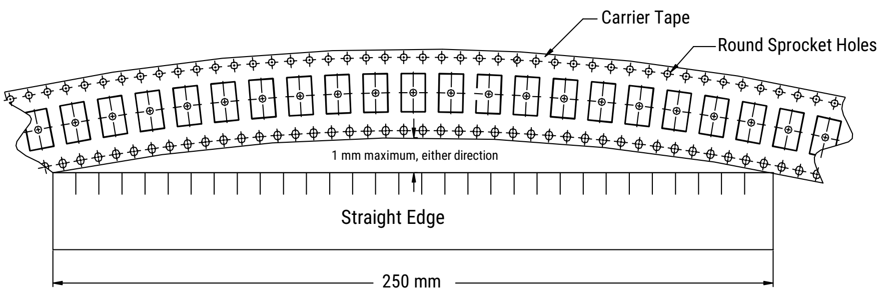


Figure 5 – Reel Dimensions

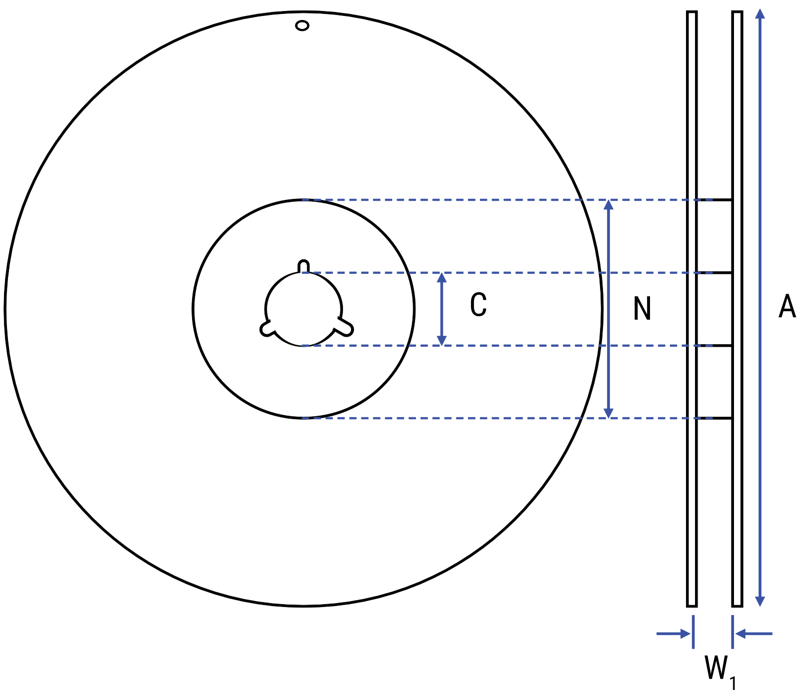


Table 6 – Reel Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)			
Tape Size	Reel Size	A	C
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	W_1	
8 mm	60 ±0.10 (2.4 ±0.04)	8.4 +1.5/−0.0 (0.331 +0.059/−0.0)	

Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs)

High Voltage, U2J Dielectric, 2,000 VDC (Commercial & Automotive Grade)

KEMET a YAGEO company

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 i^2R 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

KEMET a YAGEO company

Ordering Information

C	3640	C	153	J	G	J	A	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)
C	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"

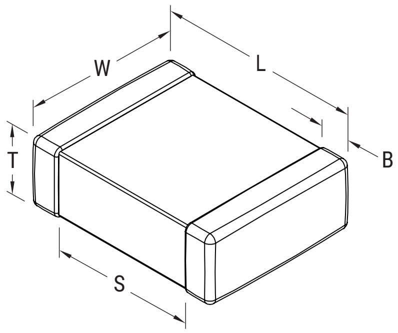
[1] Additional capacitance tolerance offerings may be available. Contact KEMET for details.

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	AUTO7210

[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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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			○		

[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

Capacitance	Cap Code	Case Size/ Series					C3640
		Voltage Code					G
		Rated Voltage (VDC)					2,000
		Capacitance Tolerance					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions
15,000 pF	153	F	G	J	K	M	MC
Capacitance	Cap Code	Rated Voltage (VDC)					2,000
		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

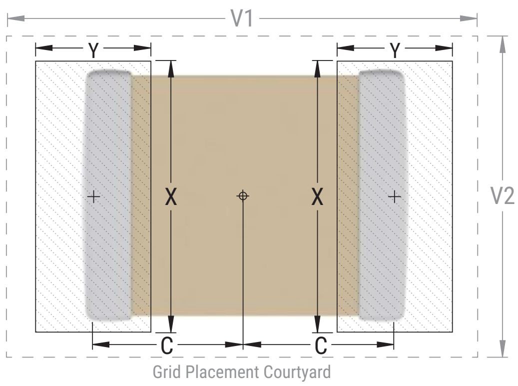
Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
MC	3640	2.50 ± 0.20	0	0	250	1,000
Thickness Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity		Plastic Quantity	

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)				
		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.

Profile Feature	Termination Finish	
	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.

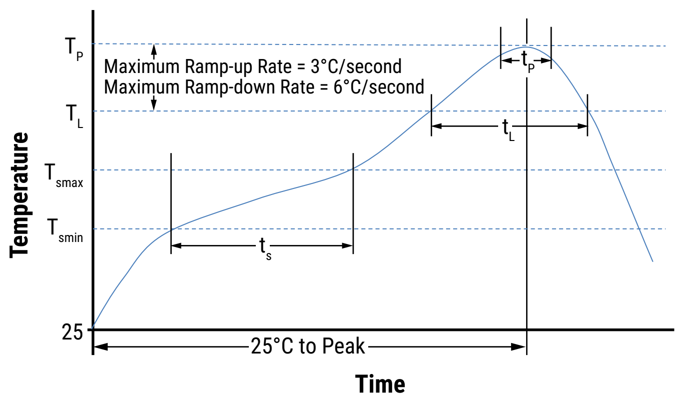


Table 4 – Performance & Reliability: Test Methods and Conditions

<table>
<tr><th>Stress</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Visual & Mechanical</td><td>KEMET Internal</td><td>No defects that may affect performance (10X)</td><td>Dimensions according KEMET Spec Sheet</td></tr>
<tr><td>Capacitance (Cap)</td><td>KEMET Internal</td><td>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</td><td>Within Tolerance</td></tr>
<tr><td>Dissipation Factor (DF)</td><td>KEMET Internal</td><td>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</td><td>Within Specification
Dissipation factor (DF) maximum limit at 25°C = 0.1%</td></tr>
<tr><td>Insulation Resistance (IR)</td><td>KEMET Internal</td><td>Rated voltage applied for 120 ±5 seconds at 25°C</td><td>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.</td></tr>
<tr><td>Temperature Coefficient of Capacitance (TCC)</td><td>KEMET Internal</td><td>Capacitance change with reference to +25°C and 0 VDC applied.
* See part number specification sheet for voltage
<table><tr><th>Step</th><th>Temperature (°C)</th></tr><tr><td>1</td><td>+25°C</td></tr><tr><td>2</td><td>−55°C</td></tr><tr><td>3</td><td>+25°C (Reference)</td></tr><tr><td>4</td><td>+125°C</td></tr></table></td><td>Within Specification: −750 ±120 ppm/°C</td></tr>
<tr><td>Dielectric Withstanding Voltage (DWV)</td><td>KEMET Internal</td><td>120% of rated voltage
(5 ±1 seconds and charge/discharge not exceeding 50 mA)</td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit

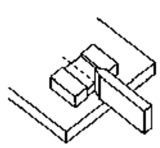
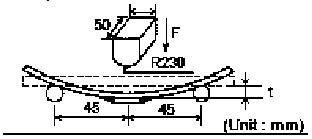
Withstand test voltage without insulation breakdown or damage.</td></tr>
<tr><td>Aging Rate (Maximum % Capacitance Loss/Decade Hour)</td><td>KEMET Internal</td><td>Maximum % capacitance loss/decade hour</td><td>0.1% Loss/Decade Hour</td></tr>
<tr><td>Terminal Strength</td><td>KEMET Internal</td><td>Shear stress test per specific case size, Time: 60±1 seconds
<table><tr><th>Case Size</th><th>Force</th></tr><tr><td>3640</td><td>18N</td></tr></table></td><td>No evidence of mechanical damage</td></tr>
</table>

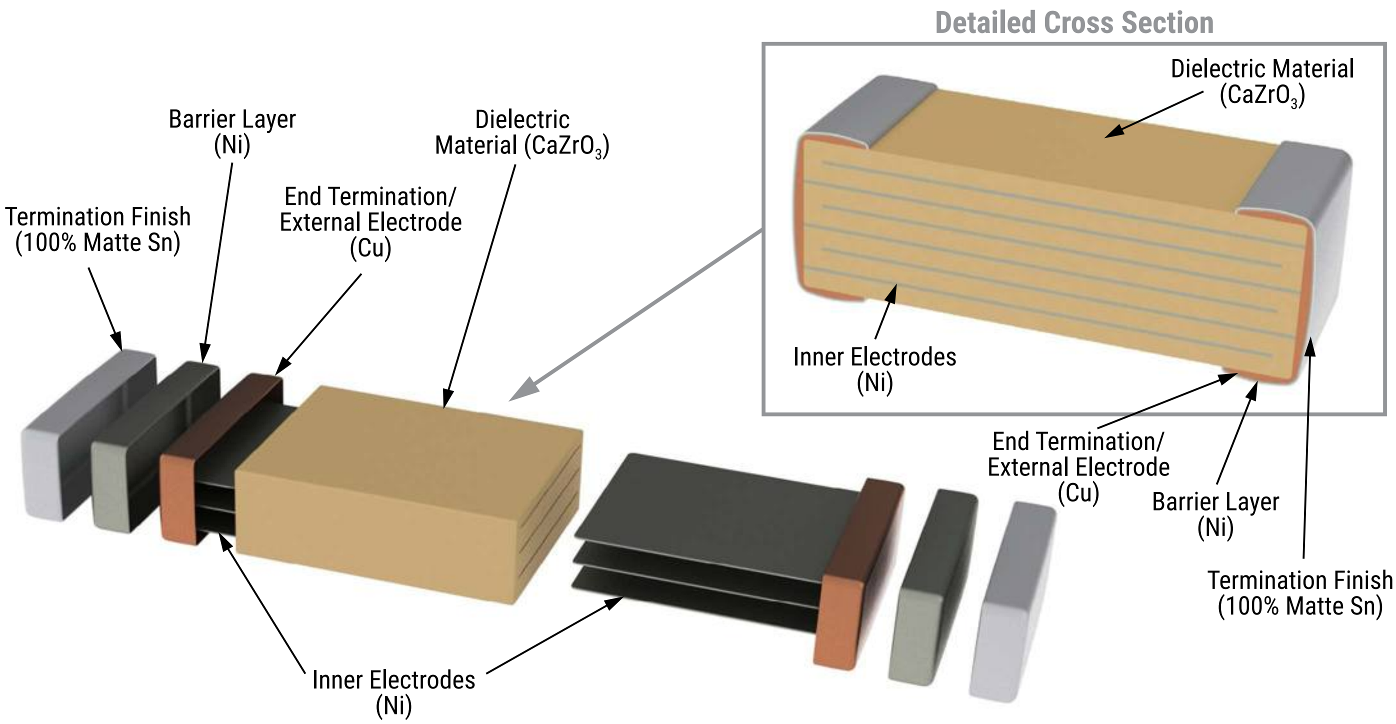
Table 4 – Performance & Reliability: Test Methods and Conditions cont.

Stress	Reference	Test Condition	Limits
Board Flex	AEC-Q200-005	3.0 mm minimum Test Time: 60 ±5 seconds Ramp Time: 1 mm/second  	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 Method 108	1,000 hours at 125°C with 2 X rated voltage applied	Within Post Environmental Limits Cap: ±0.3% or ±0.25 pF shift IR: 10% of Initial Limit DF: 0.5%
Storage Life		1,000 hours at 125°C, Unpowered	
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)

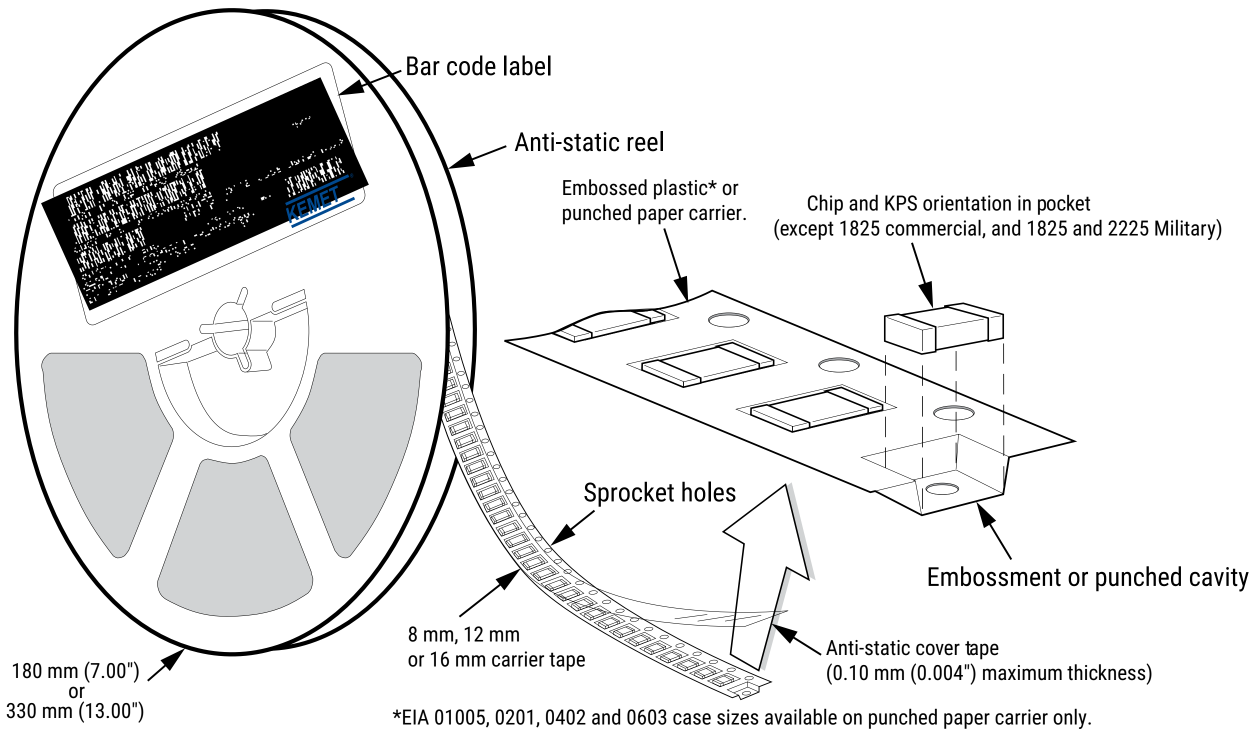
Laser marking option is not available on:

- C0G, 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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

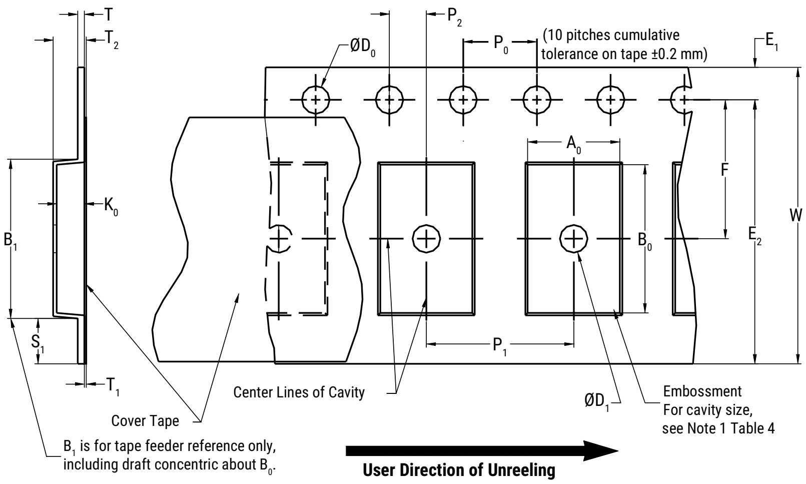


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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 (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)	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 S_1 < 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_0, B_0 and K_0 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

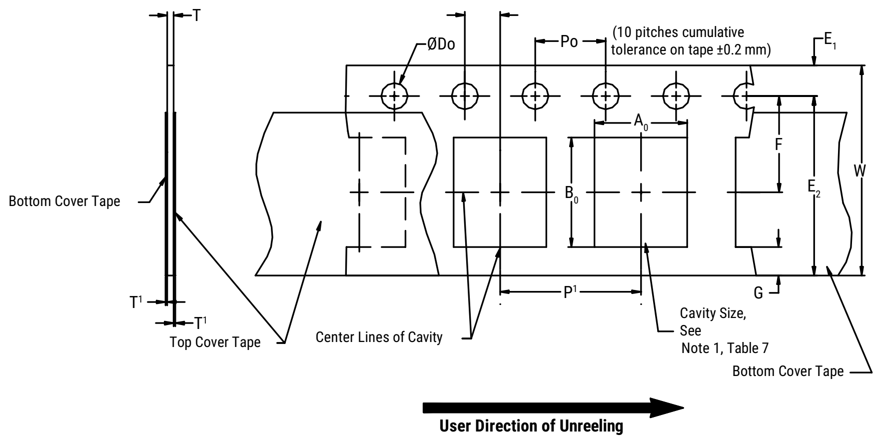


Table 7 – Punched (Paper) Carrier Tape Dimensions

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_0B_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_0, B_0 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

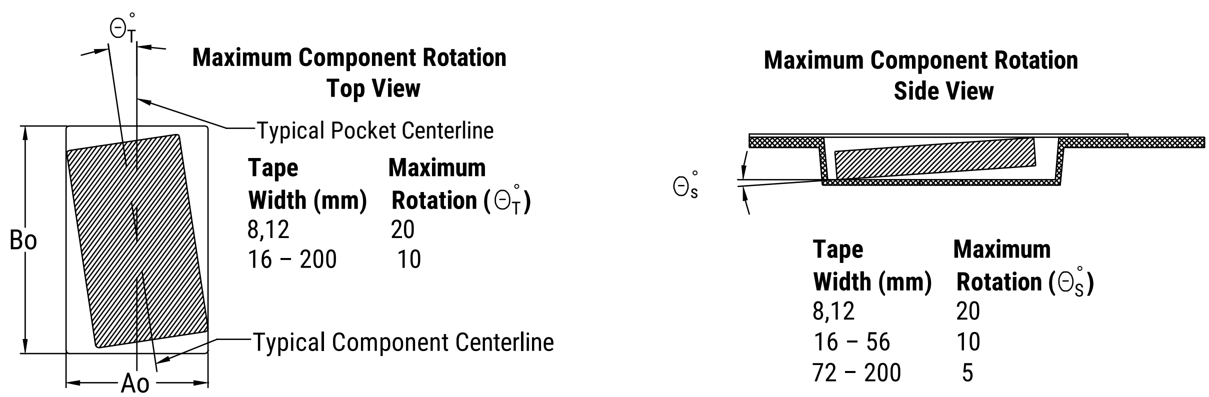


Figure 4 – Maximum Lateral Movement

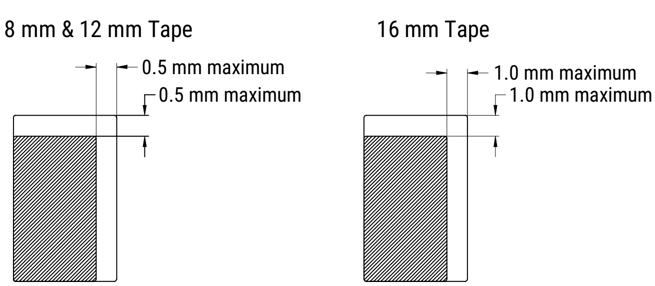


Figure 5 – Bending Radius

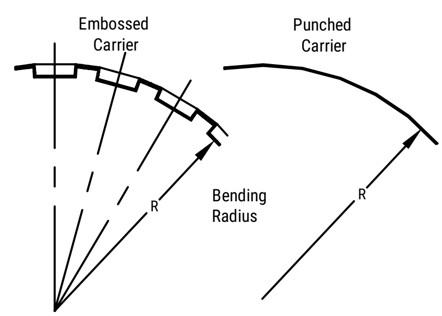
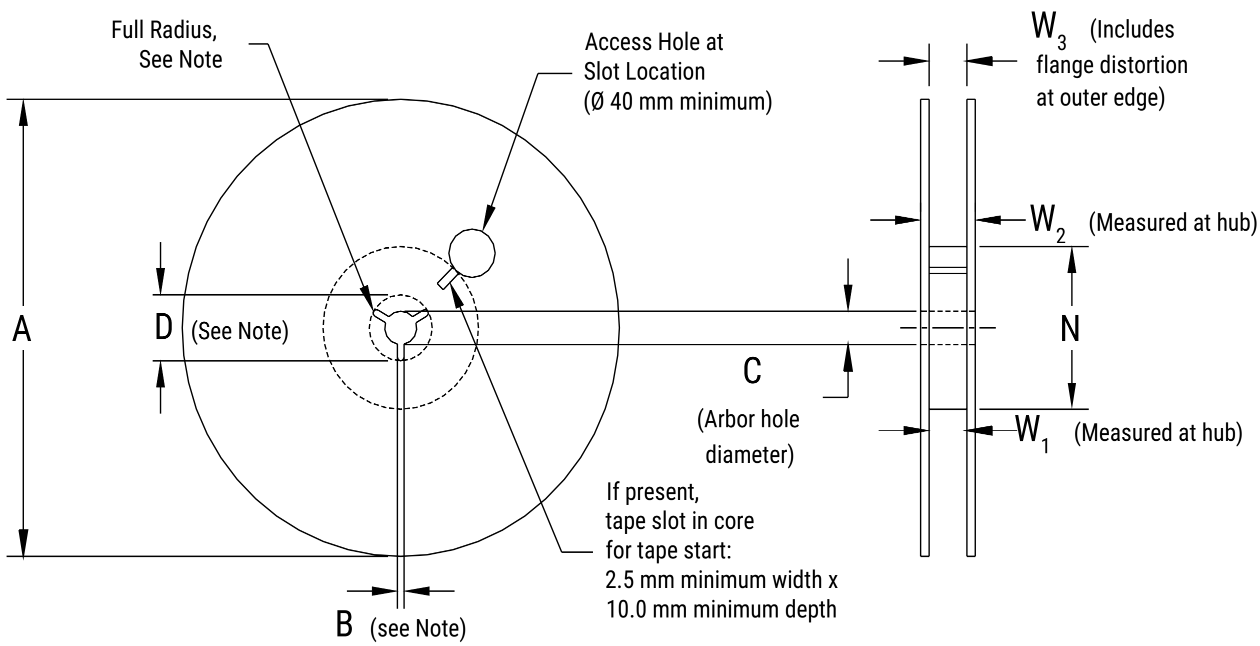


Figure 6 – Reel Dimensions



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	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

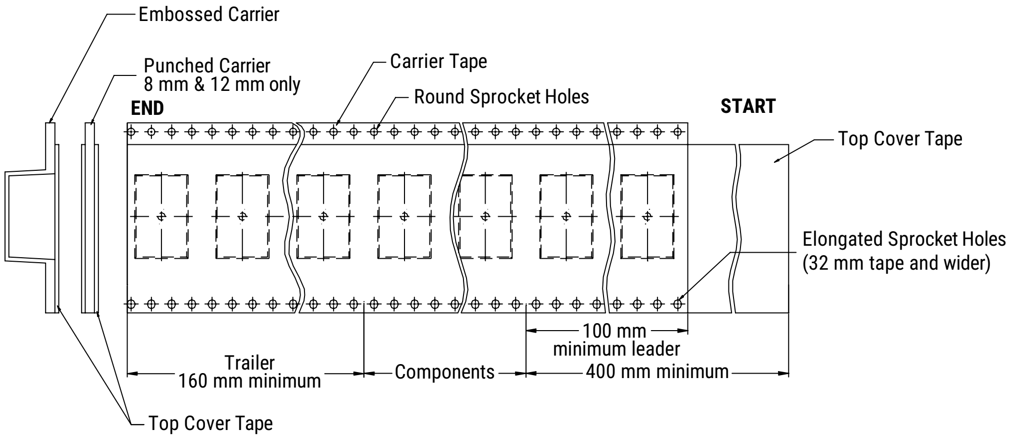
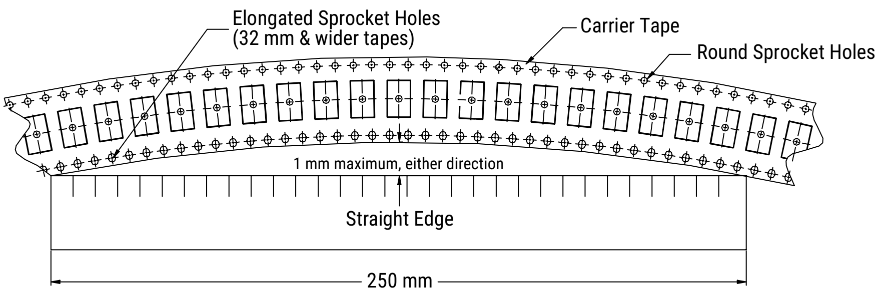


Figure 8 – Maximum Camber



Floating Electrode (FF-CAP), High Voltage with Flexible Termination X7R Dielectric, 500 – 3,000 VDC (Commercial & Automotive Grade)

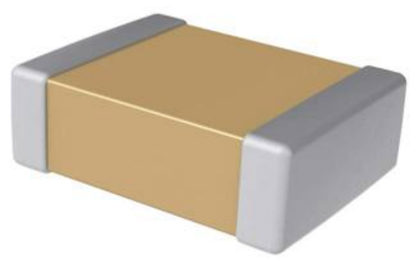
Overview

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 ±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

C	1210	Y	154	K	C	R	A	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 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.*

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	7210
7" Reel / Marked	TM
13" Reel / Marked	7215
Automotive Grade[3]	
7" Reel	AUTO
13" Reel / Unmarked	AUTO7210

[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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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:

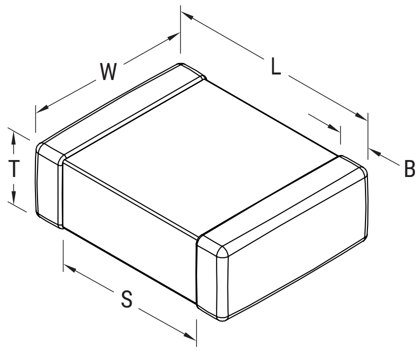
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

[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)



<table>
<tr><th>EIA Size Code</th><th>Metric Size Code</th><th>L
Length</th><th>W
Width</th><th>T
Thickness</th><th>B
Bandwidth</th><th>S
Separation Minimum</th><th>Mounting Technique</th></tr>
<tr><td>0805</td><td>2012</td><td>2.00 (0.079) ±0.30 (0.012)</td><td>1.25 (0.049) ± 0.30 (0.012)</td><td rowspan="8">See Table 2 for Thickness</td><td>0.50 (0.02) ±0.25 (0.010)</td><td>0.75 (0.030)</td><td rowspan="2">Solder Wave or Solder Reflow</td></tr>
<tr><td>1206</td><td>3216</td><td>3.30 (0.130) ±0.40 (0.016)</td><td>1.60 (0.063) ± 0.35(0.013)</td><td>0.60 (0.024) ±0.25 (0.010)</td><td rowspan="7">N/A</td></tr>
<tr><td>1210</td><td>3225</td><td>3.30 (0.130) ±0.40 (0.016)</td><td>2.60(0.102) ± 0.30(0.012)</td><td>0.60 (0.024) ±0.25 (0.010)</td><td rowspan="6">Solder Reflow Only</td></tr>
<tr><td>1808</td><td>4520</td><td>4.70 (0.185) ±0.50 (0.020)</td><td>2.00 (0.079) ± 0.20 (0.008)</td><td>0.70 (0.028) ±0.35 (0.014)</td></tr>
<tr><td>1812</td><td>4532</td><td>4.50 (0.178) ±0.40 (0.016)</td><td>3.20 (0.126) ± 0.30 (0.012)</td><td>0.70 (0.028) ±0.35 (0.014)</td></tr>
<tr><td>1825</td><td>4564</td><td>4.60 (0.181) ±0.40 (0.016)</td><td>6.40 (0.252) ± 0.40 (0.016)</td><td>0.70 (0.028) ±0.35 (0.014)</td></tr>
<tr><td>2220</td><td>5650</td><td>5.90 (0.232) ±0.75 (0.030)</td><td>5.00 (0.197) ± 0.40 (0.016)</td><td>0.70 (0.028) ±0.35 (0.014)</td></tr>
<tr><td>2225</td><td>5664</td><td>5.90 (0.232) ±0.75 (0.030)</td><td>6.40 (0.248) ± 0.40 (0.016)</td><td>0.70 (0.028) ±0.35 (0.014)</td></tr>
</table>

Table 1A – Capacitance Range/Selection Waterfall (0805 – 1812 Case Sizes)

Capacitance	Capacitance Code	Case Size/ Series			C0805Y			C1206Y					C1210Y					C1808Y							C1812Y						
		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	H
		Rated Voltage (VDC)			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 Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																										
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	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
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	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
15 pF	150	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
16 pF	160	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
18 pF	180	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
20 pF	200	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
22 pF	220	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
24 pF	240	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
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	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
33 pF	330	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
36 pF	360	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
39 pF	390	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	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
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	LB	GB	GB	GB	GB	GB	GB	GB
51 pF	510	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
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	LB	GB	GB	GB	GB	GB	GB	GB
62 pF	620	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
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	750	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
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	M	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	M	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	K	M	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	K	M	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	K	M	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	K	M	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	K	M	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
Capacitance	Capacitance Code	Rated Voltage (VDC)			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
		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	H
		Case Size/ Series			C0805Y			C1206Y					C1210Y					C1808Y							C1812Y						

Table 1A – Capacitance Range/Selection Waterfall (0805 – 1812 Case Sizes) cont.

