

# Floating Electrode Design (FE-CAP), X7R Dielectric, 6.3 – 250 VDC (Commercial & Automotive Grade)

## Overview

KEMET's Floating Electrode (FE-CAP) multilayer ceramic capacitor in X7R dielectric utilizes a cascading internal electrode design configured to form multiple capacitors in series within a single monolithic structure. This unique configuration results in enhanced voltage and ESD performance over standard capacitor designs while allowing for a fail-open condition if mechanically damaged (cracked). If damaged, the device may experience a drop in capacitance but a short is unlikely. The FE-CAP is designed to reduce the likelihood of a low IR or short circuit condition and the chance for a catastrophic and potentially costly failure event.

Driven by the demand for a more robust and reliable component, the FE-CAP was designed for critical applications where higher operating temperatures and mechanical stress are a concern. These capacitors are manufactured in state of the art ISO/TS 16949:2009 certified facilities and are widely used in power supplies (input and output filters) and general electronic applications.

Combined with the stability of an X7R dielectric, the FE-CAP complements KEMET's "Open Mode" devices by providing a fail-safe design optimized for low to mid range capacitance values. These devices exhibit a predictable change in capacitance with respect to time and voltage and boast a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to  $\pm 15\%$  from  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .

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



## Ordering Information

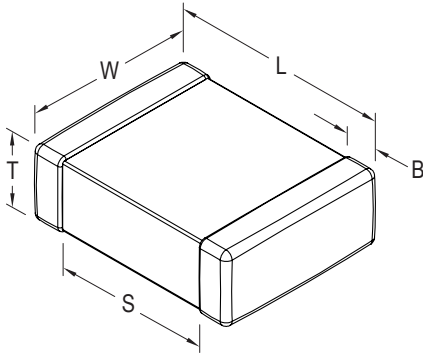
C	0805	S	104	K	5	R	A	C	TU
Ceramic	Case Size (L" x W")	Specification/ Series	Capacitance Code (pF)	Capacitance Tolerance	Voltage	Dielectric	Failure Rate/ Design	Termination Finish <sup>1</sup>	Packaging/Grade (C-Spec) <sup>2</sup>
	0402 0603 0805 1206 1210 1812	S = Floating Electrode	2 Significant Digits + Number of Zeros	J = $\pm 5\%$ K = $\pm 10\%$ M = $\pm 20\%$	9 = 6.3 V 8 = 10 V 4 = 16 V 3 = 25 V 5 = 50 V 1 = 100 V 2 = 200 V A = 250 V	R = X7R	A = N/A	C = 100% Matte Sn L = SnPb (5% minimum)	Blank = Bulk TU = 7" Reel Unmarked TM = 7" Reel Marked

<sup>1</sup> Additional termination finish options may be available. Contact KEMET for details.

<sup>1,2</sup> SnPb termination finish option is not available on automotive grade product.

<sup>2</sup> 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 (.040) ± 0.05 (.002)	0.50 (.020) ± 0.05 (.002)	See Table 2 for Thickness	0.30 (.012) ± 0.10 (.004)	0.30 (.012)	Solder Reflow Only
0603	1608	1.60 (.063) ± 0.15 (.006)	0.80 (.032) ± 0.15 (.006)		0.35 (.014) ± 0.15 (.006)	0.70 (.028)	Solder Wave or Solder Reflow
0805	2012	2.00 (.079) ± 0.20 (.008)	1.25 (.049) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	
1206	3216	3.20 (.126) ± 0.20 (.008)	1.60 (.063) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)	N/A	Solder Reflow Only
1210	3225	3.20 (.126) ± 0.20 (.008)	2.50 (.098) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)		
1812	4532	4.50 (.177) ± 0.30 (.012)	3.20 (.126) ± 0.30 (.012)		0.60 (.024) ± 0.35 (.014)		

## 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% 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.

## Qualification/Certification

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

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. For additional information regarding the Automotive Electronics Council and AEC–Q200, please visit their website at [www.aecouncil.com](http://www.aecouncil.com).

## Environmental Compliance

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



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)	±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 @ 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 @ 25°C	See Insulation Resistance Limit Table (Rated voltage applied for 120 ±5 seconds @ 25°C)