Capacitance	Capacitance Code	Case Size/ Series			C0805Y			C1206Y					C1210Y					C1808Y							C1812Y						
		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	H
		Rated Voltage (VDC)			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 Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																										
220 pF	221	J	K	M	DG	DG	DG	ES	ES	ES	EU	EU	FZ	FZ	FZ	FM	FM	LA	LA	LA	LA	LC	LC	LB	GB	GB	GB	GB	GB	GD	GE
270 pF	271	J	K	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	K	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	K	M	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	J	K	M	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	GK
820 pF	821	J	K	M	DG	DG	DG	EU	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	K	M	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	K	M	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	M	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	M	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	M	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	K	M	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	K	M	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	M	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	K	M	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	M	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	M	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	M	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									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						
Capacitance	Capacitance Code	Rated Voltage (VDC)			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
		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	H
		Case Size/ Series			C0805Y			C1206Y					C1210Y					C1808Y							C1812Y						

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

Capacitance	Cap Code	Case Size/ Series			C1825Y							C2220Y							C2225Y						
		Voltage Code			C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		Rated Voltage (VDC)			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 Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																				
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	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	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
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	J	K	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	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	K	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	M	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	M	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	M	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	M	HE	HE	HE	HG	HK			JE	JK	JK	JK	JL	JN	JN	KE	KE	KE	KE	KH	KJ	KJ
18,000 pF	183	J	K	M	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	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	HK	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						
Capacitance	Cap Code	Rated Voltage (VDC)			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
		Voltage Code			C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		Case Size/ Series			C1825Y							C2220Y							C2225Y						

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

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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	4,000
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
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
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	2225	2.00 ± 0.20	0	0	500	2,000
KJ	2225	2.50 ± 0.20	0	0	500	2,000
Thickness Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[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

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		Packaging Quantities (pieces/unit packaging)	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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.

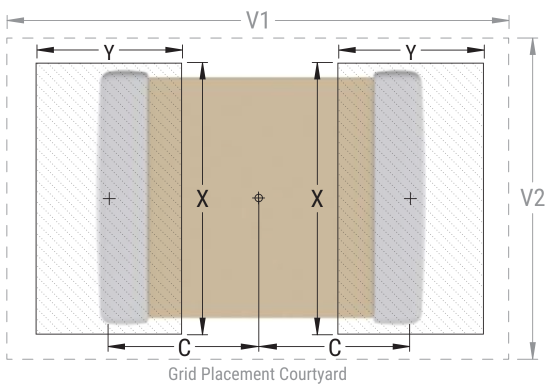
[2] A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard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

Table 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)				
		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	Termination Finish	
	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.

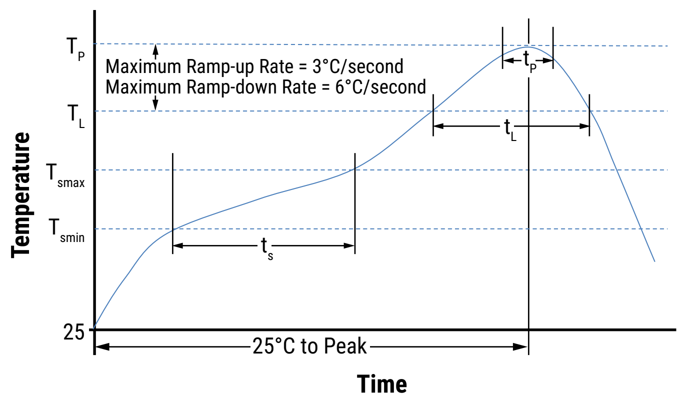


Table 4 – Performance & Reliability: Test Methods and Conditions

<table>
<tr><th>Stress</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Visual and Mechanical</td><td>KEMET Internal</td><td>No defects that may affect performance (10X)</td><td>Dimensions according KEMET Spec Sheet</td></tr>
<tr><td>Capacitance (Cap)</td><td>KEMET Internal</td><td>C ≤ 10 µF 1 kHz ±50 Hz and 1.0 ±0.2 V_{rms} or 0.5 ±0.2 V_{rms}*
C > 10 µF120 Hz ±10 Hz and 0.5 ±0.1 V_{rms}

* 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</td><td>Within Tolerance</td></tr>
<tr><td>Dissipation Factor (DF)</td><td>KEMET Internal</td><td>C ≤ 10 µF
Frequency: 1 kHz ±50 Hz
Voltage*:1.0 ±0.2 V_{rms}, 0.5 ±0.2 V_{rms},
C > 10 µF
Frequency: 120 Hz ±10 Hz
Voltage: 0.5 ±0.1 V_{rms}

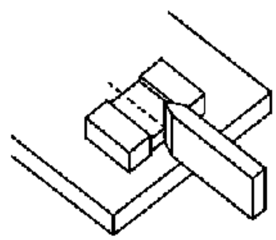
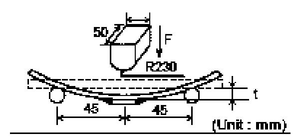
* See part number specification sheet for voltage</td><td>Within Specification
Dissipation factor (DF) maximum limit at 25°C = 2.5%</td></tr>
<tr><td>Insulation Resistance (IR)</td><td>KEMET Internal</td><td>500 VDC applied for 120 ±5 seconds at 25°C</td><td>Within Specification
To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ limit. Select the lower of the two limits.

<table>
<tr><th>EIA Case Size</th><th>1,000 Megohm Microfarads or 100 GΩ</th><th>100 Megohm Microfarads or 10 GΩ</th></tr>
<tr><td>0805</td><td>< 0.0039 µF</td><td>≥ 0.0039 µF</td></tr>
<tr><td>1206</td><td>< 0.012 µF</td><td>≥ 0.012 µF</td></tr>
<tr><td>1210</td><td>< 0.033 µF</td><td>≥ 0.033 µF</td></tr>
<tr><td>1808</td><td>< 0.018 µF</td><td>≥ 0.018 µF</td></tr>
<tr><td>1812</td><td>< 0.027 µF</td><td>≥ 0.027 µF</td></tr>
<tr><td>1825</td><td>< 0.120 µF</td><td>≥ 0.120 µF</td></tr>
<tr><td>2220</td><td>< 0.150 µF</td><td>≥ 0.150 µF</td></tr>
<tr><td>2225</td><td>< 0.180 µF</td><td>≥ 0.180 µF</td></tr>
</table></td></tr>
<tr><td>Temperature Coefficient of Capacitance (TCC)</td><td>KEMET Internal</td><td>C ≤ 10 µF
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 µF
Frequency: 120 Hz ±10 Hz
Voltage: 0.5 ±0.1 V_{rms}
* See part number specification sheet for voltage

<table>
<tr><th>Step</th><th>Temperature (°C)</th></tr>
<tr><td>1</td><td>+25°C</td></tr>
<tr><td>2</td><td>−55°C</td></tr>
<tr><td>3</td><td>+25°C (Reference Temperature)</td></tr>
<tr><td>4</td><td>+125°C</td></tr>
</table></td><td>Capacitance ±15% over −55°C to +125°C</td></tr>
</table>

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

<table>
<tr><th>Stress</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Dielectric Withstanding Voltage (DWV)</td><td>KEMET Internal</td><td>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)</td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit

Withstand test voltage without insulation breakdown or damage.</td></tr>
<tr><td>Aging Rate (Maximum % Capacitance Loss/Decade Hour)</td><td>KEMET Internal</td><td>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.</td><td>Please refer to a part number specification sheet for specific Aging rate</td></tr>
<tr><td>Terminal Strength</td><td>KEMET Internal</td><td>Shear stress test per specific case size,
Time: 60 ±1 second.
<table>
<tr><th>Case Size</th><th>Force</th></tr>
<tr><td>0805</td><td>9N</td></tr>
<tr><td>≥ 1206</td><td>18N</td></tr>
</table>
</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Board Flex</td><td>AEC-Q200-005</td><td>Standard Termination
System 2.0 mm
Flexible Termination
System 3.0 mm
Test Time: 60± 5 seconds
Ramp Time: 1 mm/second

</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Solderability</td><td>J-STD-002</td><td>Condition: 4 hours ±15 minutes at
155°C dry bake apply all methods
Test 245 ±5°C (SnPb & Pb-Free)</td><td>Visual Inspection.
95% coverage on termination.
No leaching</td></tr>
<tr><td>Temperature Cycling</td><td>JESD22
Method JA-104</td><td>1,000 cycles (−55°C to +125°C)
2 - 3 cycles per hour
Soak Time: 1 or 5 minute</td><td>Measurement at 24 hours ±4 hours after test conclusion.
Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit</td></tr>
<tr><td>Biased Humidity</td><td>MIL-STD-202
Method 103</td><td>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.</td><td>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%</td></tr>
<tr><td>Moisture Resistance</td><td>MIL-STD-202
Method 106</td><td>Number of Cycles Required: 10, 24 hours per cycle.
Steps 7a and 7b not required</td><td>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%</td></tr>
<tr><td>Thermal Shock</td><td>MIL-STD-202
Method 107</td><td>Number of Cycles Required: 5, (−55°C to 125°C)
Dwell time 15 minutes.</td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit</td></tr>
</table>

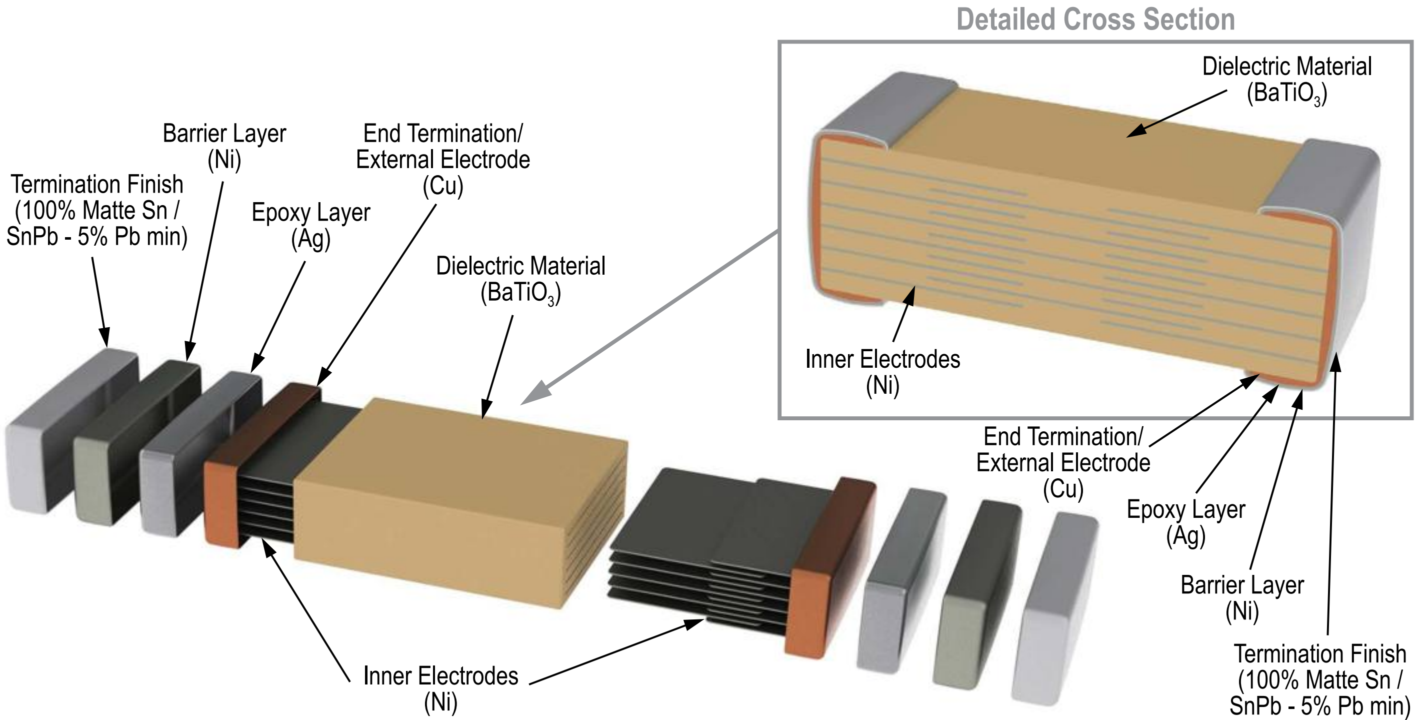
Table 4 – Performance & Reliability: Test Methods and Conditions cont.

Stress	Reference	Test Condition	Limits
High Temperature Life	MIL-STD-202 Method 108	1,000 hours at 125°C with 1.2 X rated voltage applied.	Within Post Environmental Limits Cap: ±20% shift IR: 10% of Initial Limit DF Limit Maximum: 3.0%
Storage Life		1,000 hours at 150°C, Unpowered	
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 40ºC 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)

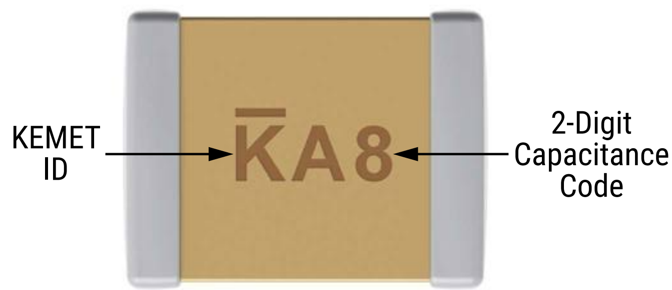
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic 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:

- C0G, 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 µF. Orientation of marking is vendor optional.

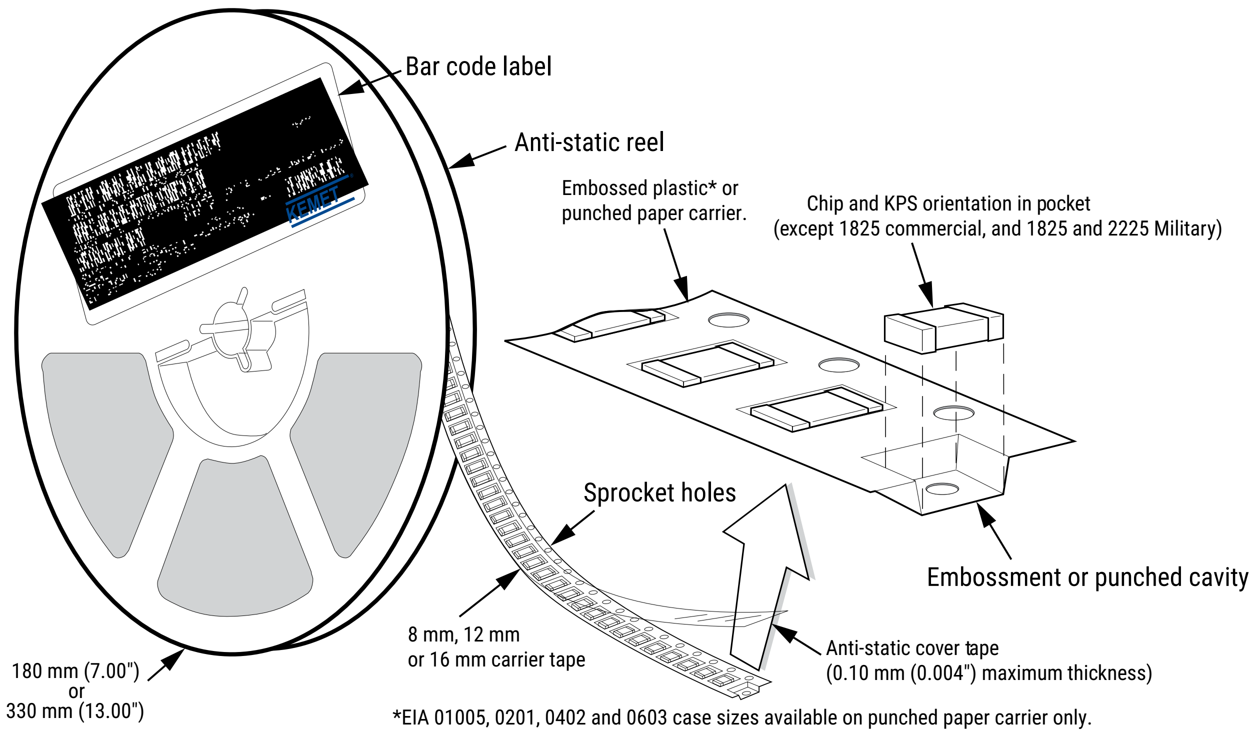


Capacitor Marking (Optional) cont.

Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.10	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

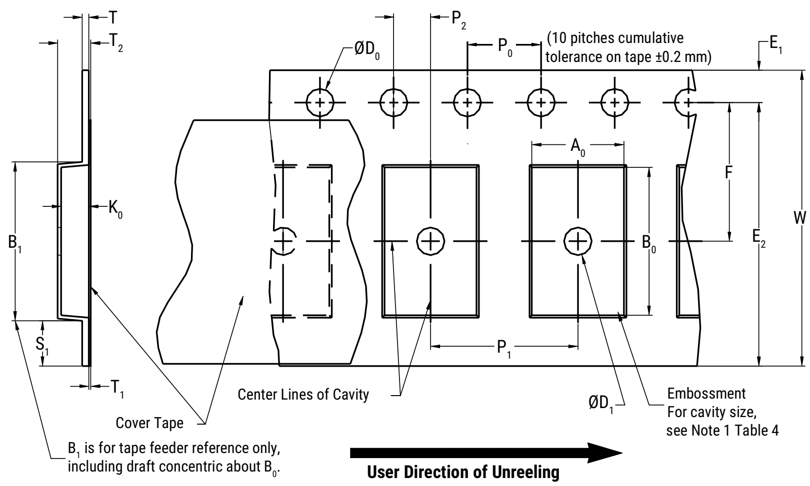


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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 (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)	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 S_1 < 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_0, B_0 and K_0 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

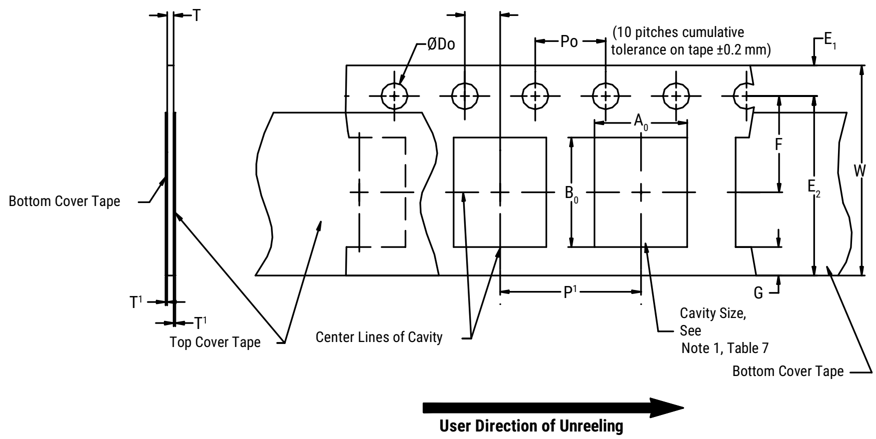


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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

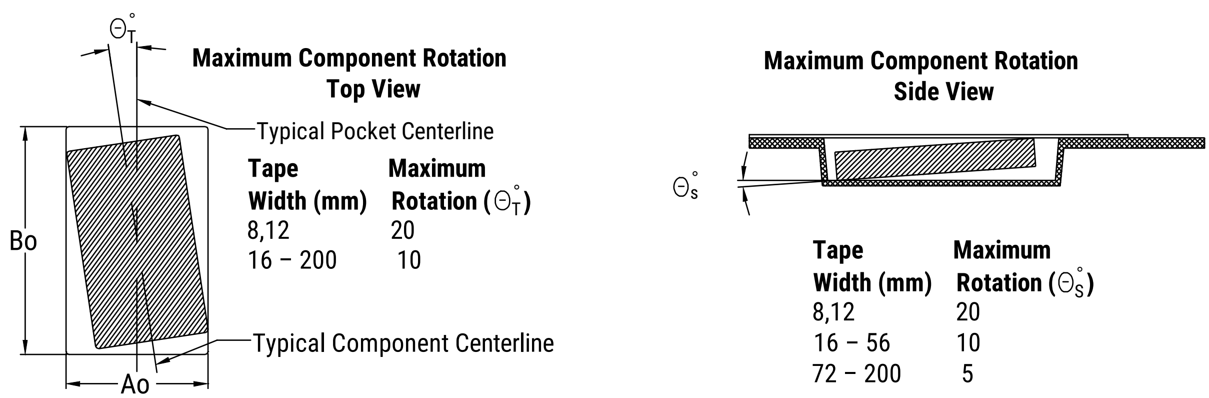


Figure 4 – Maximum Lateral Movement

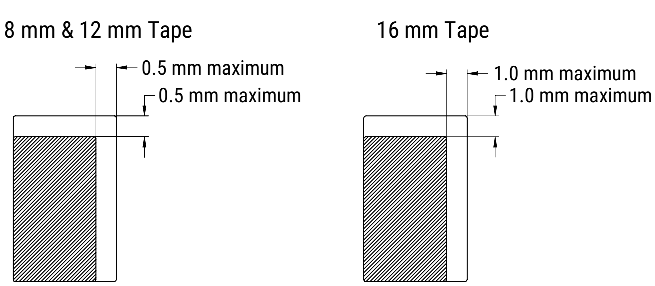


Figure 5 – Bending Radius

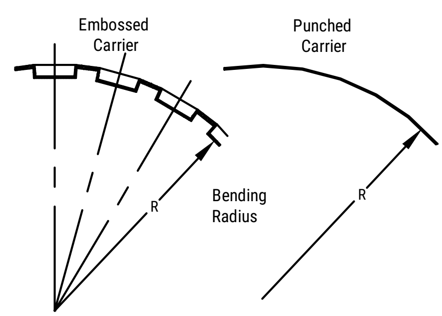
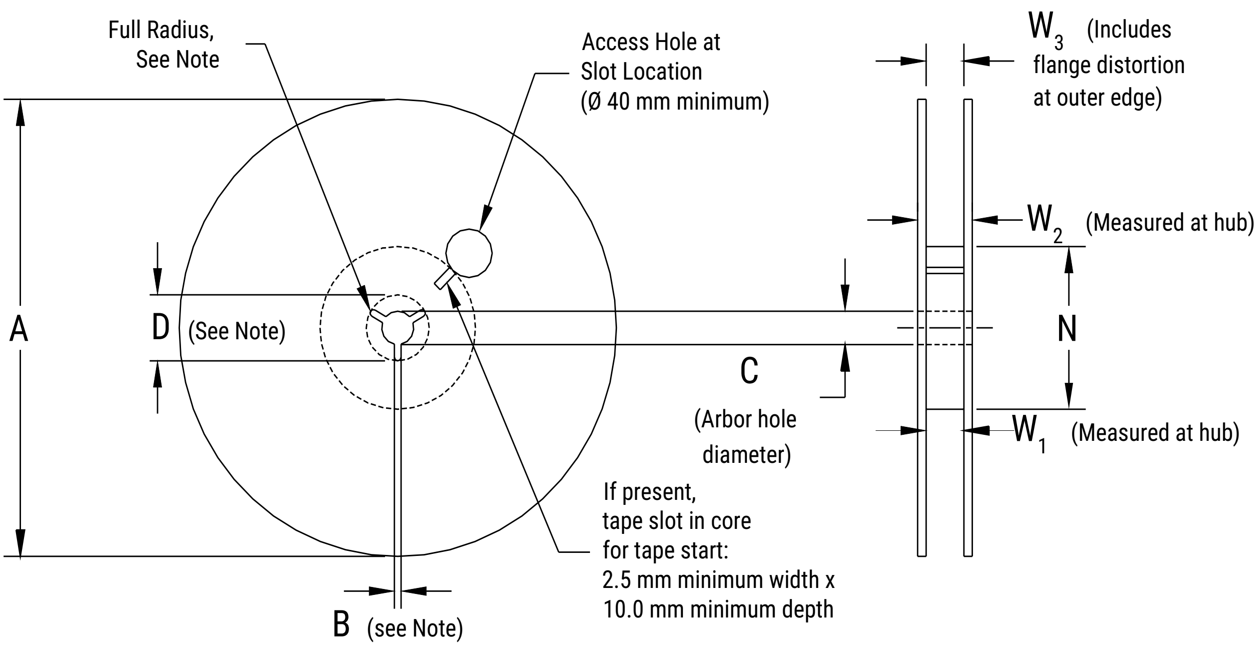


Figure 6 – Reel Dimensions



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	A	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

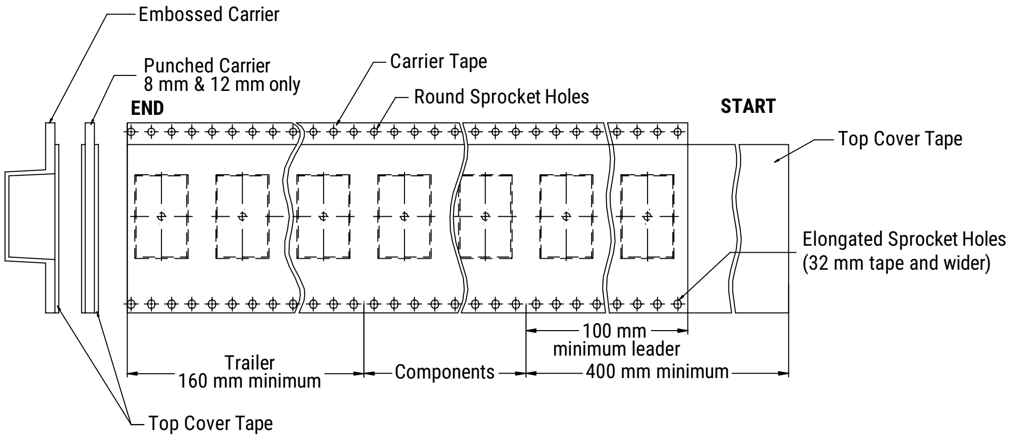
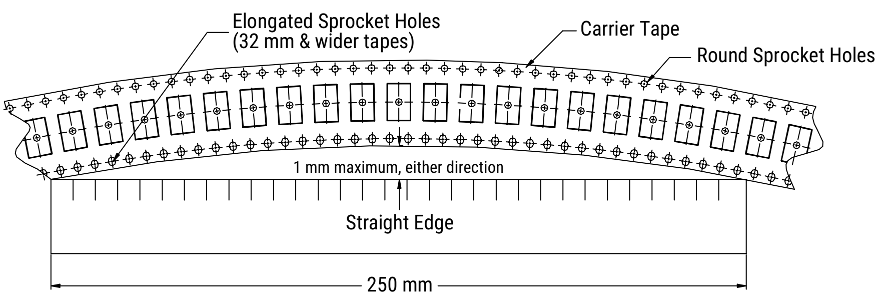


Figure 8 – Maximum Camber



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

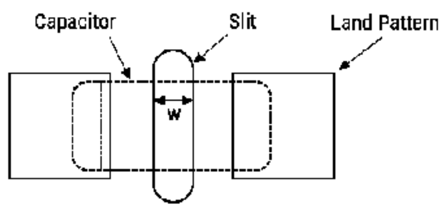
For MLCC ratings ≥1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

Dielectric	CTE (ppm/°C)
Class II $BaTiO_3$	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.



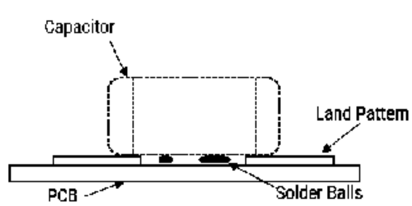
Solder Resist

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.



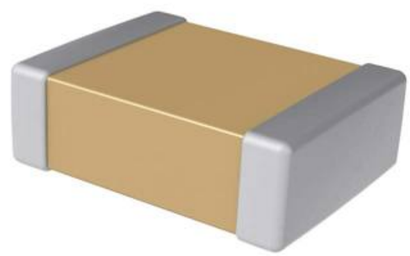
Floating Electrode (FE-CAP), High Voltage X7R Dielectric, 500 – 3,000 VDC (Commercial & Automotive Grade)

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 ±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

C	1210	S	154	K	C	R	A	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 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.*

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	7210
7" Reel / Marked	TM
13" Reel / Marked	7215
Automotive Grade[3]	
7" Reel	AUTO
13" Reel / Unmarked	AUTO7210

[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
- 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)

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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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.*

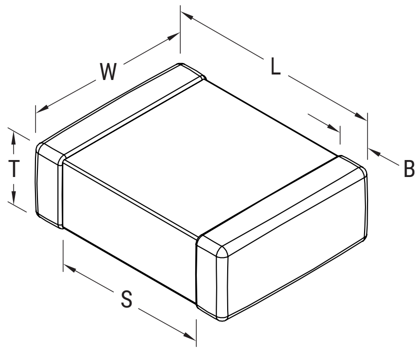
Production Part Approval Process (PPAP)
The purpose of the Production Part Approval Process is:
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements 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			○		

[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)	See Table 2 for Thickness	0.50 (0.02) ±0.25 (0.010)	0.75 (0.030)	Solder Wave or Solder Reflow
1206	3216	3.20 (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
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)		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)		

Table 1A – Capacitance Range/Selection Waterfall (0805 – 1812 Case Sizes)

Capacitance	Capacitance Code	Case Size/ Series			C0805S			C1206S					C1210S					C1808S							C1812S						
		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	H
		Rated Voltage (VDC)			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 Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																										
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	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	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
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	GB	GB	GB	GB	GB	GB	GB
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	GB	GB	GB	GB	GB	GB	GB
16 pF	160	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
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	200	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
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	GB	GB	GB	GB	GB	GB	GB
24 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	GB	GB	GB	GB	GB	GB	GB
27 pF	270	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
30 pF	300	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
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	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	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
43 pF	430	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
47 pF	470	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
51 pF	510	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	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
62 pF	620	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
68 pF	680	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
75 pF	750	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	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
91 pF	910	J	K	M	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	M	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	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	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	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	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
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	LC	GK	GK	GK	GK	GK	GK	GK
Capacitance	Capacitance Code	Rated Voltage (VDC)			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
		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	H
		Case Size/ Series			C0805S			C1206S					C1210S					C1808S							C1812S						

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Table 1A – Capacitance Range/Selection Waterfall (0805 – 1812 Case Sizes) cont.

Capacitance	Capacitance Code	Case Size/Series			C0805S			C1206S					C1210S					C1808S							C1812S						
		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	H
		Rated Voltage (VDC)			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 Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																										
220 pF	221	J	K	M	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	GE
270 pF	271	J	K	M	DG	DG	DG	ED	ED	ED	EG	EG	FG	FG	FG	FK	FK	LA	LA	LA	LB	LC	LC	LC	GB	GB	GB	GB	GB	GH	GH
330 pF	331	J	K	M	DG	DG	DG	ED	ED	EF	EG	EU	FG	FG	FG	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	ED	ED	EF	EG	EU	FG	FG	FG	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	ED	ED	EG	EG	EU	FM	FM	FM	FS	FS	LB	LB	LB	LC	LA	LB	LC	GB	GB	GB	GB	GD	GK	GK
560 pF	561	J	K	M	DG	DG	DG	ED	ED	EG	EG	EU	FM	FM	FM	FS	FS	LB	LB	LB	LC	LB	LB	LC	GB	GB	GB	GD	GH	GH	GK
680 pF	681	J	K	M	DG	DG	DG	EG	EG	EG	EU	EU	FM	FM	FM	FS	FS	LB	LB	LB	LA	LC	LC	LC	GB	GB	GB	GD	GH	GH	GK
820 pF	821	J	K	M	DG	DG	DG	EG	EG	EG	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	K	M	DG	DG	DG	EG	EG	EG	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	K	M	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	M	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	M	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	M	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	K	M	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	K	M	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	M	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	K	M	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	M	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	M	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	M	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	FH	FH	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									FH	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									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						
Capacitance	Capacitance Code	Rated Voltage (VDC)			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
		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	H
		Case Size/Series			C0805S			C1206S					C1210S					C1808S							C1812S						

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

Capacitance	Cap Code	Case Size/ Series			C1825S							C2220S							C2225S						
		Voltage Code			C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		Rated Voltage (VDC)			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 Tolerance			Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																				
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	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	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
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	J	K	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	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	K	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	M	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	M	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	M	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	M	HE	HE	HE	HG	HK			JE	JK	JK	JK	JL	JN	JN	KE	KE	KE	KE	KH	KJ	KJ
18,000 pF	183	J	K	M	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	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	HK	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						
Capacitance	Cap Code	Rated Voltage (VDC)			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
		Voltage Code			C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		Case Size/ Series			C1825S							C2220S							C2225S						

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

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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	1206	1.00 ± 0.20	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
EU	1206	1.60 ± 0.25	0	0	2,000	8,000
FG	1210	1.25 ± 0.15	0	0	2,500	10,000
FL	1210	1.40 ± 0.15	0	0	2,000	8,000
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
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
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	2225	2.00 ± 0.20	0	0	500	2,000
KJ	2225	2.50 ± 0.20	0	0	500	2,000
Thickness Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[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

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		Packaging Quantities (pieces/unit packaging)	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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.*

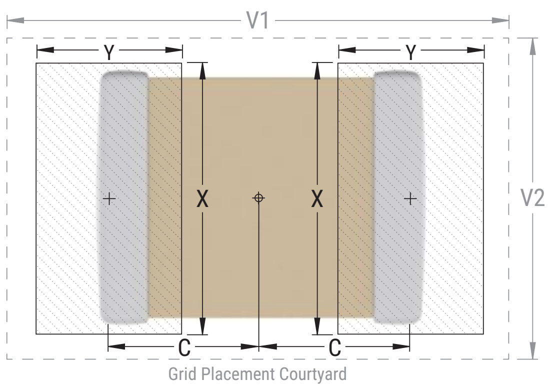
[2] *A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard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

Table 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)				
		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	
	SnPb	100% Matte Sn
Preheat/Soak Temperature Minimum (T_{Smin}) Temperature Maximum (T_{Smax}) Time (t_S) from T_{Smin} to T_{Smax}	 100°C 150°C 60 – 120 seconds	 150°C 200°C 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.

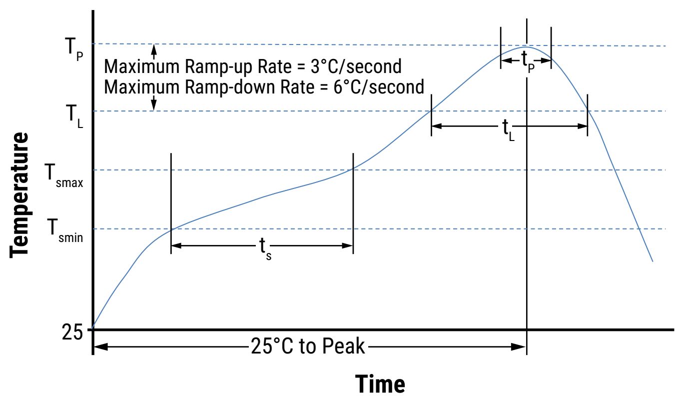


Table 4 – Performance & Reliability: Test Methods and Conditions

<table>
<tr><th>Stress</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Visual and Mechanical</td><td>KEMET Internal</td><td>No defects that may affect performance (10X)</td><td>Dimensions according KEMET Spec Sheet</td></tr>
<tr><td>Capacitance (Cap)</td><td>KEMET Internal</td><td>C ≤ 10 µF 1 kHz ±50 Hz and 1.0 ±0.2 V_{rms} or 0.5 ±0.2 V_{rms}*
C > 10 µF120 Hz ±10 Hz and 0.5 ±0.1 V_{rms}

* 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</td><td>Within Tolerance</td></tr>
<tr><td>Dissipation Factor (DF)</td><td>KEMET Internal</td><td>C ≤ 10 µF
Frequency: 1 kHz ±50 Hz
Voltage*:1.0 ±0.2 V_{rms}, 0.5 ±0.2 V_{rms},
C > 10 µF
Frequency: 120 Hz ±10 Hz
Voltage: 0.5 ±0.1 V_{rms}

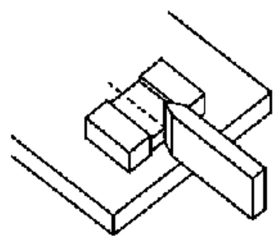
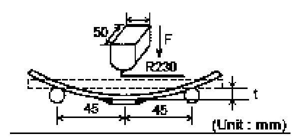
* See part number specification sheet for voltage</td><td>Within Specification
Dissipation factor (DF) maximum limit at 25°C = 2.5%</td></tr>
<tr><td>Insulation Resistance (IR)</td><td>KEMET Internal</td><td>500 VDC applied for 120 ±5 seconds at 25°C</td><td>Within Specification
To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ limit. Select the lower of the two limits.

<table>
<tr><th>EIA Case Size</th><th>1,000 Megohm Microfarads or 100 GΩ</th><th>100 Megohm Microfarads or 10 GΩ</th></tr>
<tr><td>0805</td><td>< 0.0039 µF</td><td>≥ 0.0039 µF</td></tr>
<tr><td>1206</td><td>< 0.012 µF</td><td>≥ 0.012 µF</td></tr>
<tr><td>1210</td><td>< 0.033 µF</td><td>≥ 0.033 µF</td></tr>
<tr><td>1808</td><td>< 0.018 µF</td><td>≥ 0.018 µF</td></tr>
<tr><td>1812</td><td>< 0.027 µF</td><td>≥ 0.027 µF</td></tr>
<tr><td>1825</td><td>< 0.120 µF</td><td>≥ 0.120 µF</td></tr>
<tr><td>2220</td><td>< 0.150 µF</td><td>≥ 0.150 µF</td></tr>
<tr><td>2225</td><td>< 0.180 µF</td><td>≥ 0.180 µF</td></tr>
</table></td></tr>
<tr><td>Temperature Coefficient of Capacitance (TCC)</td><td>KEMET Internal</td><td>C ≤ 10 µF
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 µF
Frequency: 120 Hz ±10 Hz
Voltage: 0.5 ±0.1 V_{rms}
* See part number specification sheet for voltage

<table>
<tr><th>Step</th><th>Temperature (°C)</th></tr>
<tr><td>1</td><td>+25°C</td></tr>
<tr><td>2</td><td>−55°C</td></tr>
<tr><td>3</td><td>+25°C (Reference Temperature)</td></tr>
<tr><td>4</td><td>+125°C</td></tr>
</table></td><td>Capacitance ±15% over −55°C to +125°C</td></tr>
</table>

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

<table>
<tr><th>Stress</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Dielectric Withstanding Voltage (DWV)</td><td>KEMET Internal</td><td>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)</td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit

Withstand test voltage without insulation breakdown or damage.</td></tr>
<tr><td>Aging Rate (Maximum % Capacitance Loss/Decade Hour)</td><td>KEMET Internal</td><td>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.</td><td>Please refer to a part number specification sheet for specific Aging rate</td></tr>
<tr><td>Terminal Strength</td><td>KEMET Internal</td><td>Shear stress test per specific case size,
Time: 60 ±1 second.
<table><tr><th>Case Size</th><th>Force</th></tr><tr><td>0805</td><td>9N</td></tr><tr><td>≥ 1206</td><td>18N</td></tr></table></td><td>No evidence of mechanical damage</td></tr>
<tr><td>Board Flex</td><td>AEC-Q200-005</td><td>Standard Termination
System 2.0 mm
Flexible Termination
System 3.0 mm
Test Time: 60± 5 seconds
Ramp Time: 1 mm/second
</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Solderability</td><td>J-STD-002</td><td>Condition: 4 hours ±15 minutes at
155°C dry bake apply all methods
Test 245 ±5°C (SnPb & Pb-Free)</td><td>Visual Inspection.
95% coverage on termination.
No leaching</td></tr>
<tr><td>Temperature Cycling</td><td>JESD22
Method JA-104</td><td>1,000 cycles (−55°C to +125°C)
2 - 3 cycles per hour
Soak Time: 1 or 5 minute</td><td>Measurement at 24 hours ±4 hours after test conclusion.
Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit</td></tr>
<tr><td>Biased Humidity</td><td>MIL-STD-202
Method 103</td><td>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.</td><td>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%</td></tr>
<tr><td>Moisture Resistance</td><td>MIL-STD-202
Method 106</td><td>Number of Cycles Required: 10, 24 hours per cycle.
Steps 7a and 7b not required</td><td>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%</td></tr>
<tr><td>Thermal Shock</td><td>MIL-STD-202
Method 107</td><td>Number of Cycles Required: 5, (−55°C to 125°C)
Dwell time 15 minutes.</td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit</td></tr>
</table>

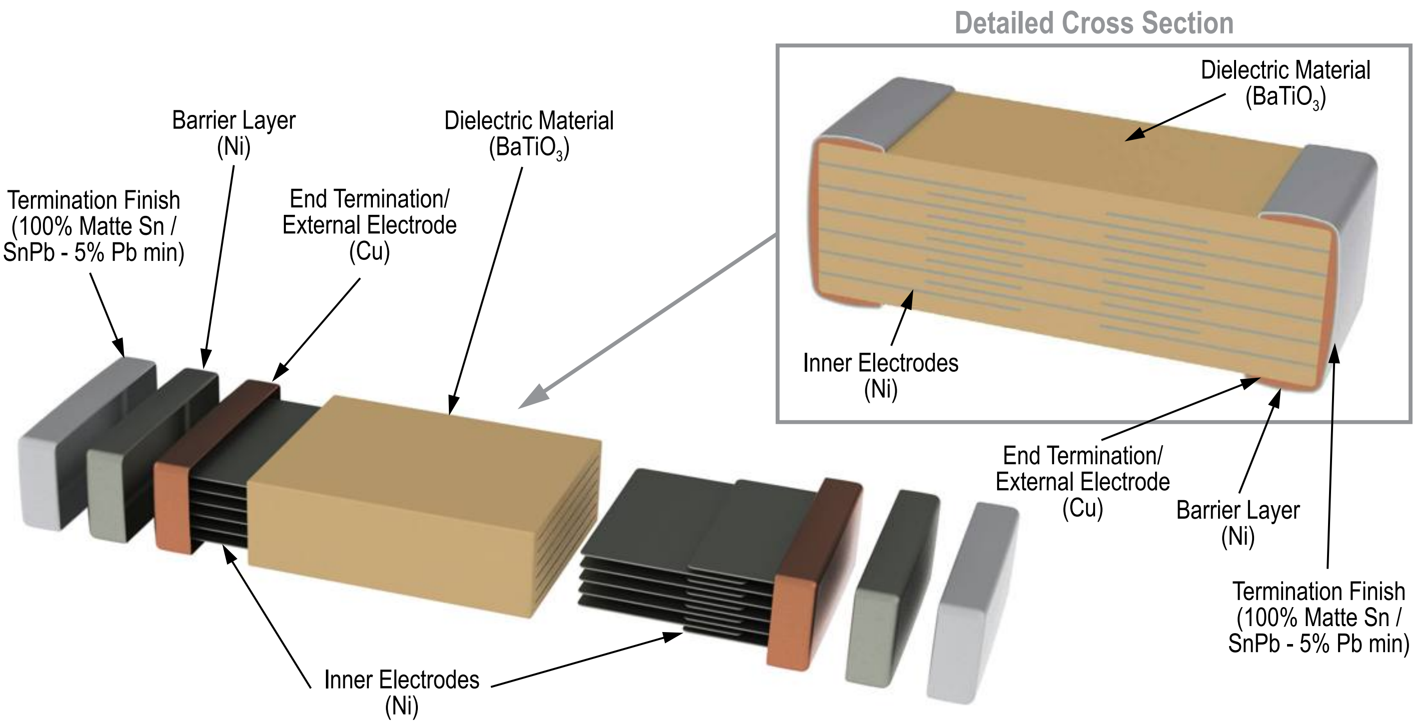
Table 4 – Performance & Reliability: Test Methods and Conditions cont.

Stress	Reference	Test Condition	Limits
High Temperature Life	MIL-STD-202 Method 108	1,000 hours at 125°C with 1.2 X rated voltage applied.	Within Post Environmental Limits Cap: ±20% shift IR: 10% of Initial Limit DF Limit Maximum: 3.0%
Storage Life		1,000 hours at 150°C, Unpowered	
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 40ºC 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:

- C0G, 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

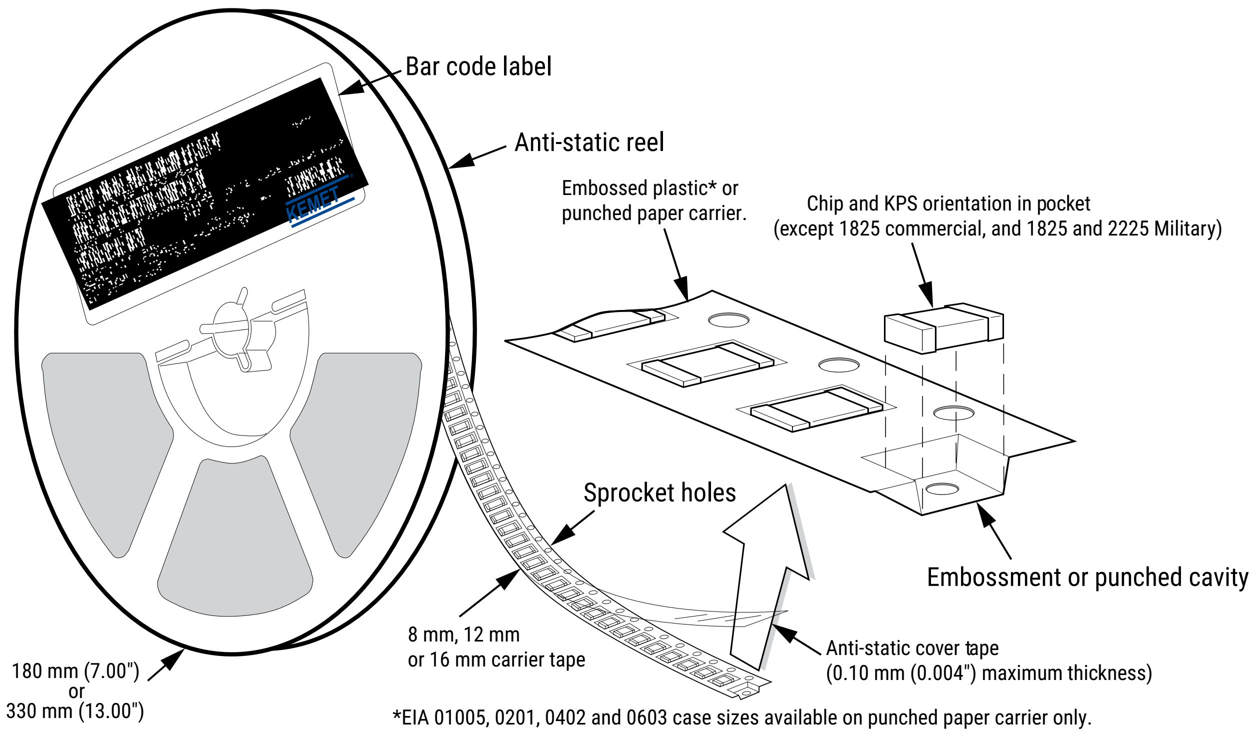
Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of "KA8", which designates a KEMET device with rated capacitance of 100 µF. Orientation of marking is vendor optional.

Capacitor Marking (Optional) cont.

Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.10	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

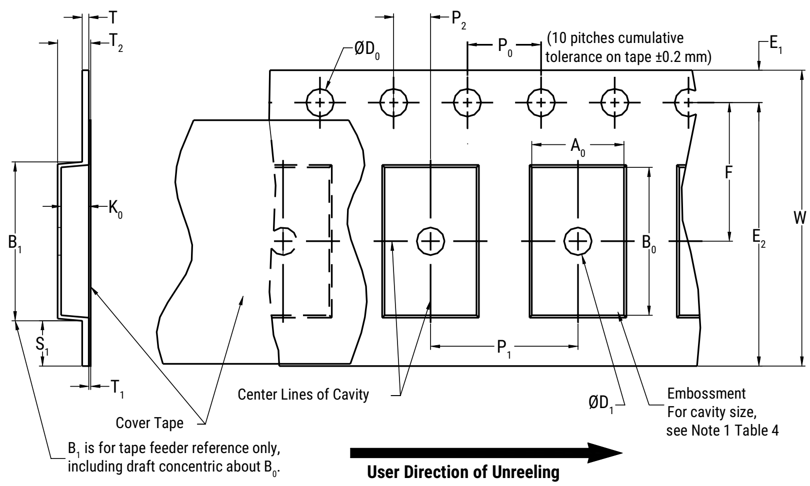


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +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)			
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)	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 S_1 < 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_0, B_0 and K_0 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

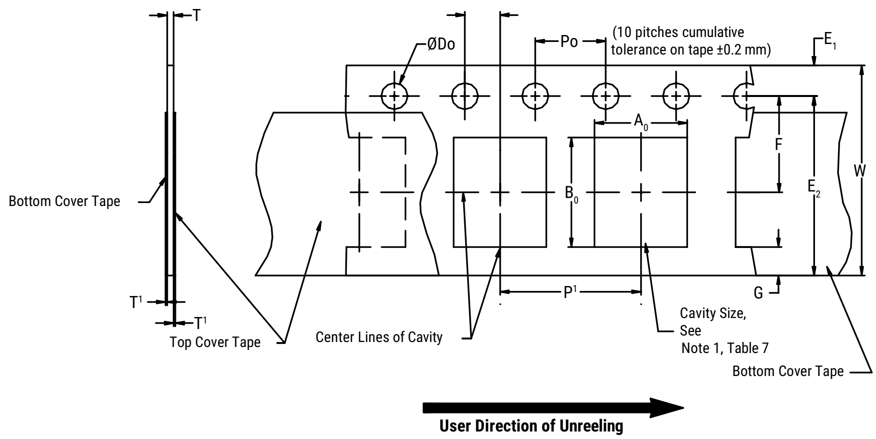


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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

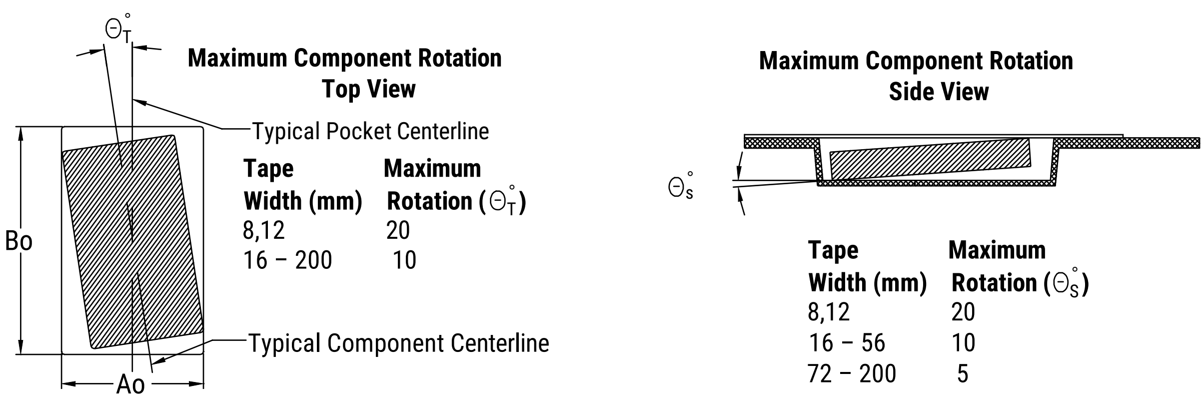


Figure 4 – Maximum Lateral Movement

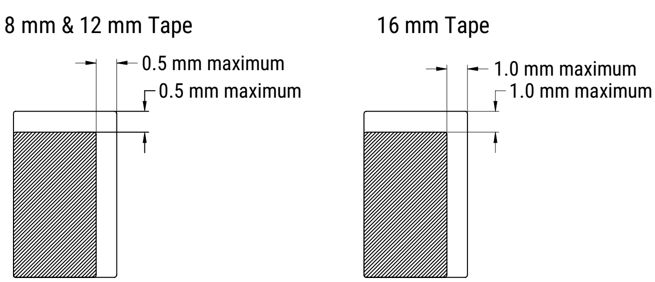


Figure 5 – Bending Radius

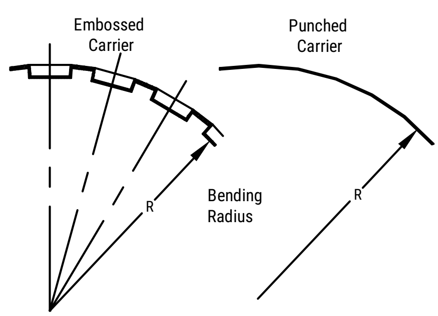
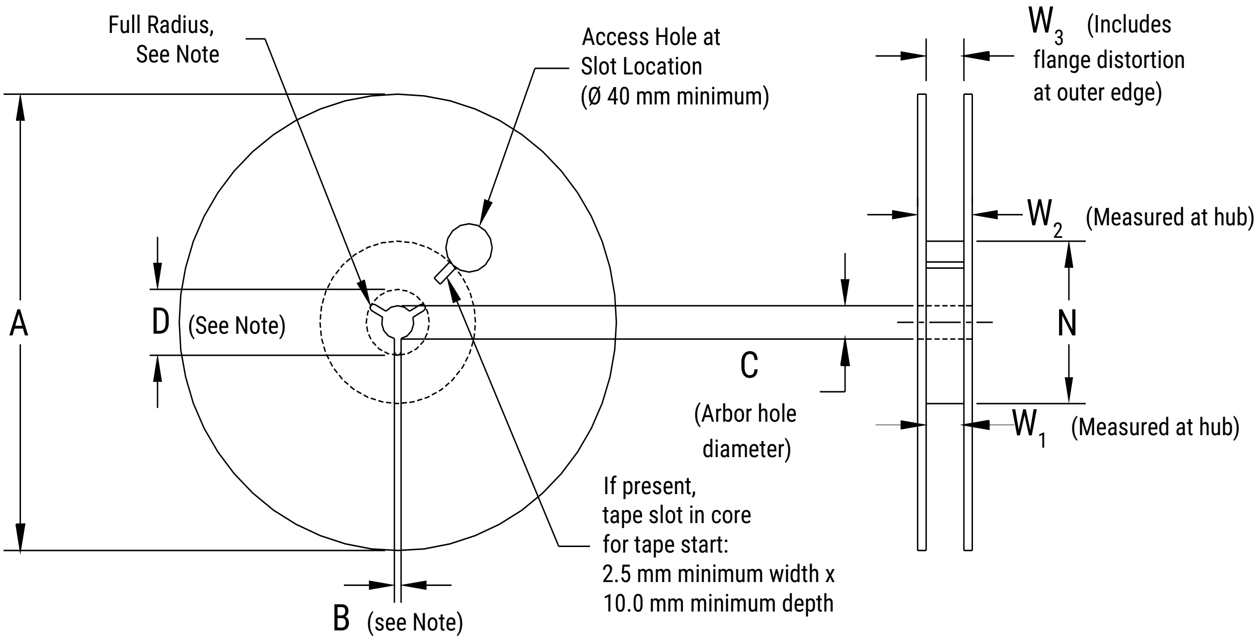


Figure 6 – Reel Dimensions



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	A	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

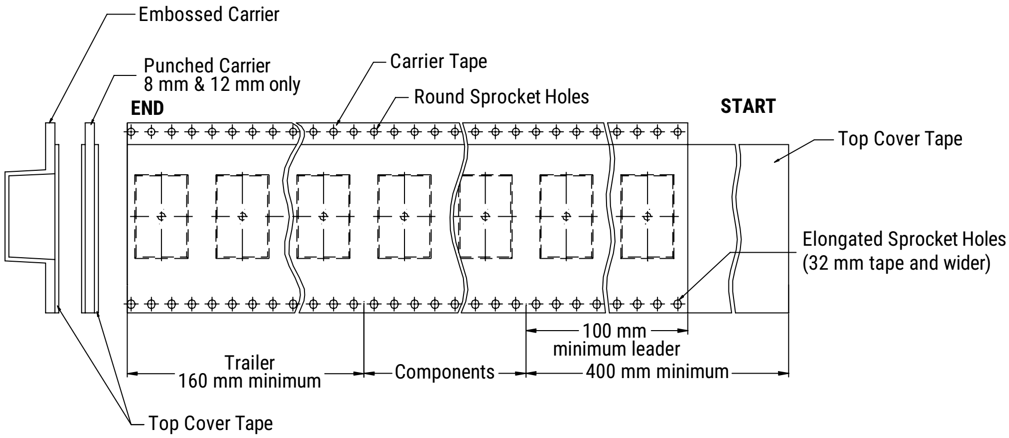
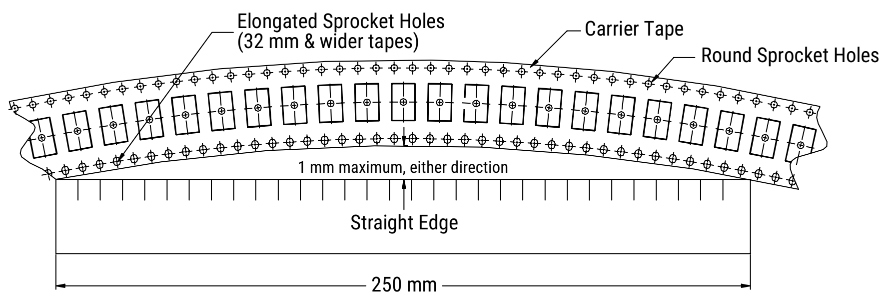


Figure 8 – Maximum Camber



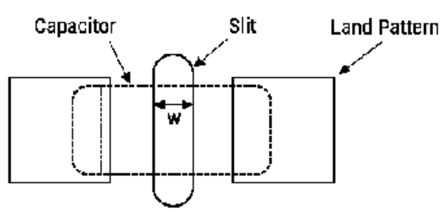
Application Guide

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 ≥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.

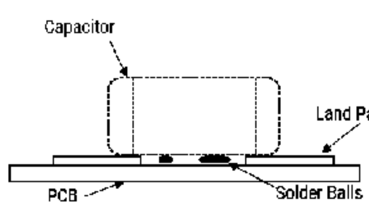
Dielectric	CTE (ppm/°C)
Class II $BaTiO_3$	10.7
Class I $CaZrO_3$	9.8

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.



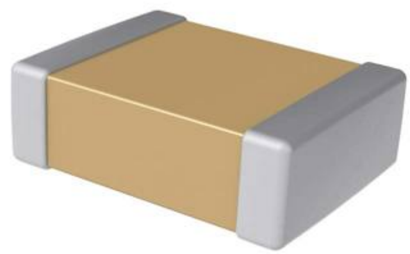
Floating Electrode (FE-CAP), High Voltage C0G Dielectric, 500 – 3,000 VDC (Commercial & Automotive Grade)

Overview

KEMET's Floating Electrode (FE-CAP) high voltage multilayer ceramic capacitor in C0G 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 C0G dielectric are temperature compensating and are suited for resonant circuit applications or those where Q and stability of capacitance characteristics are required. C0G 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.

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

C	1210	S	332	J	C	G	A	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 1808 1812 1825 2220 2225	S = Floating Electrode	Two significant digits and number of zeros	B = ±0.10pF C = ±0.25pF D = ±0.5pF F = ±1% G = ±2% J = ±5% K = ±10% M = ±20%	C = 500 B = 630 D = 1000 F = 1500 G = 2000 Z = 2500 H = 3000	G = C0G	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)
Commercial Grade[1]	
Bulk Bag	Not required (Blank)
7" Reel / Unmarked	TU
13" Reel / Unmarked	7210
Automotive Grade[2]	
7" Reel	AUTO
13" Reel / Unmarked	AUTO7210

[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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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.*

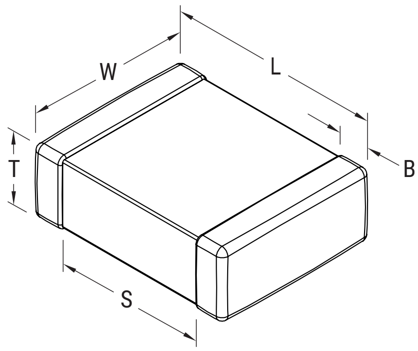
Production Part Approval Process (PPAP)
The purpose of the Production Part Approval Process is:
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements 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			○		

[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)	See Table 2 for Thickness	0.50 (0.02) ±0.25 (0.010)	0.75 (0.030)	Solder Wave or Solder Reflow
1206	3216	3.20 (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
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)		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)		

Table 1A – Capacitance Range/Selection Waterfall (0805 – 1812 Case Sizes)

Capacitance	Capacitance Code	Case Size/ Series					C0805S			C1206S					C1210S					C1808S							C1812S						
		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	H
		Rated Voltage (VDC)					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 Tolerance					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																										
1.0 - 9.1 pF*	109 - 919*	B		C		D	DG	DG	DG											LB	LB	LB	LB	LB	LB	LB							
10 pF - 47pF*	100 - 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	GB	GB	GB	GB	GB	GB	GB
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	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	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
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	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	FM	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	LB	LB	LB	LB	LB	LB	LB	GB	GB	GB	GB	GB	GB	GB
91 pF	910	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	GD	GD	GD	GD	GD	GD	GD
100 pF	101	F	G	J	K	M	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	F	G	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	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	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
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	GM
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	271	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
300 pF	301	F	G	J	K	M				ED	ED	EF	EG		FG	FG	FG	FK	FK	LA	LA	LA	LB	LC	LC		GB	GB	GB	GB	GB	GH	GO
330 pF	331	F	G	J	K	M				ED	ED	EF	EG		FG	FG	FG	FK	FK	LA	LA	LA	LB	LC	LC		GB	GB	GB	GB	GB	GH	GO
360 pF	361	F	G	J	K	M				ED	ED	EF	EG		FG	FG	FG	FK	FS	LA	LA	LA	LB	LA	LC		GB	GB	GB	GB	GD	GK	GO
390 pF	391	F	G	J	K	M				ED	ED	EF	EG		FG	FG	FG	FK	FS	LA	LA	LA	LB	LA	LC		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	K	M				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	M				ED	ED	EG	EG		FM	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		FM	FM	FM	FS	FS	LB	LB	LB	LC	LB			GB	GB	GB	GD	GH	GM	
620 pF	621	F	G	J	K	M				EG	EG	EG			FM	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	F	G	J	K	M				EG	EG	EG			FM	FM	FM	FS		LB	LB	LB	LB				GB	GB	GB	GD	GK		
910 pF	911	F	G	J	K	M				EG	EG	EG			FM	FM	FM	FS		LB	LB	LB	LB				GB	GB	GB	GH	GM		
1,000 pF	102	F	G	J	K	M				EG	EG	EG			FM	FM	FM	FS		LB	LB	LB	LB				GB	GB	GB	GH	GM		
1,100 pF	112	F	G	J	K	M									FK	FK	FK	FS		LC	LC	LC	LC				GB	GB	GB	GH	GO		
1,200 pF	122	F	G	J	K	M									FK	FK	FK	FS		LC	LC	LC	LC				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	K	M									FS	FS	FS			LC	LC	LC	LC				GB	GB	GB	GH	GO		
1,600 pF	162	F	G	J	K	M									FS	FS	FS			LC	LC	LC					GD	GD	GD	GM			
1,800 pF	182	F	G	J	K	M									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	F	G	J	K	M									FS	FS	FS			LC	LC	LC					GK	GK	GK	GO			
2,700 pF	272	F	G	J	K	M									FS	FS	FS			LC	LC	LC					GK	GK	GK	GO			
3,000 pF	302	F	G	J	K	M																					GK	GK	GK				
3,300 pF	332	F	G	J	K	M																					GK	GK	GK				
3,600 pF	362	F	G	J	K	M																					GM	GM	GM				
3,900 pF	392	F	G	J	K	M																					GM	GM	GM				
4,300 pF	432	F	G	J	K	M																					GO	GO	GO				
4,700 pF	472	F	G	J	K	M																					GO	GO	GO				
5,100 pF	512	F	G	J	K	M																					GO	GO	GO				
5,600 pF	562	F	G	J	K	M																					GO	GO	GO				
Capacitance	Capacitance Code	Rated Voltage (VDC)					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
		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	H
		Case Size/Series					C0805S			C1206S					C1210S					C1808S							C1812S						

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

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

Capacitance	Cap Code	Case Size/ Series					C1825S							C2220S							C2225S						
		Voltage Code					C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		Rated Voltage (VDC)					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 Tolerance					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																				
10 pF - 47pF*	100 - 470*	F	G	J	K	M	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	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	G	J	K	M	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	G	J	K	M	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	G	J	K	M	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	G	J	K	M	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	G	J	K	M	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	G	J	K	M	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	G	J	K	M	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	G	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	F	G	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	F	G	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	F	G	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	F	G	J	K	M	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	G	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	F	G	J	K	M	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	K	M	HE	HE	HE	HE	HE	HE	HG	JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
220 pF	221	F	G	J	K	M	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	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	HK	JE	JE	JE	JK	JK	JK	JL	KF	KF	KF	KF	KE	KF	KH
Capacitance	Cap Code	Rated Voltage (VDC)					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
		Voltage Code					C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		Case Size/ Series					C1825S							C2220S							C2225S						

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

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

Capacitance	Cap Code	Case Size/ Series					C1825S							C2220S							C2225S						
		Voltage Code					C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		Rated Voltage (VDC)					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 Tolerance					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																				
750 pF	751	F	G	J	K	M	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	K	M	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	M	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	M	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	M	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	K	M	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	K	M	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	M	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	M	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	M	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	M	HG	HG	HG	HE	HJ			JK	JK	JK	JE	JK			KE	KE	KE	KF	KF	KJ	
2,200 pF	222	F	G	J	K	M	HG	HG	HG	HE	HJ			JK	JK	JK	JE	JK			KE	KE	KE	KF	KF	KJ	
2,400 pF	242	F	G	J	K	M	HG	HG	HG	HE	HK			JK	JK	JK	JE	JL			KE	KE	KE	KE	KH		
2,700 pF	272	F	G	J	K	M	HG	HG	HG	HE	HK			JK	JK	JK	JE	JL			KE	KE	KE	KE	KH		
3,000 pF	302	F	G	J	K	M	HG	HG	HG	HG	HK			JK	JK	JK	JK	JN			KE	KE	KE	KE	KJ		
3,300 pF	332	F	G	J	K	M	HG	HG	HG	HG	HK			JK	JK	JK	JK	JN			KE	KE	KE	KE	KJ		
3,600 pF	362	F	G	J	K	M	HG	HG	HG	HJ				JK	JK	JK	JK	JN			KF	KF	KF	KF	KJ		
3,900 pF	392	F	G	J	K	M	HG	HG	HG	HJ				JK	JK	JK	JK	JN			KF	KF	KF	KF	KJ		
4,300 pF	432	F	G	J	K	M	HG	HG	HG	HJ				JK	JK	JK	JL				KF	KF	KF	KH			
4,700 pF	472	F	G	J	K	M	HG	HG	HG	HJ				JK	JK	JK	JL				KF	KF	KF	KH			
5,100 pF	512	F	G	J	K	M	HG	HG	HG	HK				JK	JK	JK	JN				KF	KF	KF	KH			
5,600 pF	562	F	G	J	K	M	HG	HG	HG	HK				JK	JK	JK	JN				KF	KF	KF	KH			
6,200pF	622	F	G	J	K	M	HJ	HJ	HJ					JK	JK	JK	JN				KF	KF	KF	KJ			
6,800pF	682	F	G	J	K	M	HJ	HJ	HJ					JK	JK	JK	JN				KF	KF	KF	KJ			
7,500pF	752	F	G	J	K	M	HJ	HJ	HJ					JL	JL	JL					KF	KF	KF				
8,200 pF	822	F	G	J	K	M	HJ	HJ	HJ					JL	JL	JL					KF	KF	KF				
9,100 pF	912	F	G	J	K	M	HK	HK	HK					JL	JL	JL					KH	KH	KH				
10,000 pF	103	F	G	J	K	M	HK	HK	HK					JL	JL	JL					KH	KH	KH				
12,000 pF	123	F	G	J	K	M								JN	JN	JN					KH	KH	KH				
15,000 pF	153	F	G	J	K	M															KJ	KJ	KJ				
Capacitance	Cap Code	Rated Voltage (VDC)					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
		Voltage Code					C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		Case Size/ Series					C1825S							C2220S							C2225S						

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

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

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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	1206	1.00 ± 0.20	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
EU	1206	1.60 ± 0.25	0	0	2,000	8,000
FG	1210	1.25 ± 0.15	0	0	2,500	10,000
FL	1210	1.40 ± 0.15	0	0	2,000	8,000
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
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
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	2225	2.00 ± 0.20	0	0	500	2,000
KJ	2225	2.50 ± 0.20	0	0	500	2,000
Thickness Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[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

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		**Packaging Quantities (pieces/unit packaging)**	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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.*

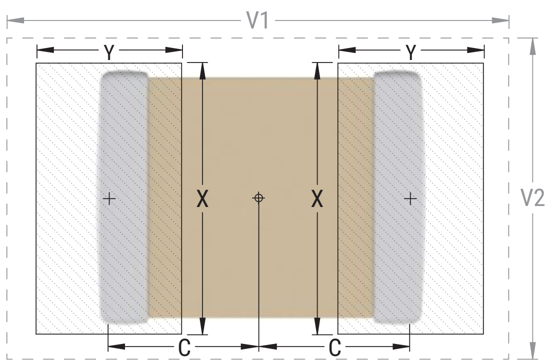
[2] *A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard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

Table 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)				
		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	
	SnPb	100% Matte Sn
Preheat/Soak Temperature Minimum (T_{Smin}) Temperature Maximum (T_{Smax}) Time (t_S) from T_{Smin} to T_{Smax}	 100°C 150°C 60 – 120 seconds	 150°C 200°C 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.

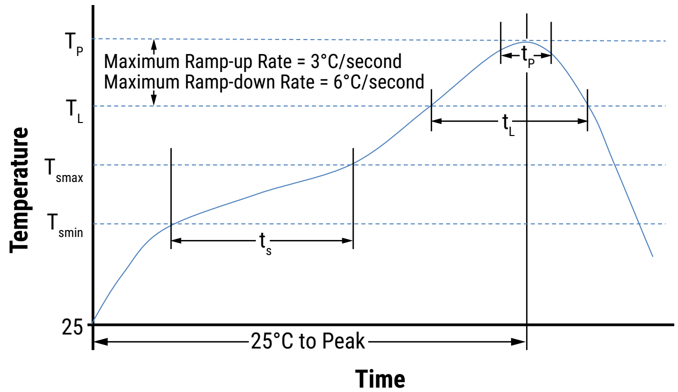


Table 4 – Performance & Reliability: Test Methods and Conditions

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

TCC test steps:

Step	Temperature (°C)
1	+25°C
2	−55°C
3	+25°C (Reference Temperature)
4	+125°C

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

<table>
<tr><th>Stress</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Dielectric Withstanding Voltage (DWV)</td><td>KEMET Internal</td><td>See Dielectric Withstanding Voltage (DWV) Table
(5 ±1 seconds and charge/discharge not exceeding 50 mA)
<table>
<tr><th>EIA Case Size</th><th>500 V</th><th>630 V</th><th>≥ 1,000 V</th></tr>
<tr><td>0603</td><td rowspan="9">150% of rated voltage</td><td>130% of rated voltage</td><td rowspan="9">120% of rated voltage</td></tr>
<tr><td>0805</td><td>< 620pF 150% of rated voltage
≥ 620pF 130% of rated voltage</td></tr>
<tr><td>1206</td><td>< 5.1nF 150% of rated voltage
≥ 5.1nF 130% of rated voltage</td></tr>
<tr><td>1210</td><td>< 7.5nF 150% of rated voltage
≥ 7.5nF 130% of rated voltage</td></tr>
<tr><td>1808</td><td>< 5.1nF 150% of rated voltage
≥ 5.1nF 130% of rated voltage</td></tr>
<tr><td>1812</td><td>< 12nF 150% of rated voltage
≥ 12nF 130% of rated voltage</td></tr>
<tr><td>1825</td><td>< 22nF 150% of rated voltage
≥ 22nF 130% of rated voltage</td></tr>
<tr><td>2220</td><td>< 27nF 150% of rated voltage
≥ 27nF 130% of rated voltage</td></tr>
<tr><td>2225</td><td>< 33nF 150% of rated voltage
≥ 33nF 130% of rated voltage</td></tr>
</table></td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit

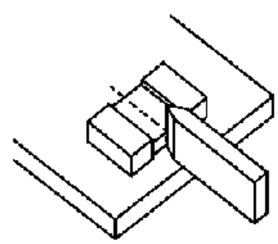
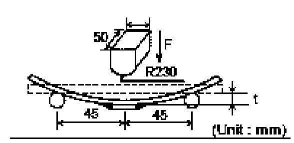
Withstand test voltage without insulation breakdown or damage.</td></tr>
<tr><td>Aging Rate (Maximum % Capacitance Loss/Decade Hour)</td><td>KEMET Internal</td><td>Maximum % capacitance loss/decade hour</td><td>0% Loss/Decade Hour</td></tr>
<tr><td>Terminal Strength</td><td>KEMET Internal</td><td>Shear stress test per specific case size,
Time: 60 ±1 second.
<table>
<tr><th>Case Size</th><th>Force</th></tr>
<tr><td>0603</td><td>5N</td></tr>
<tr><td>0805</td><td>9N</td></tr>
<tr><td>≥ 1206</td><td>18N</td></tr>
</table>
</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Board Flex</td><td>AEC-Q200-005</td><td>Standard Termination
System 2.0 mm
Flexible Termination
System 3.0 mm
Test Time: 60± 5 seconds
Ramp Time: 1 mm/second

</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Solderability</td><td>J-STD-002</td><td>Condition: 4 hours ±15 minutes at
155°C dry bake apply all methods
Test 245 ±5°C (SnPb & Pb-Free)</td><td>Visual Inspection.
95% coverage on termination.
No leaching</td></tr>
<tr><td>Temperature Cycling</td><td>JESD22
Method JA-104</td><td>1,000 cycles (−55°C to +125°C)
2 - 3 cycles per hour
Soak Time: 1 or 5 minute</td><td>Measurement at 24 hours ±4 hours after test conclusion.
Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit</td></tr>
</table>

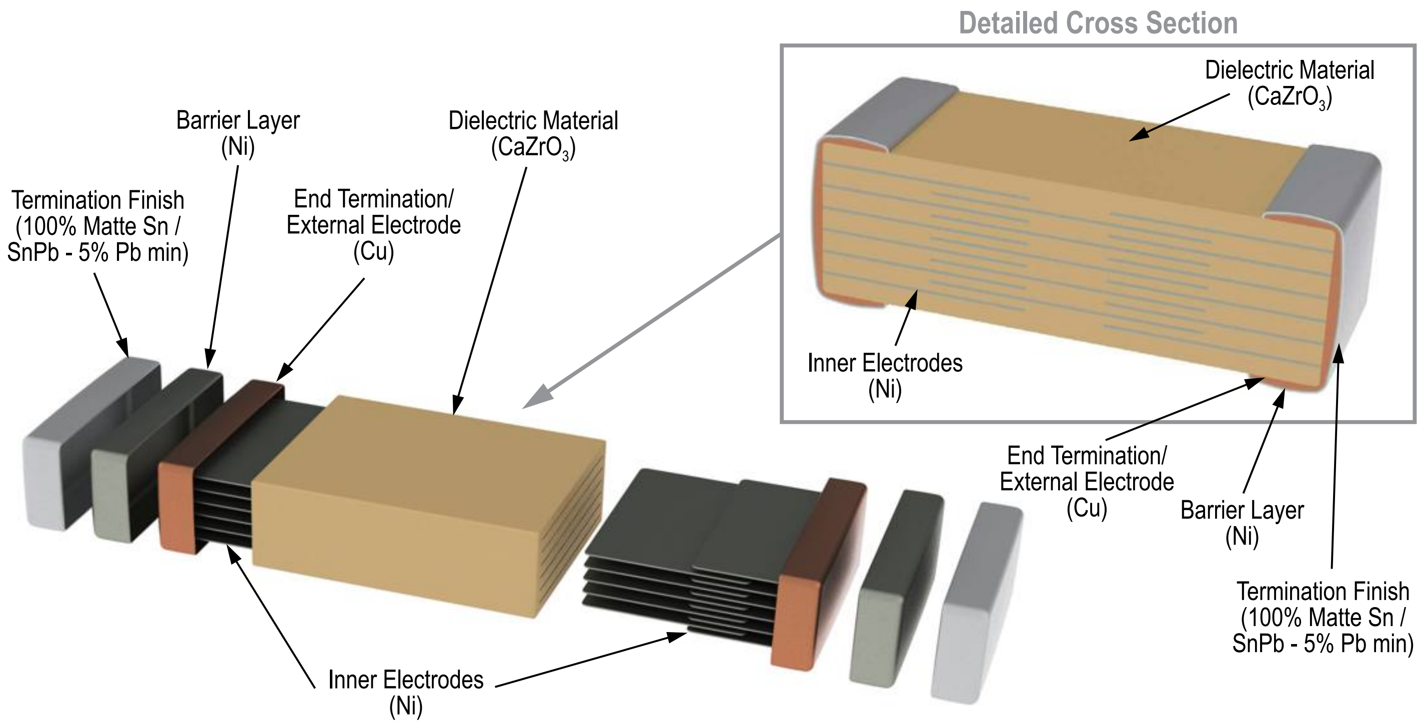
Table 4 – Performance & Reliability: Test Methods and Conditions cont.

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 Method 108	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 IR: 10% of Initial Limit DF Limits Maximum: 0.5%
Storage Life		1,000 hours at 150°C, Unpowered	
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 40ºC 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)

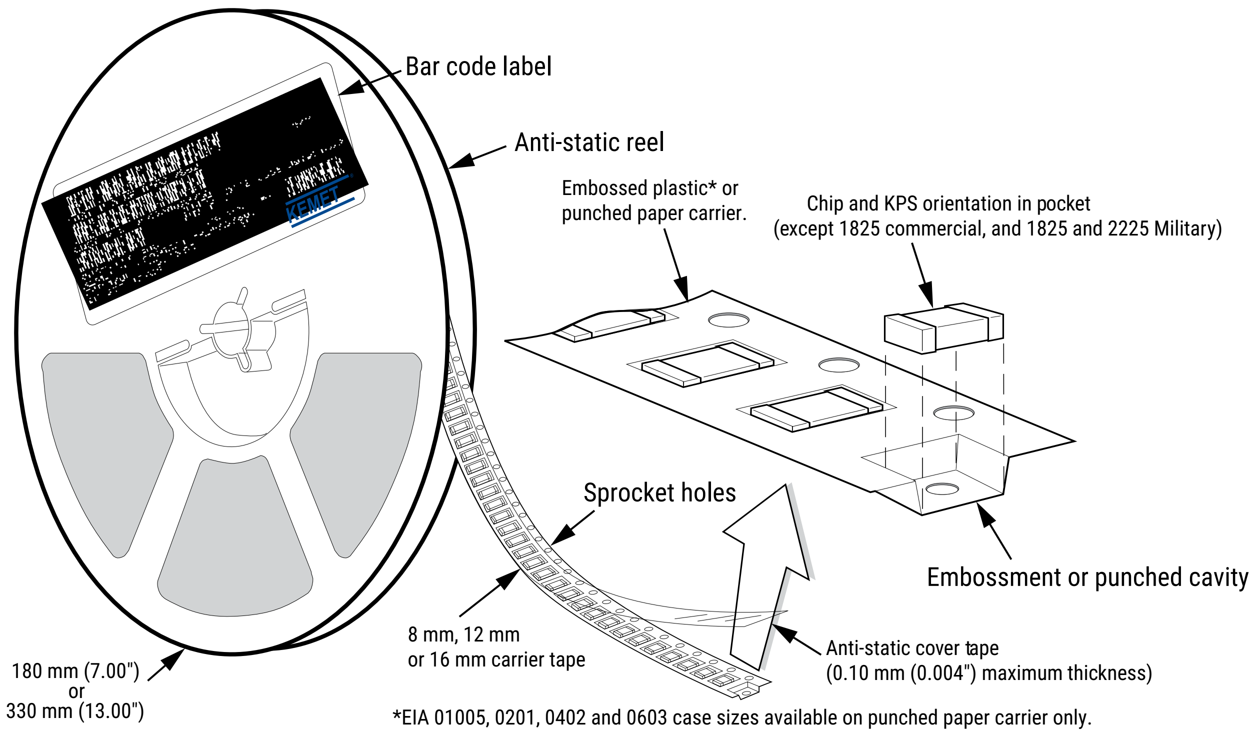
Laser marking option is not available on:

- C0G, 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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

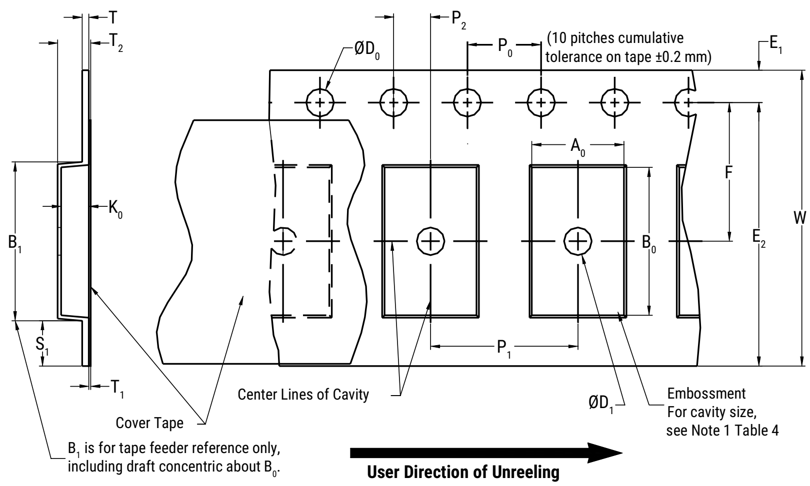


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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 (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)	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 S_1 < 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_0, B_0 and K_0 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

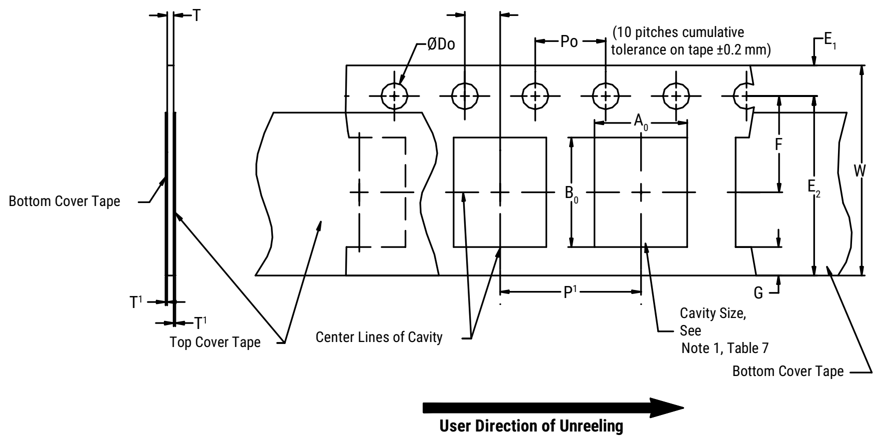


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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

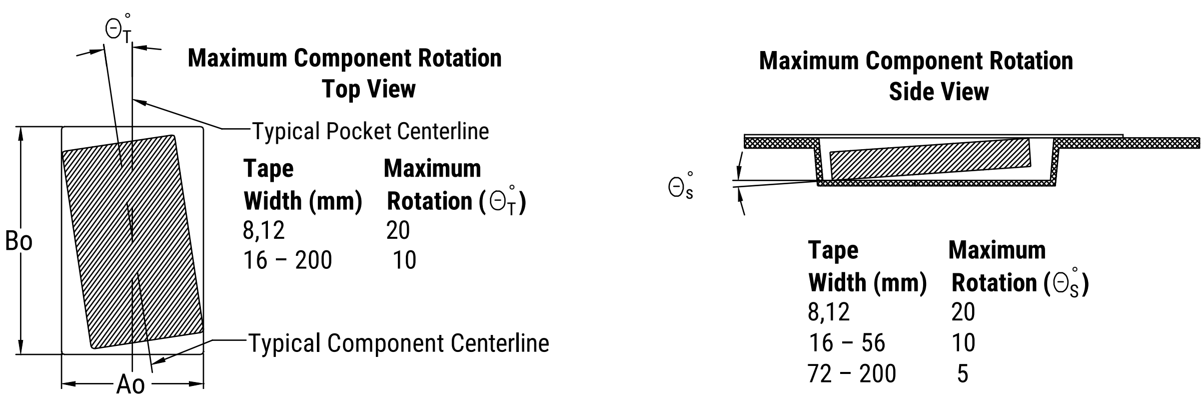


Figure 4 – Maximum Lateral Movement

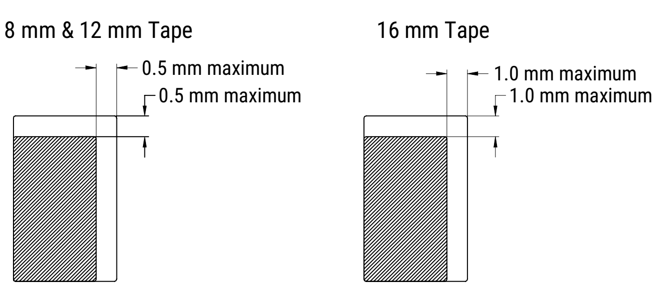


Figure 5 – Bending Radius

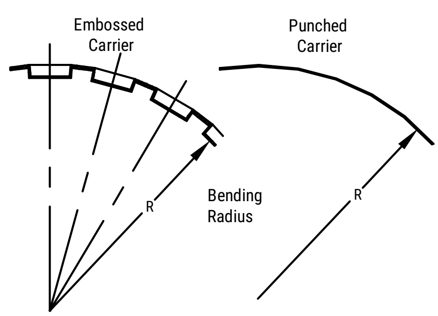
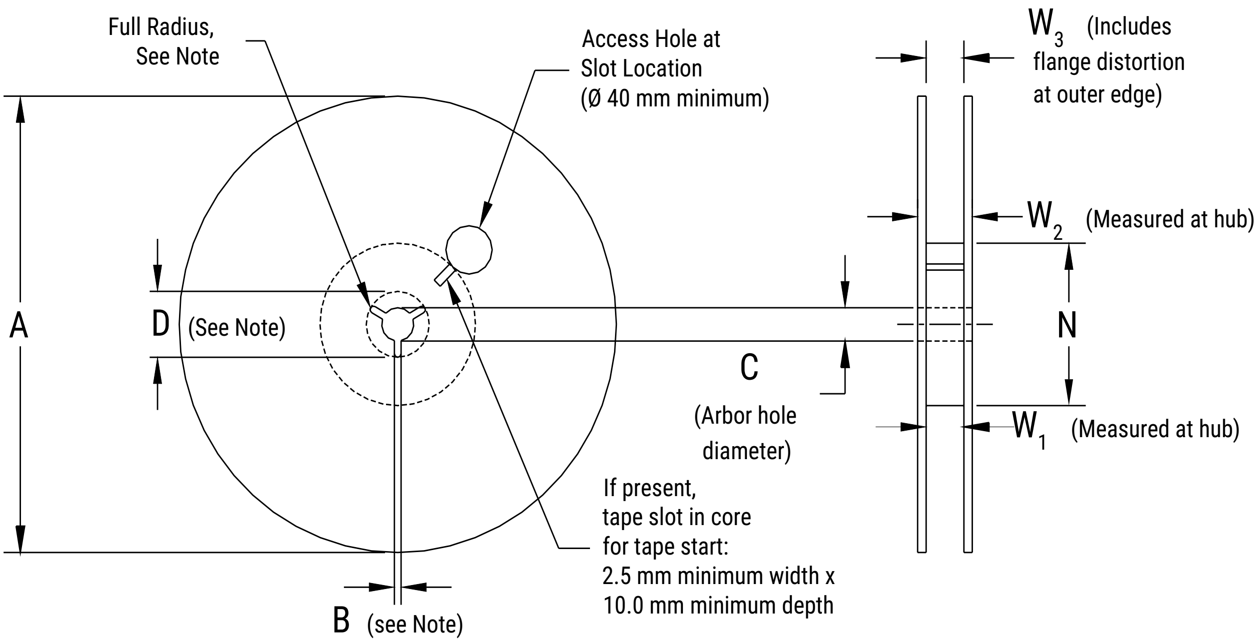


Figure 6 – Reel Dimensions



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	A	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

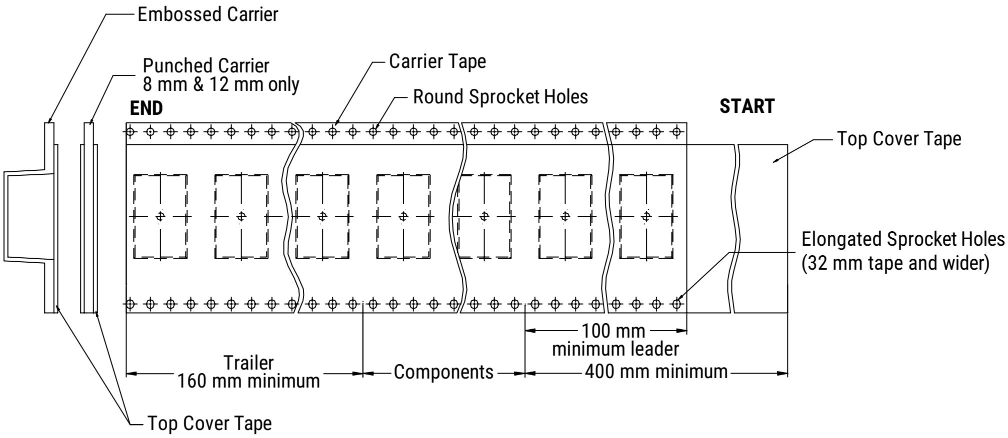
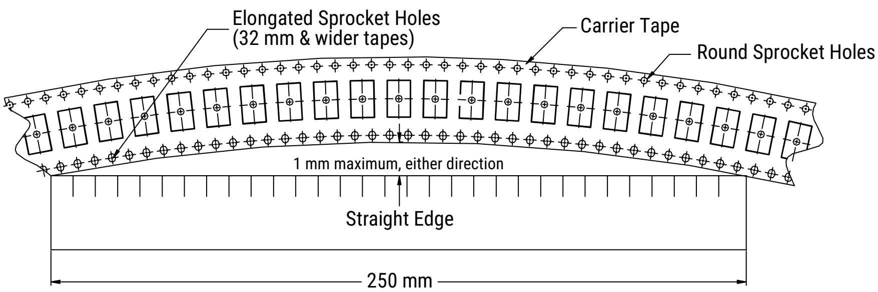


Figure 8 – Maximum Camber



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

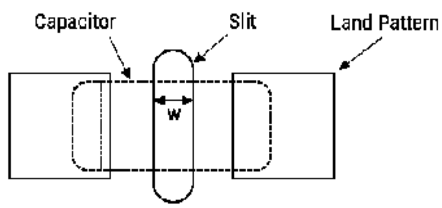
For MLCC ratings ≥1500V, it is recommended to apply a conformal coating to MLCC to prevent surface arcing. To reduce possibility of inducing cracks in the MLCC, select a coating with thermal expansions close to that of the MLCC.

Dielectric	CTE (ppm/°C)
Class II $BaTiO_3$	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.



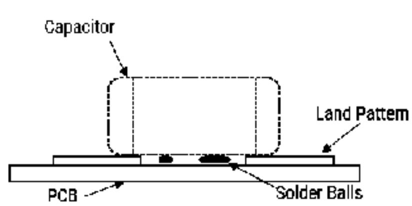
Solder Resist

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.



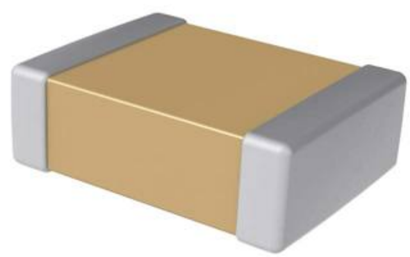
Floating Electrode (FF-CAP), High Voltage with Flexible Termination C0G Dielectric, 500 – 3,000 VDC (Commercial & Automotive Grade)

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 C0G (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/ºC 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

C	2225	Y	393	J	C	G	A	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 1808 1812 1825 2220 2225	Y = Floating Electrode with Flexible Termination	Two significant digits and number of zeros	B = ±0.10 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 = C0G	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)
Commercial Grade[1]	
Bulk Bag	Not required (Blank)
7" Reel / Unmarked	TU
13" Reel / Unmarked	7210
Automotive Grade[2]	
7" Reel	AUTO
13" Reel / Unmarked	AUTO7210

[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 C-Spec	Customer Notification Due To:		Days Prior To Implementation
	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.*

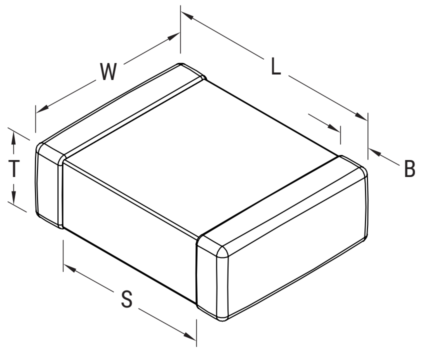
Production Part Approval Process (PPAP)
The purpose of the Production Part Approval Process is:
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements 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			○		

[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)	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	
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)		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)		
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)		

Table 1A – Capacitance Range/Selection Waterfall (0805 – 1808 Case Sizes)

Capacitance	Capacitance Code	Case Size/ Series					C0805Y			C1206Y					C1210Y					C1808Y						
		Voltage Code					C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		Rated Voltage (VDC)					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 Tolerance					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																			
1.0 - 9.1 pF*	109 - 169*	B		C		D	DG	DG	DG											LB	LB	LB	LB	LB	LB	LB
10 pF	100	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
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	LB
12 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
13 pF	130	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	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	M	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	240	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
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	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	M	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
47 pF	470	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
51 pF	510	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
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	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	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	FM	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	
Capacitance	Capacitance Code	Rated Voltage (VDC)					500	630	1,000	500	630	1,000	1,500	2,000	500	630	1000	1500	2000	500	630	1000	1500	2000	2500	3000
		Voltage Code					C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		Case Size/Series					C0805Y			C1206Y					C1210Y					C1808Y						

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

Table 1A – Capacitance Range/Selection Waterfall (0805 – 1808 Case Sizes) cont.

Capacitance	Capacitance Code	Case Size/ Series					C0805Y			C1206Y					C1210Y					C1808Y						
		Voltage Code					C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		Rated Voltage (VDC)					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 Tolerance					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																			
270 pF	271	F	G	J	K	M	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		FZ	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	M				EU	EU	EU			FM	FM	FM	FS	FS	LB	LB	LB	LA	LC		
680 pF	681	F	G	J	K	M				EU	EU	EU			FM	FM	FM	FS	FS	LB	LB	LB	LA	LC		
750 pF	751	F	G	J	K	M				EU	EU	EU			FM	FM	FM	FS		LB	LB	LB	LB			
820 pF	821	F	G	J	K	M				EU	EU	EU			FM	FM	FM	FS		LB	LB	LB	LB			
910 pF	911	F	G	J	K	M				EU	EU	EU			FM	FM	FM	FS		LB	LB	LB	LB			
1,000 pF	102	F	G	J	K	M				EU	EU	EU			FM	FM	FM	FS		LB	LB	LB	LB			
1,100 pF	112	F	G	J	K	M									FK	FK	FK	FS		LC	LC	LC	LC			
1,200 pF	122	F	G	J	K	M									FK	FK	FK	FS		LC	LC	LC	LC			
1,300 pF	132	F	G	J	K	M									FS	FS	FS			LC	LC	LC	LC			
1,500 pF	152	F	G	J	K	M									FS	FS	FS			LC	LC	LC	LC			
1,600 pF	162	F	G	J	K	M									FS	FS	FS			LC	LC	LC				
1,800 pF	182	F	G	J	K	M									FS	FS	FS			LC	LC	LC				
2,000 pF	202	F	G	J	K	M									FS	FS	FS			LB	LB	LB				
2,200 pF	222	F	G	J	K	M									FS	FS	FS			LB	LB	LB				
2,400 pF	242	F	G	J	K	M									FS	FS	FS			LC	LC	LC				
2,700 pF	272	F	G	J	K	M									FS	FS	FS			LC	LC	LC				
Capacitance	Capacitance Code	Rated Voltage (VDC)					500	630	1,000	500	630	1,000	1,500	2,000	500	630	1000	1500	2000	500	630	1000	1500	2000	2500	3000
		Voltage Code					C	B	D	C	B	D	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		Case Size/Series					C0805Y			C1206Y					C1210Y					C1808Y						

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

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

Capacitance	Capacitance Code	Case Size/ Series					C1812Y							C1825Y							C2220Y							C2225Y						
		Voltage Code					C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		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					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																												
10 pF	100	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
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	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
15 pF	150	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
16 pF	160	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
18 pF	180	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
20 pF	200	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
22 pF	220	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
24 pF	240	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
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	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
36 pF	360	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
39 pF	390	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
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
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
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
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
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
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
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
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
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
110 pF	111	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
120 pF	121	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
130 pF	131	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
150 pF	151	F	G	J	K	M	GK	GK	GK	GK	GK	GK	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	G	J	K	M	GK	GK	GK	GK	GK	GK	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	G	J	K	M	GK	GK	GK	GK	GK	GK	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	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
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	GH	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	GO	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	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	M	GB	GB	GB	GB	GD	GK		HE	HE	HE	HE	HE	HE	HJ	JE	JE	JE	JE	JE	JK	JL	KF	KF	KF	KF	KE	KE	KF
Capacitance	Capacitance 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
		Voltage Code					C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		Case Size/ Series					C1812Y							C1825Y							C2220Y							C2225Y						

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

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

Capacitance	Capacitance Code	Case Size/ Series					C1812Y							C1825Y							C2220Y							C2225Y						
		Voltage Code					C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		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					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																											
470 pF	471	F	G	J	K	M	GB	GB	GB	GB	GD	GK		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	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
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	GO		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	GB	GB	GB	GD	GH	GO		HE	HE	HE	HE	HG	HG	HK	JE	JE	JE	JK	JK	JK	JL	KF	KF	KF	KF	KE	KF	KH
750 pF	751	F	G	J	K	M	GB	GB	GB	GD	GK			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	K	M	GB	GB	GB	GD	GK			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	M	GB	GB	GB	GH	GM			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	M	GB	GB	GB	GH	GM			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	M	GB	GB	GB	GH	GO			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	K	M	GB	GB	GB	GH	GO			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	K	M	GB	GB	GB	GH	GO			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	M	GB	GB	GB	GH	GO			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	M	GD	GD	GD	GM				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	M	GD	GD	GD	GM				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	M	GH	GH	GH	GO				HG	HG	HG	HE	HJ			JK	JK	JK	JE	JK			KE	KE	KE	KF	KF	KJ	
2,200 pF	222	F	G	J	K	M	GH	GH	GH	GO				HG	HG	HG	HE	HJ			JK	JK	JK	JE	JK			KE	KE	KE	KF	KF	KJ	
2,400 pF	242	F	G	J	K	M	GK	GK	GK	GO				HG	HG	HG	HE	HK			JK	JK	JK	JE	JL			KE	KE	KE	KE	KH		
2,700 pF	272	F	G	J	K	M	GK	GK	GK	GO				HG	HG	HG	HE	HK			JK	JK	JK	JE	JL			KE	KE	KE	KE	KH		
3,000 pF	302	F	G	J	K	M	GK	GK	GK					HG	HG	HG	HG	HK			JK	JK	JK	JK	JN			KE	KE	KE	KE	KJ		
3,300 pF	332	F	G	J	K	M	GK	GK	GK					HG	HG	HG	HG	HK			JK	JK	JK	JK	JN			KE	KE	KE	KE	KJ		
3,600 pF	362	F	G	J	K	M	GM	GM	GM					HG	HG	HG	HJ				JK	JK	JK	JK	JN			KF	KF	KF	KF	KJ		
3,900 pF	392	F	G	J	K	M	GM	GM	GM					HG	HG	HG	HJ				JK	JK	JK	JK	JN			KF	KF	KF	KF	KJ		
4,300 pF	432	F	G	J	K	M	GO	GO	GO					HG	HG	HG	HJ				JK	JK	JK	JL				KF	KF	KF	KH			
4,700 pF	472	F	G	J	K	M	GO	GO	GO					HG	HG	HG	HJ				JK	JK	JK	JL				KF	KF	KF	KH			
5,100 pF	512	F	G	J	K	M	GO	GO	GO					HG	HG	HG	HK				JK	JK	JK	JN				KF	KF	KF	KH			
5,600 pF	562	F	G	J	K	M	GO	GO	GO					HG	HG	HG	HK				JK	JK	JK	JN				KF	KF	KF	KH			
6,200 pF	622	F	G	J	K	M								HJ	HJ	HJ					JK	JK	JK	JN				KF	KF	KF	KJ			
6,800 pF	682	F	G	J	K	M								HJ	HJ	HJ					JK	JK	JK	JN				KF	KF	KF	KJ			
7,500 pF	752	F	G	J	K	M								HJ	HJ	HJ					JL	JL	JL					KF	KF	KF				
8,200 pF	822	F	G	J	K	M								HJ	HJ	HJ					JL	JL	JL					KF	KF	KF				
9,100 pF	912	F	G	J	K	M								HK	HK	HK					JL	JL	JL					KH	KH	KH				
10,000 pF	103	F	G	J	K	M								HK	HK	HK					JL	JL	JL					KH	KH	KH				
12,000 pF	123	F	G	J	K	M															JN	JN	JN					KH	KH	KH				
15,000 pF	153	F	G	J	K	M																						KJ	KJ	KJ				
Capacitance	Capacitance 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
		Voltage Code					C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H	C	B	D	F	G	Z	H
		Case Size/ Series					C1812Y							C1825Y							C2220Y							C2225Y						

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

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			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 Code	Case Size[1]	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[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

Packaging Type		Loose Packaging	
		Bulk Bag (default)	
Packaging C-Spec[1]		N/A[2]	
Case Size		Packaging Quantities (pieces/unit packaging)	
EIA (in)	Metric (mm)	Minimum	Maximum
0402	1005	1	50,000
0603	1608		
0805	2012		
1206	3216		
1210	3225		
1808	4520		20,000
1812	4532		
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.*

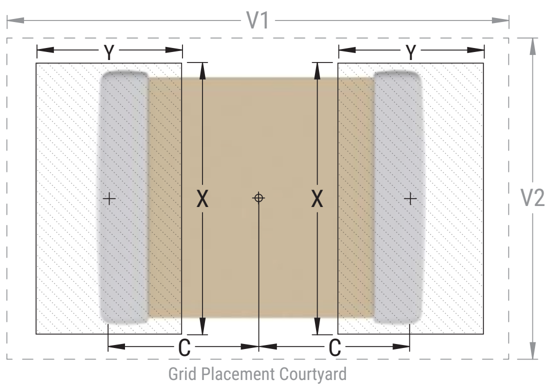
[2] *A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard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

Table 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)				
		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	Termination Finish	
	SnPb	100% Matte Sn
Preheat/Soak Temperature Minimum (T_{Smin}) Temperature Maximum (T_{Smax}) Time (t_S) from T_{Smin} to T_{Smax}	 100°C 150°C 60 – 120 seconds	 150°C 200°C 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.

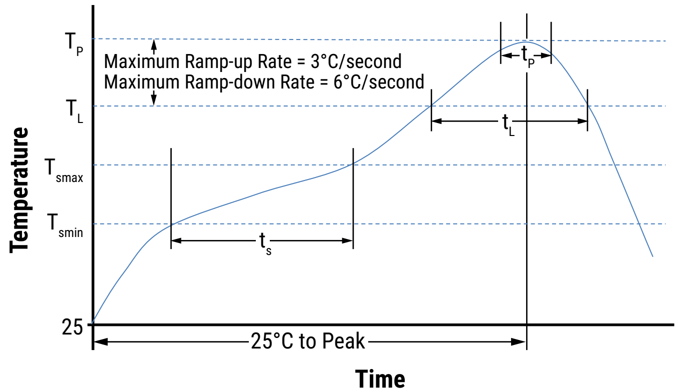


Table 4 – Performance & Reliability: Test Methods and Conditions

<table>
<tr><th>Stress</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Visual and Mechanical</td><td>KEMET Internal</td><td>No defects that may affect performance (10X)</td><td>Dimensions according KEMET Spec Sheet</td></tr>
<tr><td>Capacitance (Cap)</td><td>KEMET Internal</td><td>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</td><td>Within Tolerance</td></tr>
<tr><td>Dissipation Factor (DF)</td><td>KEMET Internal</td><td>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</td><td>Within Specification
Dissipation factor (DF) maximum limit at 25°C = 0.1%</td></tr>
<tr><td>Insulation Resistance (IR)</td><td>KEMET Internal</td><td>500 VDC applied for 120 ±5 seconds at 25°C</td><td>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.</td></tr>
<tr><td>Temperature Coefficient of Capacitance (TCC)</td><td>KEMET Internal</td><td>Capacitance change with reference to +25°C and 0 VDC applied.

* See part number specification sheet for voltage

<table><tr><th>Step</th><th>Temperature (°C)</th></tr><tr><td>1</td><td>+25°C</td></tr><tr><td>2</td><td>−55°C</td></tr><tr><td>3</td><td>+25°C (Reference Temperature)</td></tr><tr><td>4</td><td>+125°C</td></tr></table></td><td>Within Specification: ±30 ppm / °C</td></tr>
</table>

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

<table>
<tr><th>Stress</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Dielectric Withstanding Voltage (DWV)</td><td>KEMET Internal</td><td>See Dielectric Withstanding Voltage (DWV) Table
(5 ±1 seconds and charge/discharge not exceeding 50 mA)
<table>
<tr><th>EIA Case Size</th><th>500 V</th><th>630 V</th><th>≥ 1,000 V</th></tr>
<tr><td>0603</td><td rowspan="9">150% of rated voltage</td><td>130% of rated voltage</td><td rowspan="9">120% of rated voltage</td></tr>
<tr><td>0805</td><td>< 620pF 150% of rated voltage
≥ 620pF 130% of rated voltage</td></tr>
<tr><td>1206</td><td>< 5.1nF 150% of rated voltage
≥ 5.1nF 130% of rated voltage</td></tr>
<tr><td>1210</td><td>< 7.5nF 150% of rated voltage
≥ 7.5nF 130% of rated voltage</td></tr>
<tr><td>1808</td><td>< 5.1nF 150% of rated voltage
≥ 5.1nF 130% of rated voltage</td></tr>
<tr><td>1812</td><td>< 12nF 150% of rated voltage
≥ 12nF 130% of rated voltage</td></tr>
<tr><td>1825</td><td>< 22nF 150% of rated voltage
≥ 22nF 130% of rated voltage</td></tr>
<tr><td>2220</td><td>< 27nF 150% of rated voltage
≥ 27nF 130% of rated voltage</td></tr>
<tr><td>2225</td><td>< 33nF 150% of rated voltage
≥ 33nF 130% of rated voltage</td></tr>
</table></td><td>Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit

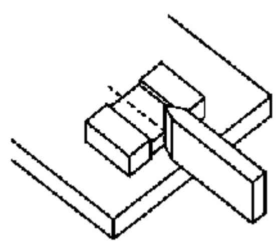
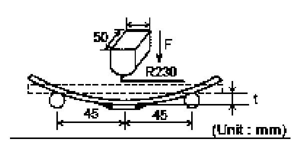
Withstand test voltage without insulation breakdown or damage.</td></tr>
<tr><td>Aging Rate (Maximum % Capacitance Loss/Decade Hour)</td><td>KEMET Internal</td><td>Maximum % capacitance loss/decade hour</td><td>0% Loss/Decade Hour</td></tr>
<tr><td>Terminal Strength</td><td>KEMET Internal</td><td>Shear stress test per specific case size,
Time: 60 ±1 second.
<table>
<tr><th>Case Size</th><th>Force</th></tr>
<tr><td>0603</td><td>5N</td></tr>
<tr><td>0805</td><td>9N</td></tr>
<tr><td>≥ 1206</td><td>18N</td></tr>
</table>
</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Board Flex</td><td>AEC-Q200-005</td><td>Standard Termination
System 2.0 mm
Flexible Termination
System 3.0 mm
Test Time: 60± 5 seconds
Ramp Time: 1 mm/second

</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Solderability</td><td>J-STD-002</td><td>Condition: 4 hours ±15 minutes at
155°C dry bake apply all methods
Test 245 ±5°C (SnPb & Pb-Free)</td><td>Visual Inspection.
95% coverage on termination.
No leaching</td></tr>
<tr><td>Temperature Cycling</td><td>JESD22
Method JA-104</td><td>1,000 cycles (−55°C to +125°C)
2 - 3 cycles per hour
Soak Time: 1 or 5 minute</td><td>Measurement at 24 hours ±4 hours after test conclusion.
Cap: Initial Limit
DF: Initial Limit
IR: Initial Limit</td></tr>
</table>

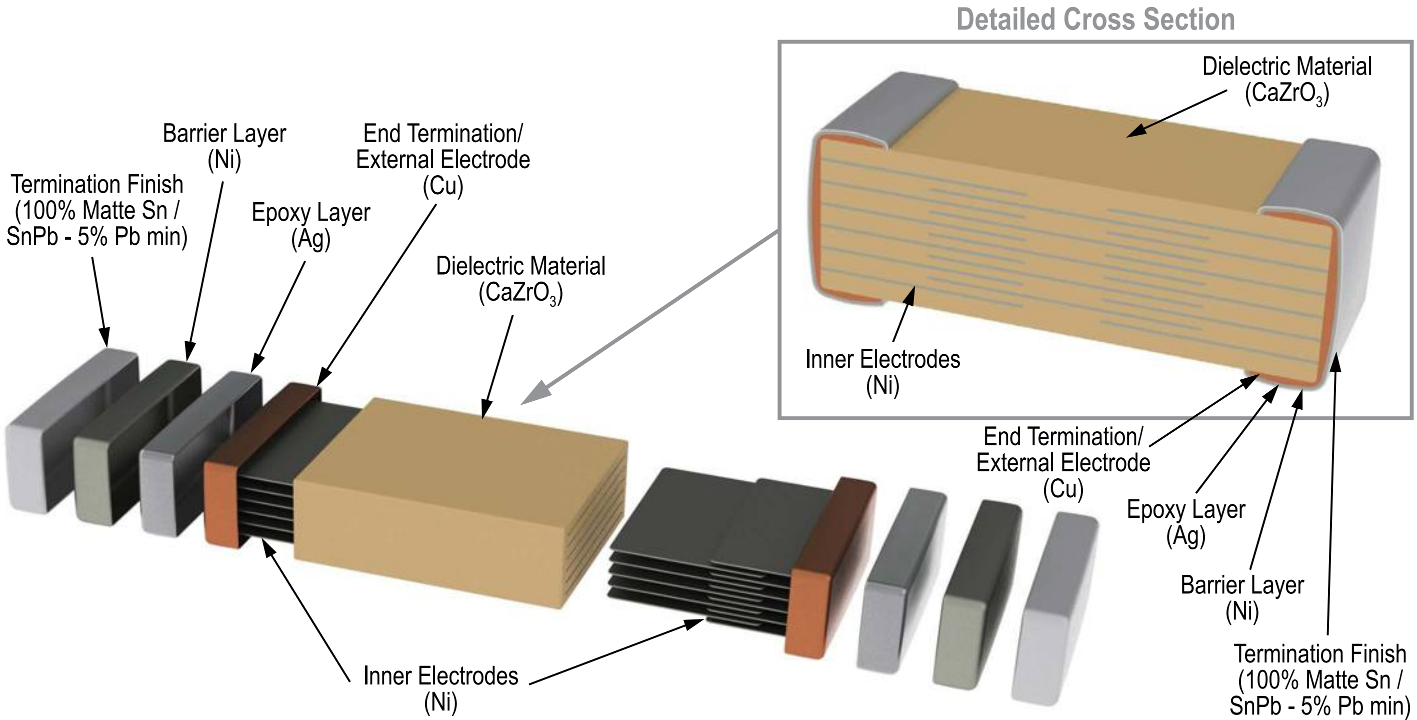
Table 4 – Performance & Reliability: Test Methods and Conditions cont.

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 Method 108	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 IR: 10% of Initial Limit DF Limits Maximum: 0.5%
Storage Life		1,000 hours at 150°C, Unpowered	
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 40ºC 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)

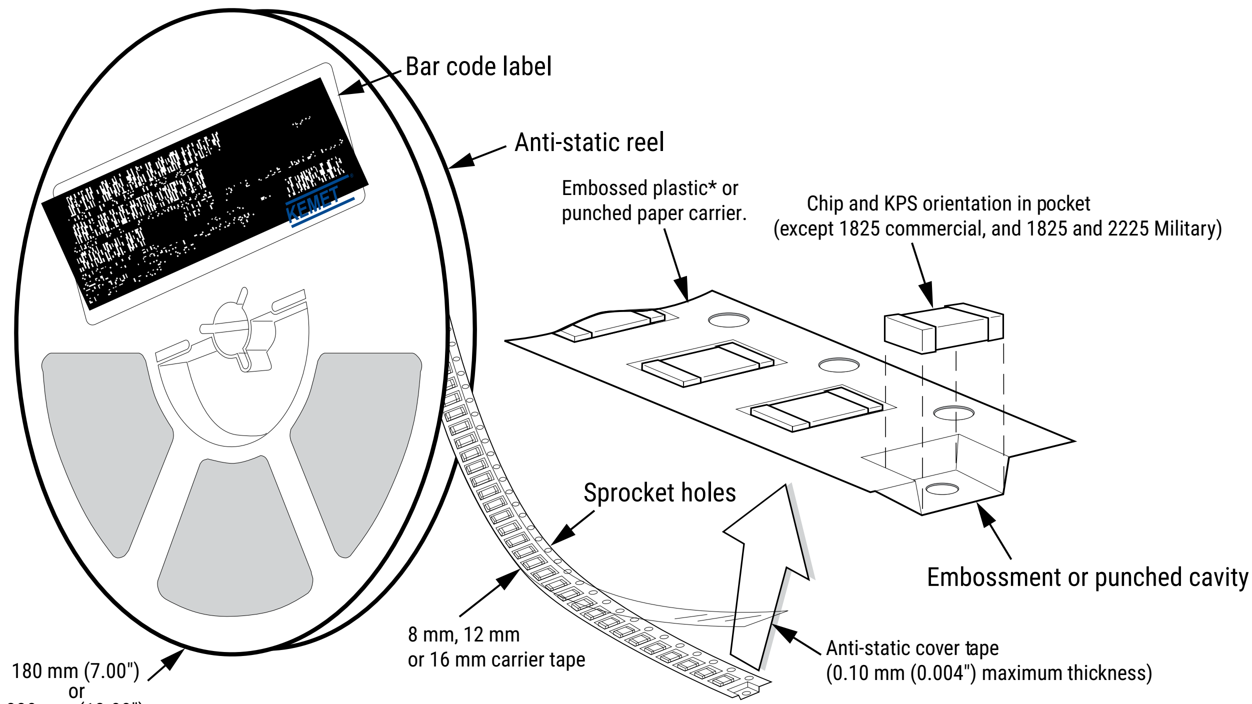
Laser marking option is not available on:

- C0G, 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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

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

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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

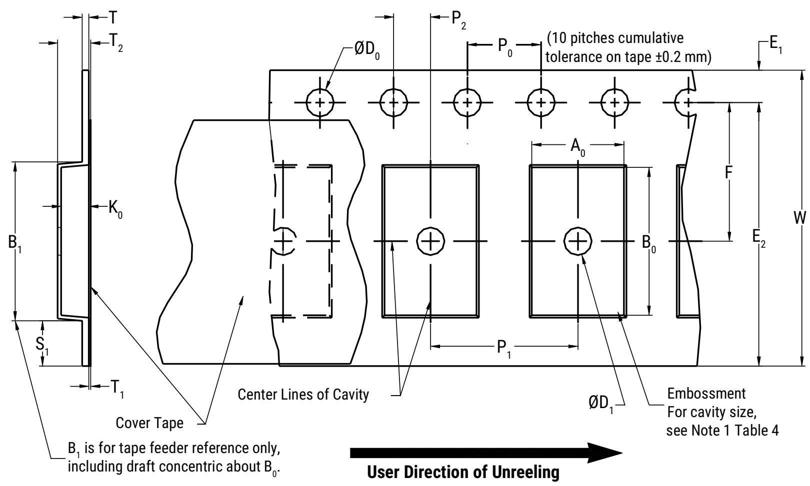


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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	1.5 +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)			
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)	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 S_1 < 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_0, B_0 and K_0 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

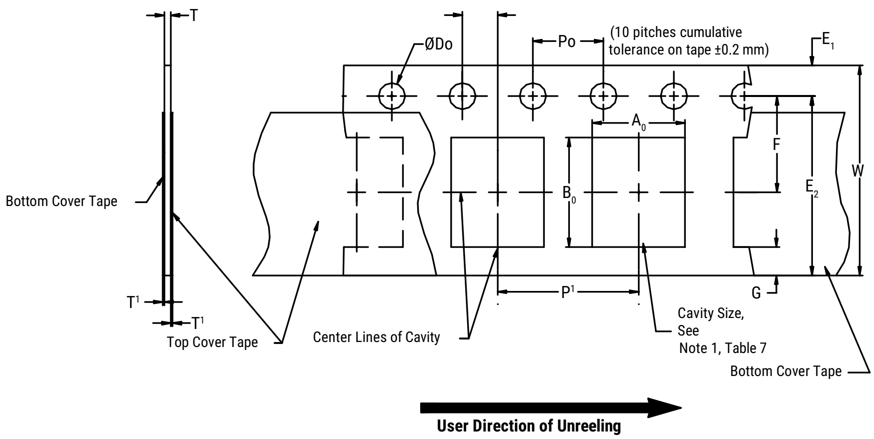


Table 7 – Punched (Paper) Carrier Tape Dimensions

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 (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_0, B_0 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

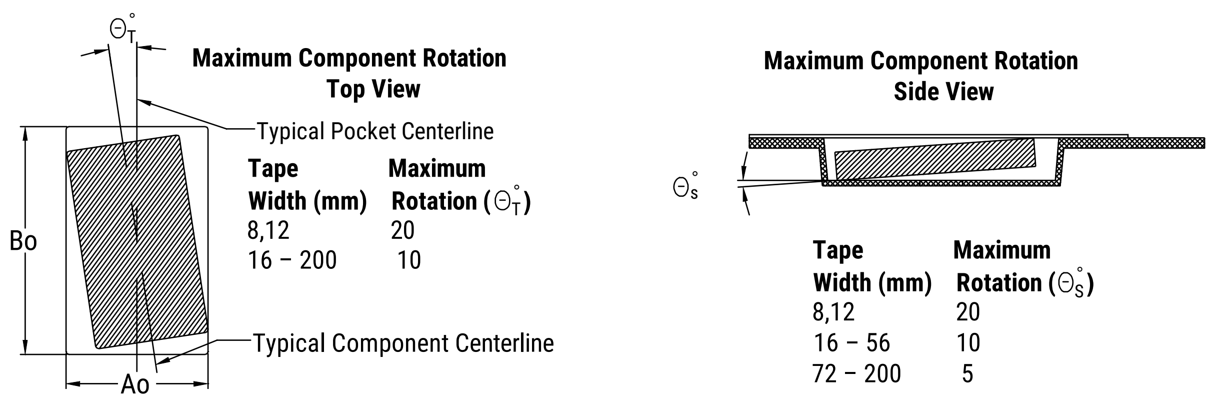


Figure 4 – Maximum Lateral Movement

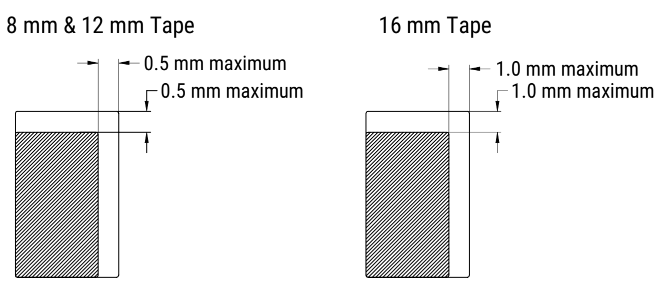


Figure 5 – Bending Radius

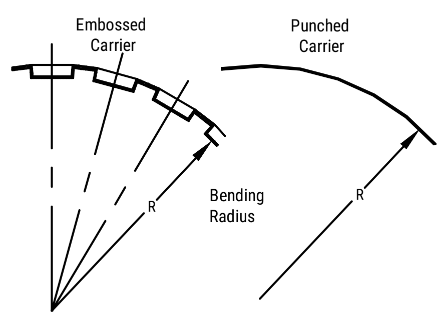
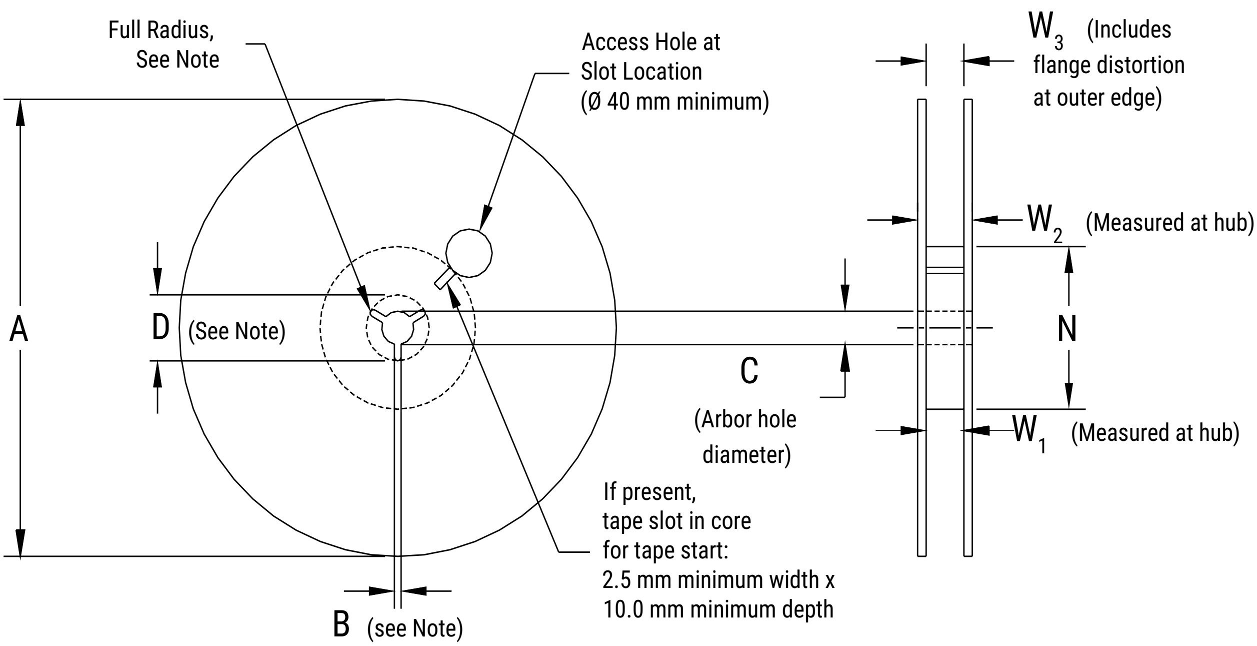


Figure 6 – Reel Dimensions



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	A	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

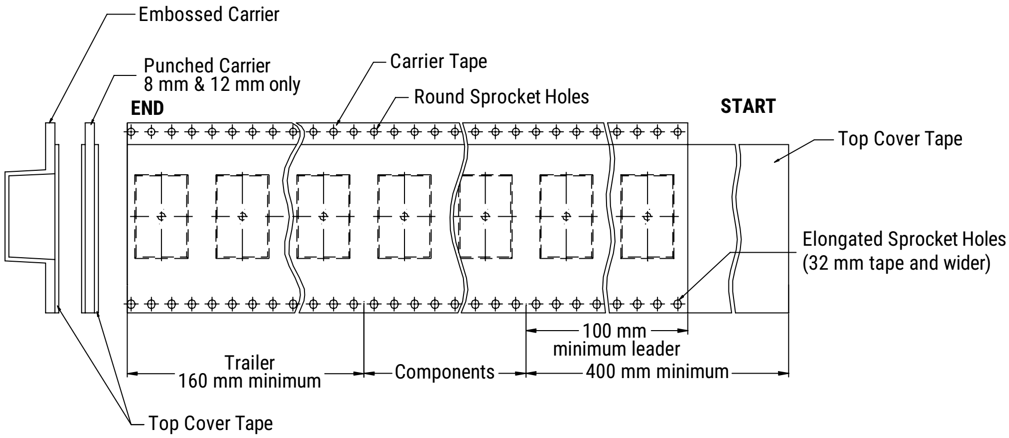
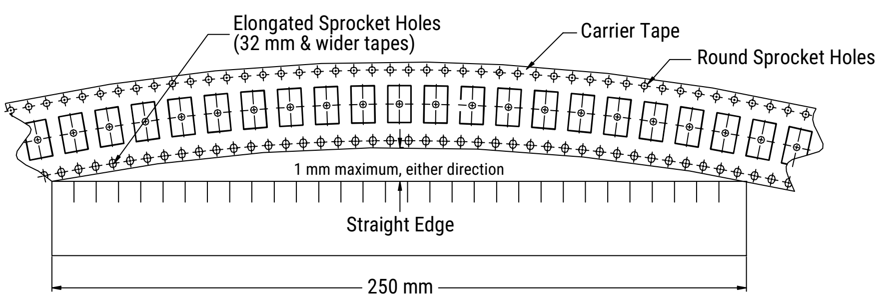


Figure 8 – Maximum Camber



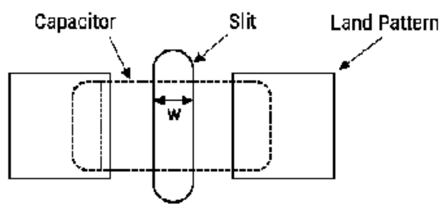
Application Guide

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 ≥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.

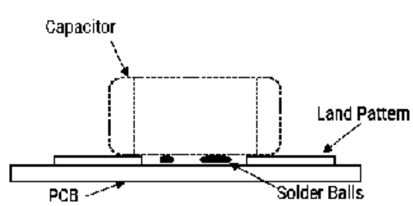
Dielectric	CTE (ppm/°C)
Class II $BaTiO_3$	10.7
Class I $CaZrO_3$	9.8

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.

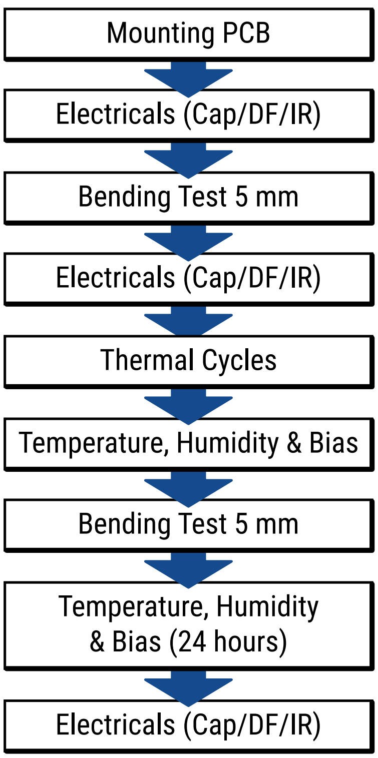


Surface Mount Multilayer Ceramic Capacitors (SMD MLCCs)

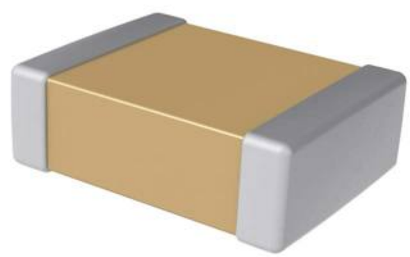
Flexible Termination System (FT-CAP), High Voltage, X7R Dielectric, 500 – 1,000 VDC, VW 80808 Specification

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.



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.



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

Applications

- Direct Battery/Power Circuits
- Filtering (power plane/bus)
- High Voltage Heater
- Inverter, DC/DC
- BMS
- Power Factor Correction

Application Note

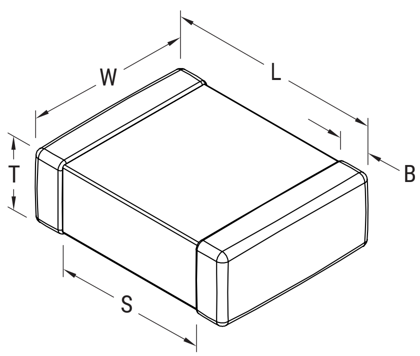
X7R dielectric is not recommended for AC line filtering or pulse applications. These capacitors and/or the assembled circuit board containing these capacitors may require a protective surface coating to prevent external surface arcing.

Ordering Information

C	1210	X	104	K	C	R	A	C	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)



<table>
<tr><th>EIA Size Code</th><th>Metric Size Code</th><th>L
Length</th><th>W
Width</th><th>T
Thickness</th><th>B
Bandwidth</th><th>S
Separation Minimum</th><th>Mounting Technique</th></tr>
<tr><td>0603</td><td>1608</td><td>1.60 (0.063)
±0.17 (0.007)</td><td>0.80 (0.032)
±0.15 (0.006)</td><td rowspan="4">See Table 2 for Thickness</td><td>0.45 (0.018)
±0.15 (0.006)</td><td>0.58 (0.023)</td><td rowspan="3">Solder wave
or
solder reflow</td></tr>
<tr><td>0805</td><td>2012</td><td>2.00 (0.079)
±0.30 (0.012)</td><td>1.25 (0.049)
±0.30 (0.012)</td><td>0.50 (0.02)
±0.25 (0.010)</td><td>0.75 (0.030)</td></tr>
<tr><td>1206</td><td>3216</td><td>3.30 (0.130)
±0.40 (0.016)</td><td>1.60 (0.063)
±0.35 (0.013)</td><td>0.60 (0.024)
±0.25 (0.010)</td><td rowspan="2">N/A</td></tr>
<tr><td>1210</td><td>3225</td><td>3.30 (0.130)
±0.40 (0.016)</td><td>2.60 (0.102)
±0.30 (0.012)</td><td>0.60 (0.024)
±0.25 (0.010)</td><td>Solder reflow only</td></tr>
</table>

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.
[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 ≤ 10 µF
120 Hz ±10 Hz and 0.5 ±0.1 V_{rms} if capacitance > 10 µF
[4] To obtain IR limit, divide MΩ - µF value by the capacitance and compare to GΩ 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
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)

Capacitance (pF)	Cap Code	Case Size/ Series	C0603X		C0805X			C1206X			C1210X		
		Rated Voltage (VDC)	500	630	500	630	1,000	500	630	1,000	500	630	1,000
		Voltage Code	C	B	C	B	D	C	B	D	C	B	D
10 - 20 pF*	100 - 200*	J = ±5% K = ±10% M = ±20%			DG	DG	DG	ES	ES	ES	FM	FM	FM
24 - 68pF	240 - 680*				DG	DG	DG	ES	ES	ES	FM	FM	FM
75 pF	750				DG	DG	DG	EF	EF	EF	FM	FM	FM
82 pF	820				DG	DG	DG	EF	EF	EF	FM	FM	FM
91 pF	910				DG	DG	DG	EF	EF	EF	FM	FM	FM
100 - 150 pF**	101 - 151**				DG	DG	DG	EF	EF	EF	FM	FM	FM
110 pF	111				DG	DG	DG	EU	EU	EU	FM	FM	FM
120 pF	121				DG	DG	DG	EU	EU	EU	FM	FM	FM
130 pF	131				DG	DG	DG	EU	EU	EU	FM	FM	FM
150 pF	151				DG	DG	DG	EU	EU	EU	FM	FM	FM
180 pF	181				DG	DG	DG	EU	EU	EU	FM	FM	FM
220 pF	221				DG	DG	DG	EU	EU	EU	FM	FM	FM
270 pF	271				DG	DG	DG	EU	EU	EU	FK	FK	FK
330 pF	331				DG	DG	DG	EU	EU	EU	FK	FK	FK
390 pF	391				DG	DG	DG	EU	EU	EU	FS	FS	FS
470 pF	471				DG	DG	DG	EU	EU	EU	FS	FS	FS
560 pF	561				DG	DG	DG	EU	EU	EU	FL	FL	FL
680 pF	681				DG	DG		EU	EU	EU	FL	FL	FL
820 pF	821				DG	DG		EU	EU	EU	FL	FL	FL
1,000 pF	102		CG	CG	DG	DG		EU	EU	EU	FL	FL	FL
1,200 pF	122		CG		DG	DG		EU	EU	EU	FM	FM	FM
1,500 pF	152		CG		DG	DG		EU	EU	EU	FM	FM	FM
1,800 pF	182				DG	DG		EU	EU	EU	FM	FM	FM
2,200 pF	222				DG	DG		EU	EU	EU	FM	FM	FM
2,700 pF	272				DG	DG		EU	EU	EU	FM	FM	FM
3,300 pF	332				DG	DG		EU	EU	EU	FS	FS	FS
3,900 pF	392				DG	DG		EU	EU	EU	FS	FS	FS
4,700 pF	472				DG	DG		EU	EU	EU	FS	FS	FS
5,600 pF	562				DG			EU	EU	EU	FS	FS	FS
6,800 pF	682				DG			EU	EU	EU	FS	FS	FS
Capacitance (pF)	Cap Code	Voltage Code	C	B	C	B	D	C	B	D	C	B	D
		Rated Voltage (VDC)	500	630	500	630	1,000	500	630	1,000	500	630	1,000
		Case Size/Series	C0603X		C0805X			C1206X			C1210X		

Table 1 – Capacitance Range/Selection Waterfall (0603 – 1210 Case Sizes) cont.

Capacitance (pF)	Cap Code	Case Size/ Series	C0603X		C0805X			C1206X			C1210X		
		Rated Voltage (VDC)	500	630	500	630	1,000	500	630	1,000	500	630	1,000
		Voltage Code	C	B	C	B	D	C	B	D	C	B	D
8,200 pF	822				DG			EU	EU	EU	FK	FK	FK
10,000 pF	103				DG			EU	EU	EU	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							EJ	EJ		FM	FM	FM
27,000 pF	273	J = ±5% K = ±10% M = ±20%						EJ			FK	FK	FK
33,000 pF	333							EJ			FS	FS	FS
39,000 pF	393										FS	FS	FS
47,000 pF	473										FK	FK	
56,000 pF	563										FK	FK	
68,000 pF	683										FS	FS	
82,000 pF	823										FS		
0.10 µF	104										FK		
Capacitance (pF)	Cap Code	Voltage Code	C	B	C	B	D	C	B	D	C	B	D
		Rated Voltage (VDC)	500	630	500	630	1,000	500	630	1,000	500	630	1,000
		Case Size/Series	C0603X		C0805X			C1206X			C1210X		

Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

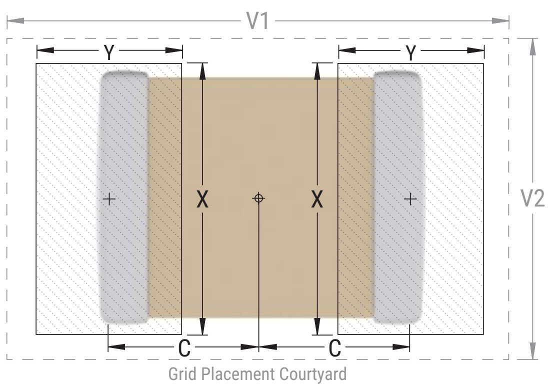
Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
CG	0603	0.80 ± 0.10	4,000	15,000	0	0
DG	0805	1.25 ± 0.15	0	0	2,500	10,000
ES	1206	1.00 ± 0.20	0	0	2,500	10,000
EF	1206	1.20 ± 0.15	0	0	2,500	10,000
EU	1206	1.60 ± 0.25	0	0	2,000	8,000
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 Code	Case Size	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[1]		Plastic Quantity	

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)				
		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:

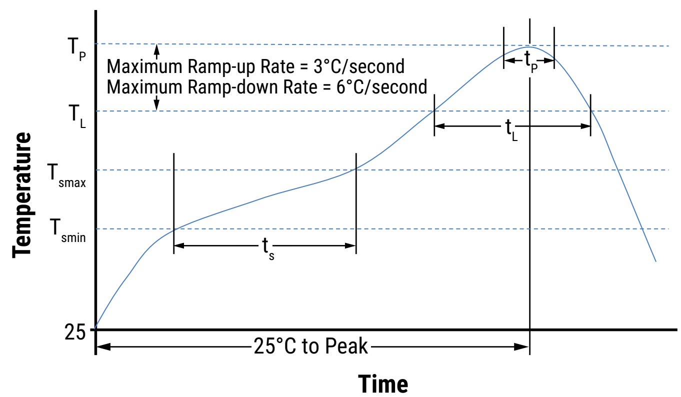
- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- All other EIA case sizes are limited to solder reflow only

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

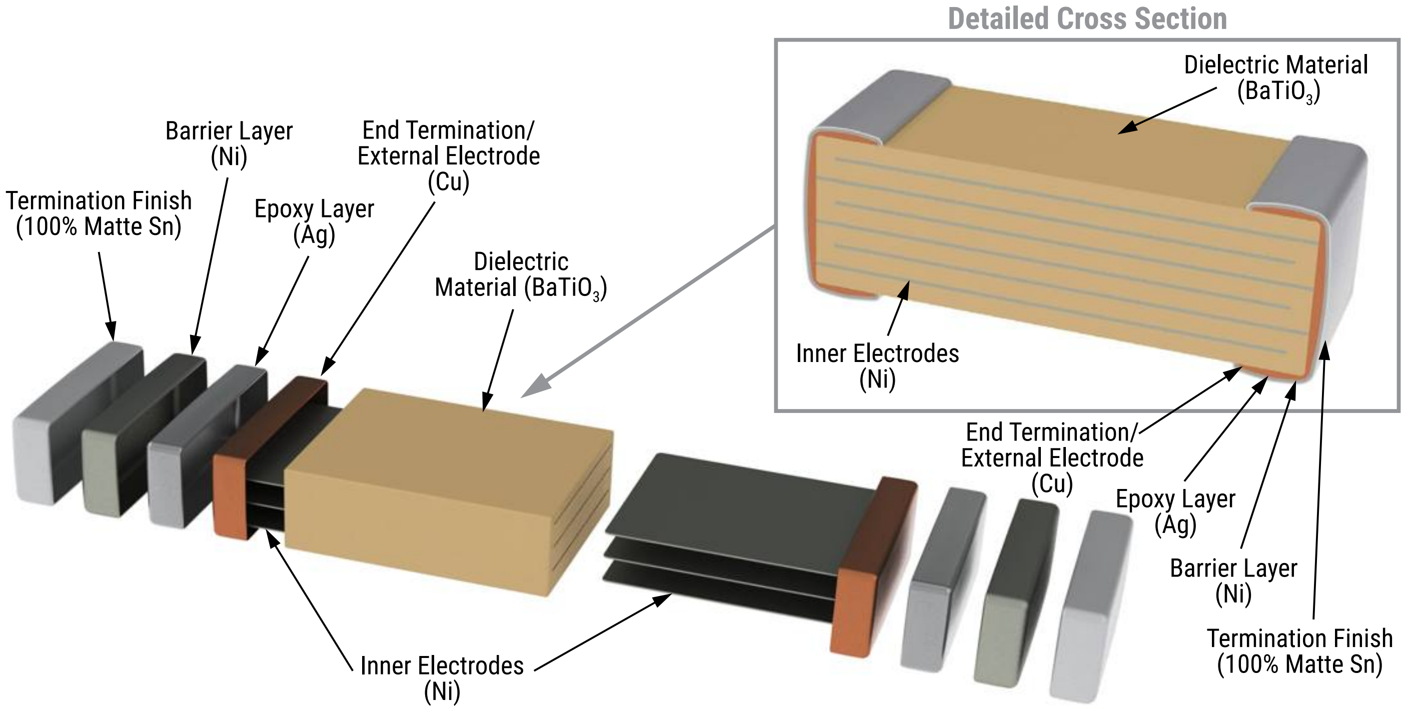
Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.



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 40ºC 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)

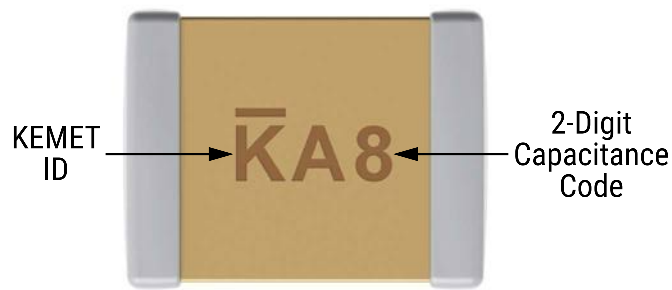
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic 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:

- C0G, 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 µF. Orientation of marking is vendor optional.

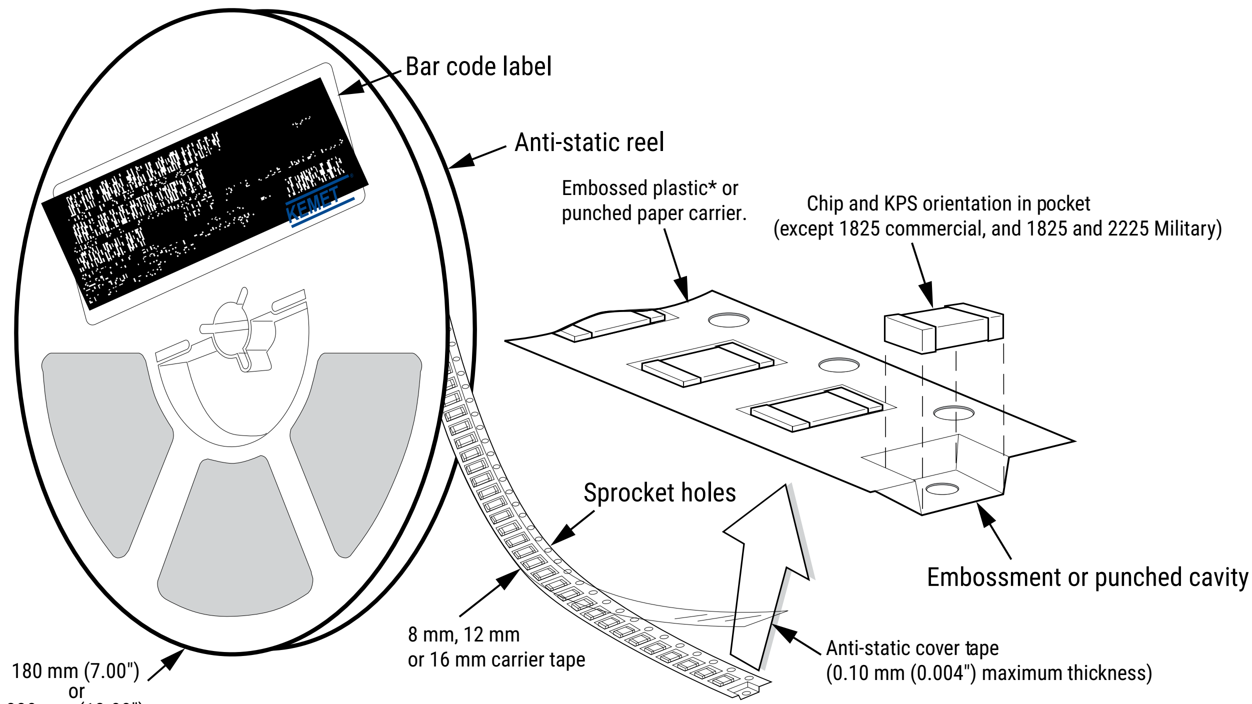


Capacitor Marking (Optional) cont.

Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.10	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

Table 4 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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 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

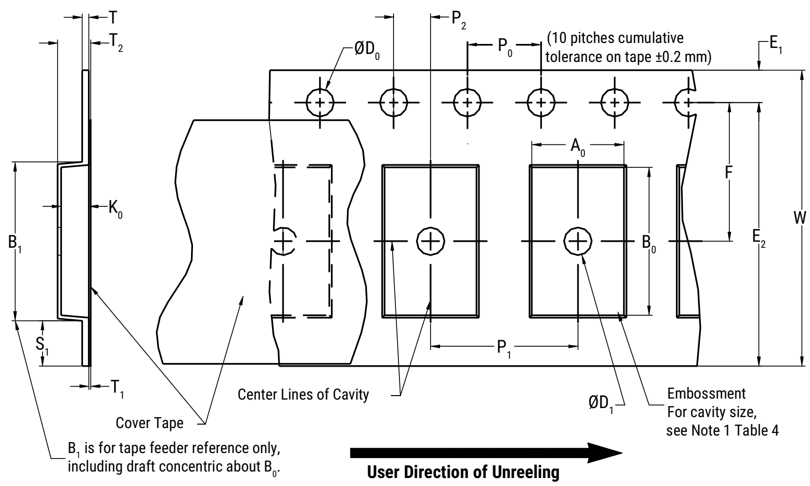


Table 5 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)									
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									
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 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)	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)	
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 S_1 < 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_1 dimension is a reference dimension for tape feeder clearance only.
5. The cavity defined by A_0, B_0 and K_0 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

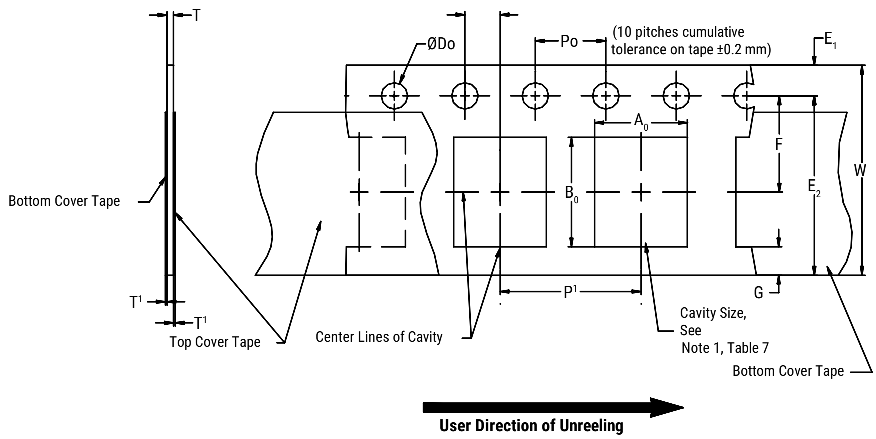


Table 6 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)							
Tape Size	D_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 (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_0, B_0 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

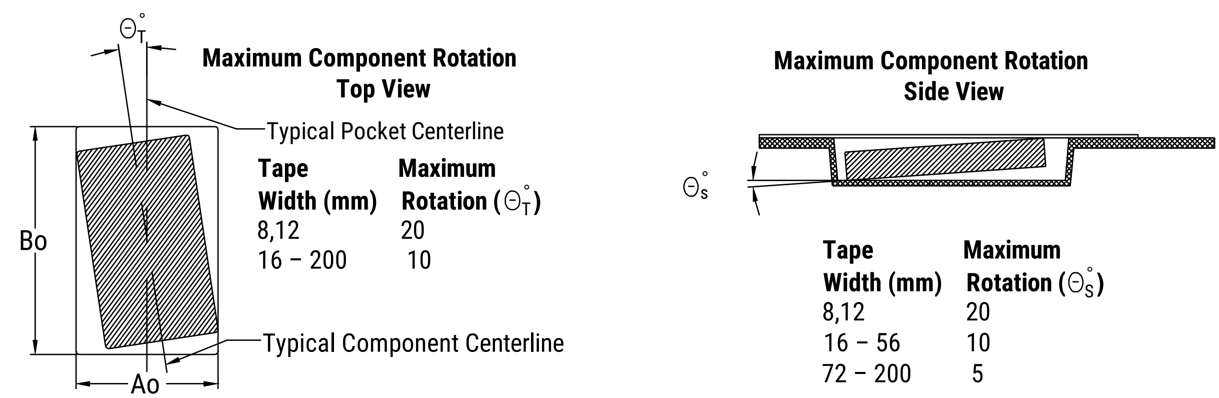


Figure 4 – Maximum Lateral Movement

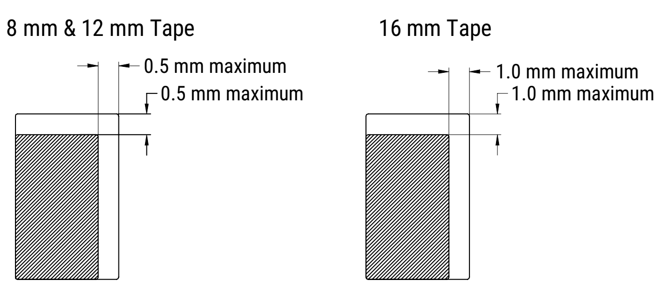


Figure 5 – Bending Radius

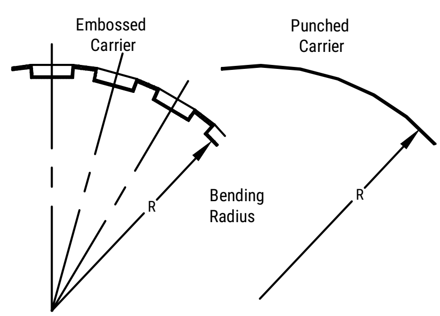
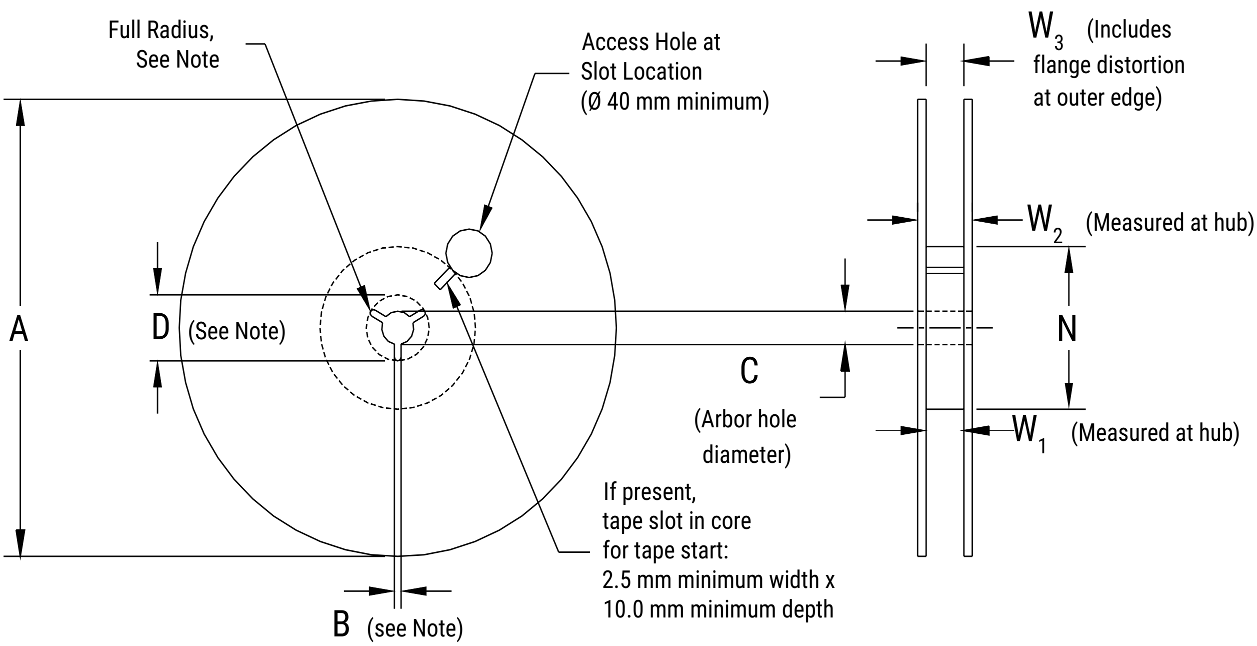


Figure 6 – Reel Dimensions



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

Table 7 – Reel Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)				
Tape Size	A	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				
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

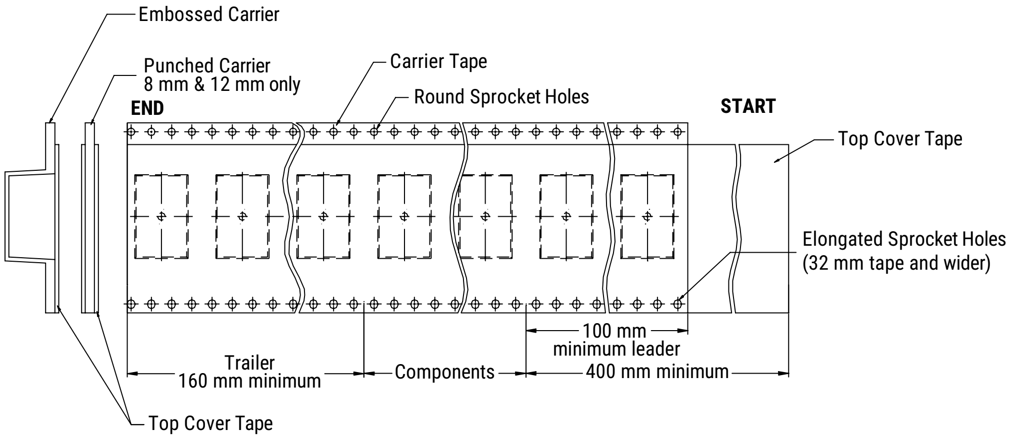
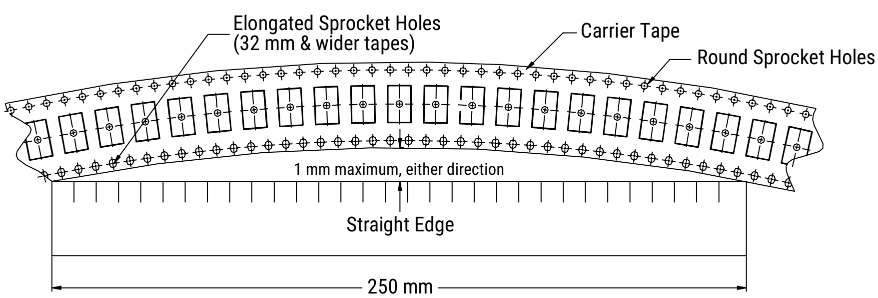


Figure 8 – Maximum Camber



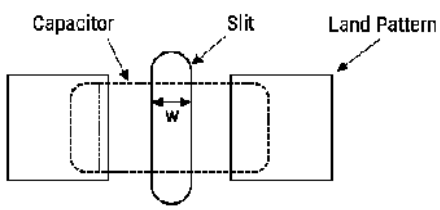
Application Guide

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 ≥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.

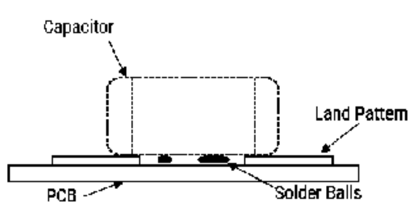
Dielectric	CTE (ppm/°C)
Class II $BaTiO_3$	10.7
Class I $CaZrO_3$	9.8

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.

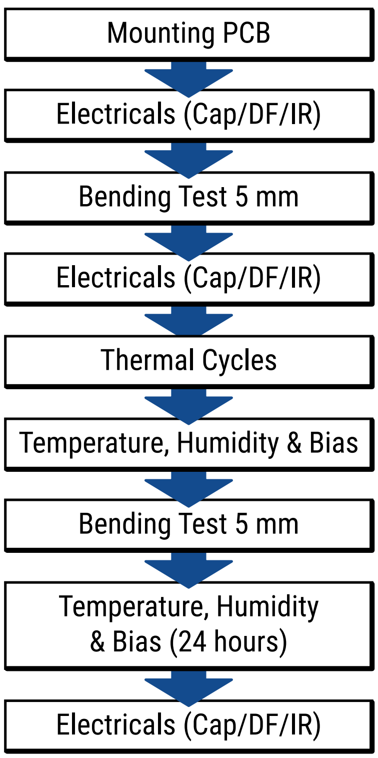


Surface Mount Multilayer Ceramic Capacitors (SMD MLCCs)

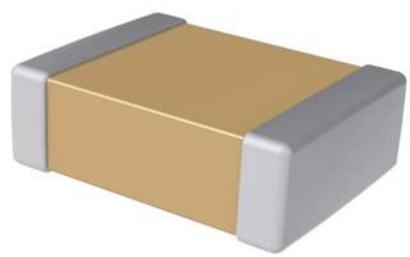
Flexible Termination System (FT-CAP), X7R Dielectric, 6.3 – 250 VDC, VW 80808 Specification

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.



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.



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

Applications

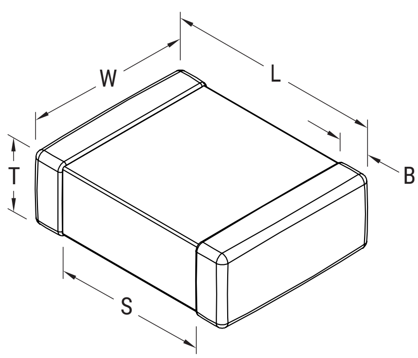
- High current applications (automobile battery line)
- Circuits (direct battery/power connection)
- Control units, sensors, and actuators in motor vehicles
- Filtering (power plane/bus)
- Electronic and Electrical subsystems

Ordering Information

C	1210	X	106	K	8	R	A	C	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)	See Table 2 for Thickness	0.45 (0.018) ±0.15 (0.006)	0.58 (0.023)	Solder wave or solder reflow
[2]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)	
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	
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

[1] *For capacitance values ≥ 0.56 µF add 0.03 (0.001) to length tolerance dimension.*
[2] *For capacitance values ≥ 2.7 µF 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.

[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 ≤ 10 µF

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

[4] To obtain IR limit, divide MΩ - µF value by the capacitance and compare to GΩ 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
X7R	> 25	All	3.0	±20%	10% of Initial Limit
	16/25		5.0		
	< 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
0603	< 200 V	< 0.047 µF	≥ 0.047 µF	N/A
	≥ 200 V	< 1.0nF	N/A	≥ 1.0nF
0805	< 200 V	< 0.15 µF	≥ 0.15 µF	N/A
	≥ 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
1210	< 200 V	< 0.39 µF	≥ 0.39 µF	N/A
	≥ 200 V	< 0.047µF	N/A	≥ 0.047µF

KEMET

Table 1 – Capacitance Range/Selection Waterfall (0603 – 1210 Case Sizes)

Capacitance (pF)	Cap Code	Case Size/ Series	C0603X								C0805X								C1206X								C1210X							
		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	181		CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DR	DR	DG																
220pF	221		CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DR	DR	DG																
270pF	271		CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DR	DR	DG																
330pF	331		CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DR	DR	DG																
390pF	391		CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DR	DR	DG																
470pF	471		CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DR	DR	DG																
560pF	561		CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DR	DR	DG																
680pF	681		CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DR	DR	DG																
820pF	821		CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DR	DR	DG																
1.0 nF	102		CJ	CJ	CJ	CJ	CJ	CJ	CG	CG	DR	DR	DR	DR	DR	DR	DR	DG	EQ	EQ	EQ	EQ	EQ	EQ	EU	EU								
1.2 nF	122		CJ	CJ	CJ	CJ	CJ	CJ	CG	CG	DR	DR	DR	DR	DR	DR	DR	DG	EQ	EQ	EQ	EQ	EQ	EQ	EU	EU								
1.5 nF	152		CJ	CJ	CJ	CJ	CJ	CJ	CG	CG	DR	DR	DR	DR	DR	DR	DR	DG	EQ	EQ	EQ	EQ	EQ	EQ	EU	EU								
1.8 nF	182		CJ	CJ	CJ	CJ	CJ	CJ	CG	CG	DR	DR	DR	DR	DR	DR	DR	DG	EQ	EQ	EQ	EQ	EQ	EQ	EU	EU								
2.2 nF	222		CJ	CJ	CJ	CJ	CJ	CJ	CG	CG	DR	DR	DR	DR	DR	DR	DR	DG	EQ	EQ	EQ	EQ	EQ	EQ	EU	EU	FN	FN	FN	FN	FN	FN	FM	FM
2.7 nF	272		CJ	CJ	CJ	CJ	CJ	CJ	CG	CG	DR	DR	DR	DR	DR	DR	DR	DG	EQ	EQ	EQ	EQ	EQ	EQ	EU	EU	FN	FN	FN	FN	FN	FN	FM	FM
3.3 nF	332		CJ	CJ	CJ	CJ	CJ	CJ	CG	CG	DR	DR	DR	DR	DR	DR	DR	DG	EQ	EQ	EQ	EQ	EQ	EQ	EU	EU	FN	FN	FN	FN	FN	FN	FS	FS
3.9 nF	392		CJ	CJ	CJ	CJ	CJ	CJ	CG	CG	DR	DR	DR	DR	DR	DR	DR	DG	EQ	EQ	EQ	EQ	EQ	EQ	EU	EU	FN	FN	FN	FN	FN	FN	FS	FS
4.7 nF	472		CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DR	DR	DG	EQ	EQ	EQ	EQ	EQ	EQ	EU	EU	FN	FN	FN	FN	FN	FN	FS	FS
5.6 nF	562		CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DR	DR	DG	EQ	EQ	EQ	EQ	EQ	EQ	EU	EU	FN	FN	FN	FN	FN	FN	FS	FS
6.8 nF	682		CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DR	DR	DG	EQ	EQ	EQ	EQ	EQ	EQ	EU	EU	FN	FN	FN	FN	FN	FN	FS	FS
8.2 nF	822	Capacitance Tolerances: J = ±5% K = ±10% M = ±20%	CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DR	DR	DG	EQ	EQ	EQ	EQ	EQ	EQ	EU	EU	FN	FN	FN	FN	FN	FN	FK	FK
10 nF	103		CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DR	DR	DG	EQ	EQ	EQ	EQ	EQ	EQ	EU	EU	FN	FN	FN	FN	FN	FN	FK	FK
12 nF	123		CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DR	DR	DR	DG	EQ	EQ	EQ	EQ	EQ	EQ	EJ	EJ	FN	FN	FN	FN	FN	FN	FK	FK
15 nF	153		CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DD	DR	DR	DG	EQ	EQ	EQ	EQ	EQ	EQ	EJ	EJ	FN	FN	FN	FN	FN	FN	FL	FL
18 nF	183		CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DD	DR	DR	DG	EQ	EQ	EQ	EQ	EQ	EQ	EJ	EJ	FN	FN	FN	FN	FN	FN	FM	FM
22 nF	223		CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DD	DR	DR	DG	EQ	EQ	EQ	EQ	EQ	EQ	EJ	EJ	FN	FN	FN	FN	FN	FN	FM	FM
27 nF	273		CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DD	DS			EQ	EQ	EQ	EQ	EQ	EQ	EJ	EJ	FN	FN	FN	FN	FN	FN	FK	FK
33 nF	333		CJ	CJ	CJ	CJ	CJ	CJ			DR	DR	DR	DR	DD	DS			EQ	EQ	EQ	EQ	EQ	EQ	EJ	EJ	FN	FN	FN	FN	FN	FN	FS	FS
39 nF	393		CJ	CJ	CJ	CJ	CJ				DR	DR	DR	DR	DD	DS			EQ	EQ	EQ	EQ	ER	EQ	EJ	EJ	FN	FN	FN	FN	FN	FN	FS	FS
47 nF	473		CJ	CJ	CJ	CJ	CJ				DR	DR	DR	DR	DS	DG			EQ	EQ	EQ	EQ	ER	ES	EJ	EJ	FN	FN	FN	FN	FN	FQ	FK	FK
56 nF	563		CJ	CJ	CJ	CJ	CJ				DD	DD	DD	DD	DS	DD			EQ	EQ	EQ	EQ	EQ	ES	EJ	EJ	FN	FN	FN	FN	FN	FQ	FK	FK
68 nF	683		CJ	CJ	CJ	CJ	CJ				DD	DD	DD	DD	DS	DD			EQ	EQ	EQ	EQ	EQ	ES	EJ	EJ	FN	FN	FN	FN	FN	FQ	FS	FS
82 nF	823		CJ	CJ	CJ	CJ	CJ				DD	DD	DD	DD	DS	DD			EQ	EQ	EQ	EQ	EQ	ES			FN	FN	FN	FN	FQ	FA	FK	FK
100 nF	104		CJ	CJ	CJ	CJ	CJ				DR	DR	DR	DR	DS	DD			EQ	EQ	EQ	EQ	EQ	EM			FN	FN	FN	FN	FX	FZ	FS	FS
120 nF	124		CJ	CJ	CJ	CJ					DD	DD	DD	DD	DG	DG			ER	ER	ER	ER	ER	EU			FN	FN	FN	FN	FX	FU	FK	FK
150 nF	154		CJ	CJ	CJ	CJ					DD	DD	DD	DD	DG	DG			ER	ER	ER	ER	ER	EU			FQ	FQ	FQ	FQ	FX	FM	FK	FK
180 nF	184		CJ	CJ	CJ						DD	DD	DD	DD	DD				ER	ER	ER	ER	ER	ER			FQ	FQ	FQ	FQ	FX	FK		
220 nF	224										DD	DD	DD	DD	DD				ER	ER	ER	ER	ER	ER			FQ	FQ	FQ	FQ	FX	FK		
270 nF	274										DD	DD	DD	DD	DD				ER	ER	ER	ER	EM	EM			FQ	FQ	FQ	FQ	FX	FX		
330 nF	334										DD	DD	DD	DD	DD				ER	ER	ER	ER	EU	EU			FX	FX	FX	FX	FX	FX		
390 nF	394										DS	DS	DS	DS	DS				ER	ER	ER	ER	ER	EU			FX	FX	FX	FX	FX	FX		
470 nF	474										DS	DS	DS	DS	DS				ER	ER	ER	ER	ER	EU			FX	FX	FX	FX	FX	FX		
560 nF	564										DG	DG	DG	DG					ER	ER	ER	ER	ER				FX	FX	FX	FX	FA	FA		
680 nF	684										DG	DG	DG	DG					ES	ES	ES	ES	ES				FX	FX	FX	FX	FZ	FZ		
820 nF	824										DG	DG	DG	DG					ES	ES	ES	ES	ES				FA	FA	FA	FA	FL	FL		
Capacitance (pF)	Cap Code	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
		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	C0603X								C0805X								C1206X								C1210X							

Table 1 – Capacitance Range/Selection Waterfall (0603 – 1210 Case Sizes) cont.

Capacitance (pF)	Cap Code	Case Size/ Series	C0603X								C0805X								C1206X								C1210X							
		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	Capacitance Tolerances:									DG	DG	DG	DG					ES	ES	ES	ES	ES				FU	FU	FU	FU	FM	FM		
1.2 µF	125	J = ±5%									DS	DS							EH	EH	EH	EH	EH				FZ	FZ	FZ	FZ	FZ			
1.5 µF	155	K = ±10%									DG	DG							EH	EH	EH	EH	EH				FZ	FZ	FZ	FZ	FZ			
1.8 µF	185	M = ±20%																	EH	EH	EH	EH	EH				FZ	FZ	FZ	FZ	FZ			
2.2 µF	225																		EH	EH	EH	EH	EH				FZ	FZ	FZ	FZ	FZ			
2.7 µF	275																		EH	EH	EH						FZ	FZ	FZ	FU	FU			
3.3 µF	335																		EH	EH	EH						FM	FM	FM	FM	FM			
3.9 µF	395																										FK	FK	FK	FK	FK			
4.7 µF	475																										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						
Capacitance (pF)	Cap Code	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
		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	C0603X								C0805X								C1206X								C1210X							

Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

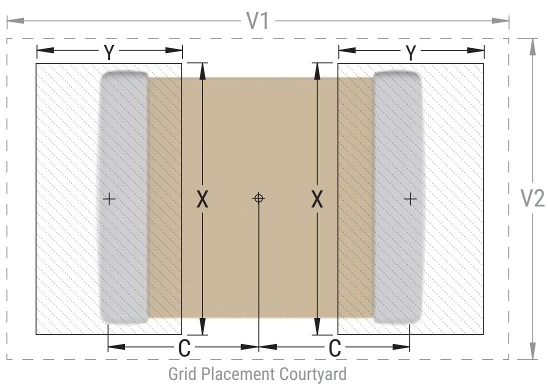
Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
CG	0603	0.80 ± 0.10	4,000	15,000	0	0
CJ	0603	0.80 ± 0.15	4,000	15,000	0	0
DR	0805	0.78 ± 0.20	0	0	4,000	10,000
DD	0805	0.90 ± 0.10	0	0	4,000	10,000
DS	0805	1.00 ± 0.20	0	0	2,500	10,000
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 Code	Case Size	Thickness ± Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity[1]		Plastic Quantity	

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)				
		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:

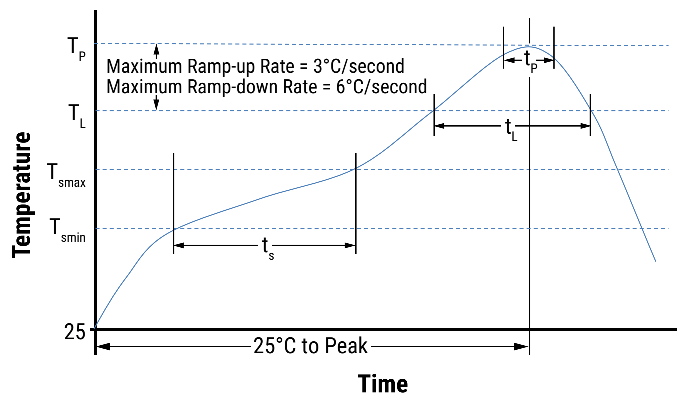
- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- All other EIA case sizes are limited to solder reflow only

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	
	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

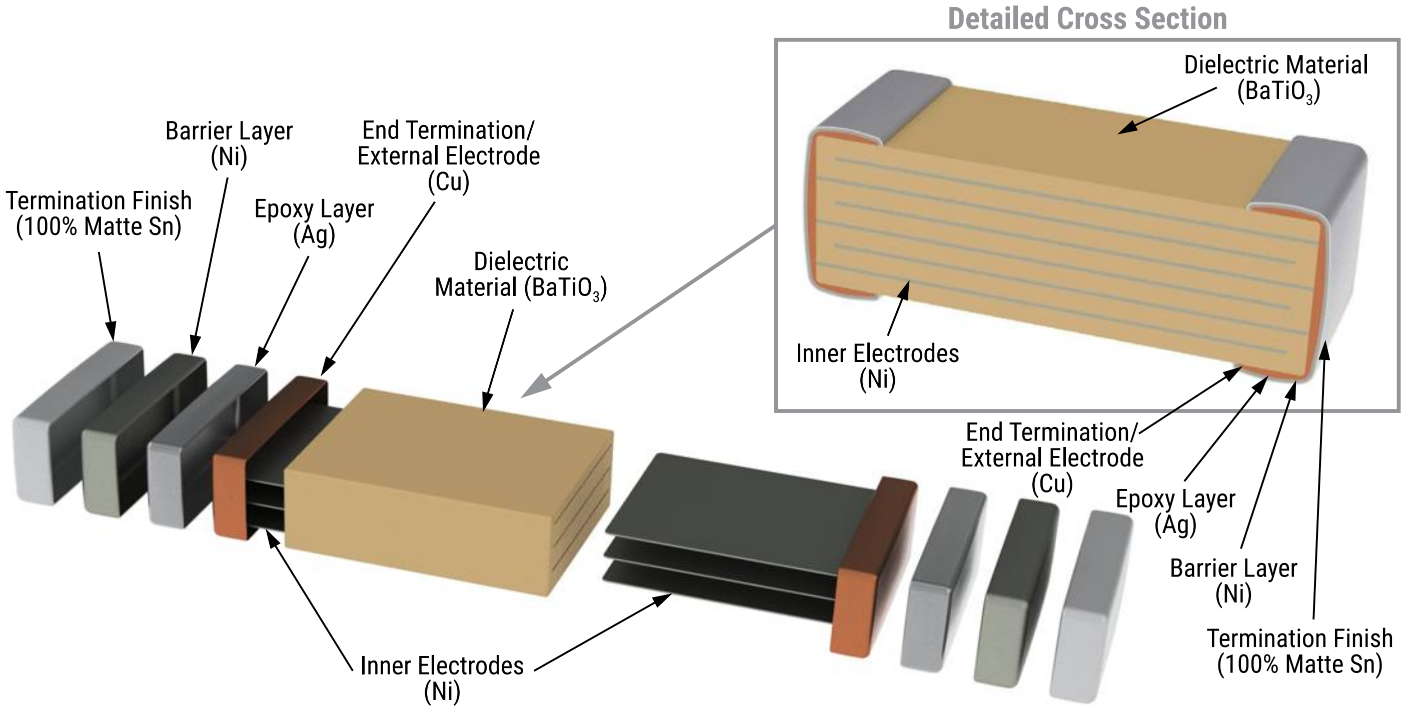
Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.



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 40ºC 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.

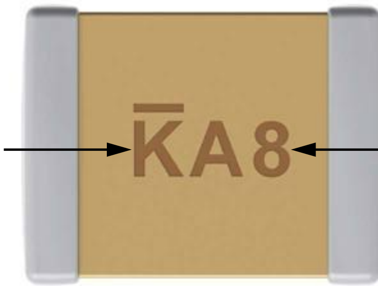
Laser marking option is not available on:

- C0G, 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 µF. Orientation of marking is vendor optional.

KEMET
ID



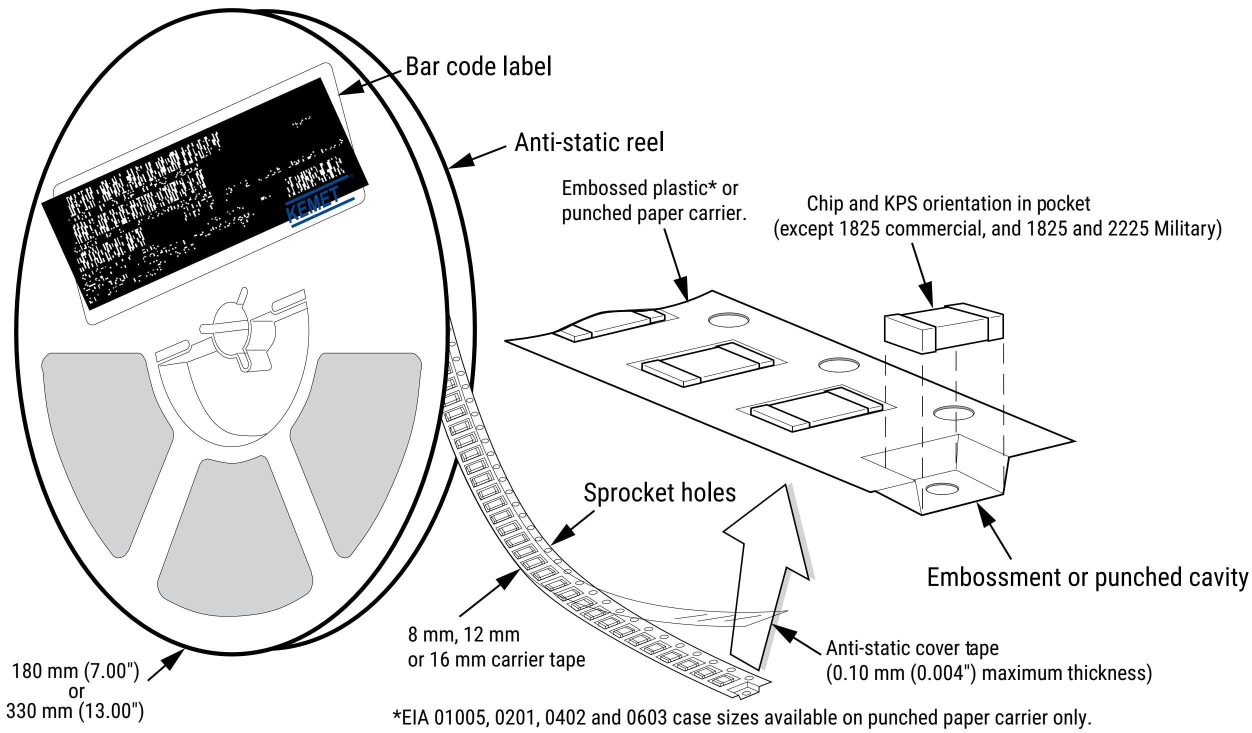
2-Digit
Capacitance
Code

Capacitor Marking (Optional) cont.

Capacitance (pF) For Various Alpha/Numeral Identifiers										
Alpha Character	Numeral									
	9	0	1	2	3	4	5	6	7	8
	Capacitance (pF)									
A	0.10	1.0	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
B	0.11	1.1	11	110	1,100	11,000	110,000	1,100,000	11,000,000	110,000,000
C	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
H	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
K	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
M	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
P	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
T	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
X	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
a	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
e	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
y	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.



*EIA 01005, 0201, 0402 and 0603 case sizes available on punched paper carrier only.

Table 4 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		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 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

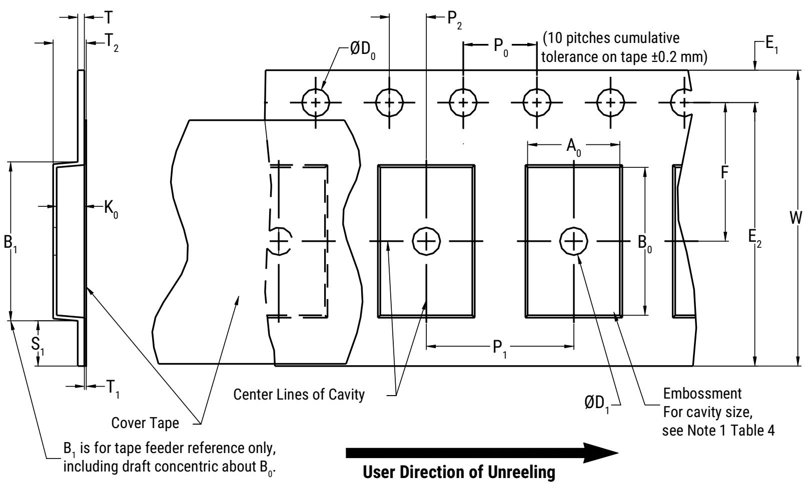


Table 5 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)									
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)	0.100 (0.004)
12 mm		1.5 (0.059)				30 (1.181)			
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 ±0.10 (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	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)	
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 S_1 < 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_1 dimension is a reference dimension for tape feeder clearance only.
5. The cavity defined by A_0, B_0 and K_0 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

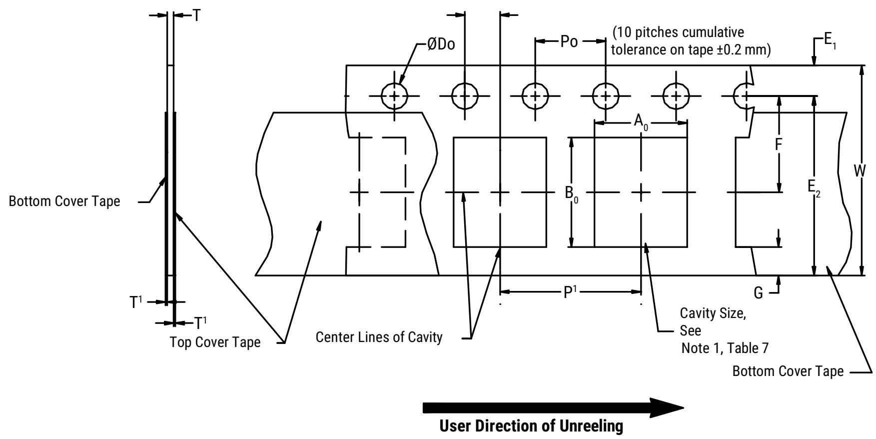


Table 6 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)							
Tape Size	D_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 (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_0, B_0 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).

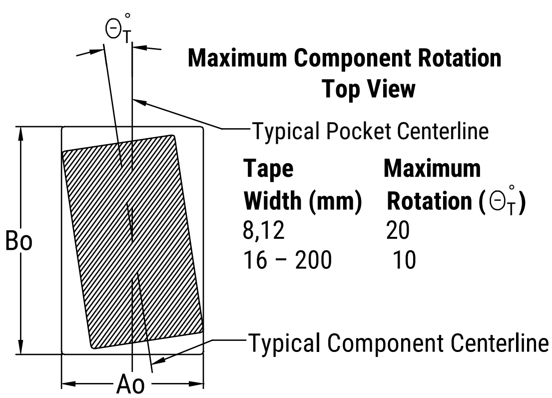
Packaging Information Performance Notes

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



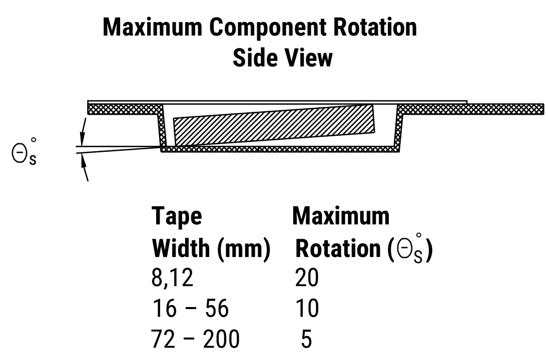


Figure 4 – Maximum Lateral Movement

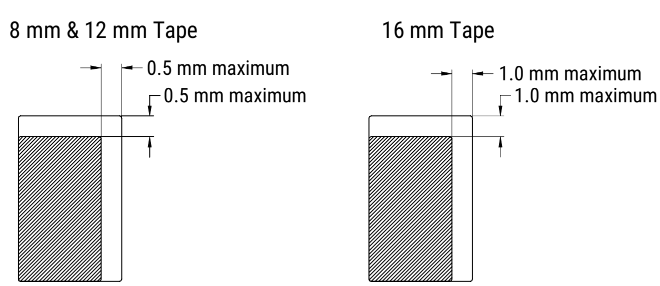


Figure 5 – Bending Radius

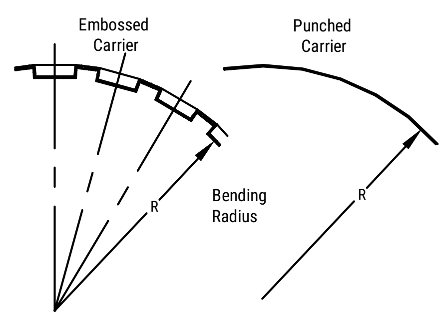
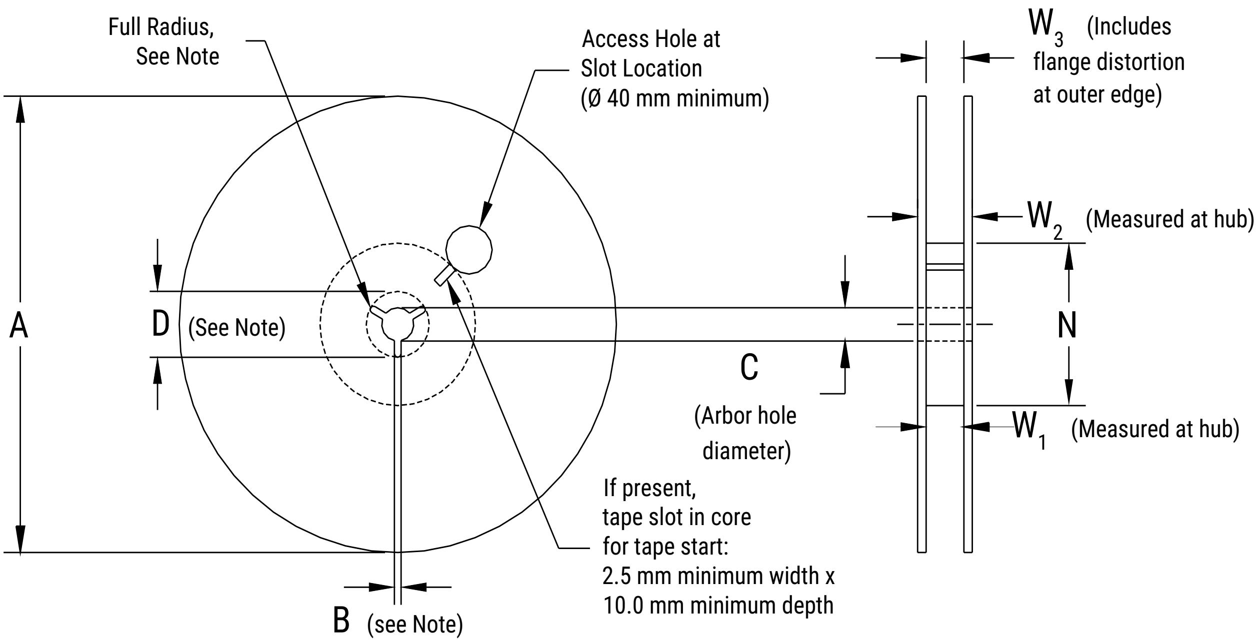


Figure 6 – Reel Dimensions



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

Table 7 – Reel Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)				
Tape Size	A	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				
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

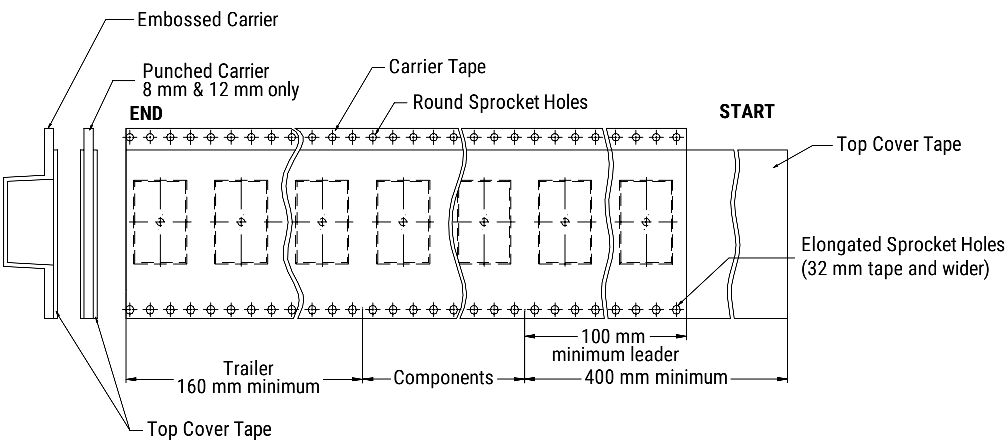


Figure 8 – Maximum Camber