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

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

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

1 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 (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	CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
180 pF	181	J K M	BB	BB	BB	BB	BB	CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
220 pF	221	J K M	BB	BB	BB	BB	BB	CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
270 pF	271	J K M	BB	BB	BB	BB	BB	CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
330 pF	331	J K M	BB	BB	BB	BB	BB	CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
390 pF	391	J K M	BB	BB	BB	BB	BB	CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
470 pF	471	J K M	BB	BB	BB	BB	BB	CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
560 pF	561	J K M	BB	BB	BB	BB	BB	CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
680 pF	681	J K M	BB	BB	BB	BB	BB	CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
820 pF	821	J K M	BB	BB	BB	BB	BB	CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
1,000 pF	102	J K M	BB	BB	BB	BB	BB	CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
1,200 pF	122	J K M						CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
1,500 pF	152	J K M						CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
1,800 pF	182	J K M						CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
2,200 pF	222	J K M						CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
2,700 pF	272	J K M						CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
3,300 pF	332	J K M						CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
3,900 pF	392	J K M						CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
4,700 pF	472	J K M						CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
5,600 pF	562	J K M						CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
6,800 pF	682	J K M						CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
8,200 pF	822	J K M						CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
10,000 pF	103	J K M						CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
12,000 pF	123	J K M						CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DC	DC
15,000 pF	153	J K M						CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DD	DD
18,000 pF	183	J K M						CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DD	DD
22,000 pF	223	J K M						CF	CF	CF	CF	CF	CF	CF	CF	DC	DC	DC	DC	DC	DC	DD	DD
27,000 pF	273	J K M														DC	DC	DC	DC	DC	DC		
33,000 pF	333	J K M														DC	DC	DC	DC	DC	DC		
39,000 pF	393	J K M														DC	DC	DC	DC	DC	DC		
47,000 pF	473	J K M														DC	DC	DC	DC	DC	DC		
56,000 pF	563	J K M														DD	DD	DD	DD	DD	DD		
68,000 pF	683	J K M														DD	DD	DD	DD	DD	DD		
82,000 pF	823	J K M														DG	DG	DG	DG	DG	DG		
0.10 µF	104	J K M														DG	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	EB																
1,200 pF	122	J K M	EB	EB	EB	EB	EB	EB	EB	EB	EB																
1,500 pF	152	J K M	EB	EB	EB	EB	EB	EB	EB	EB	EB																
1,800 pF	182	J K M	EB	EB	EB	EB	EB	EB	EB	EB	EB																
2,200 pF	222	J K M	EB	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	EB	FB	FB	FB	FB	FB	FB	FB	FB								
3,300 pF	332	J K M	EB	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	EB	FB	FB	FB	FB	FB	FB	FB	FB								
4,700 pF	472	J K M	EB	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	EB	FB	FB	FB	FB	FB	FB	FB	FB								
6,800 pF	682	J K M	EB	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	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	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	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	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	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	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	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	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	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	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	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	EB				FB	FB	FB	FB	FB	FB			GB	GB	GB	GB	GB			
82,000 pF	823	J K M	EB	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	FD			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 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
DC	0805	0.78 ± 0.10	4,000	10,000	0	0
DD	0805	0.90 ± 0.10	4,000	10,000	0	0
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
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
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 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 <sup>1</sup>	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

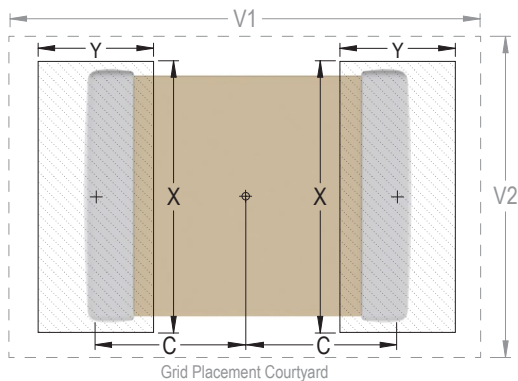
<sup>1</sup> Only for capacitance values  $\geq 22 \mu\text{F}$

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

**Density Level B:** For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes.

**Density Level C:** For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).

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





## Soldering Process

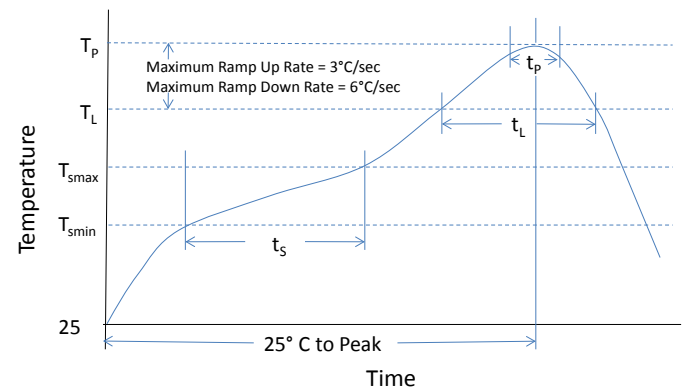
### Recommended Soldering Technique:

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

### Recommended Reflow Soldering Profile:

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

Profile Feature	Termination Finish	
	SnPb	100% Matte Sn
<b>Preheat/Soak</b>		
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.

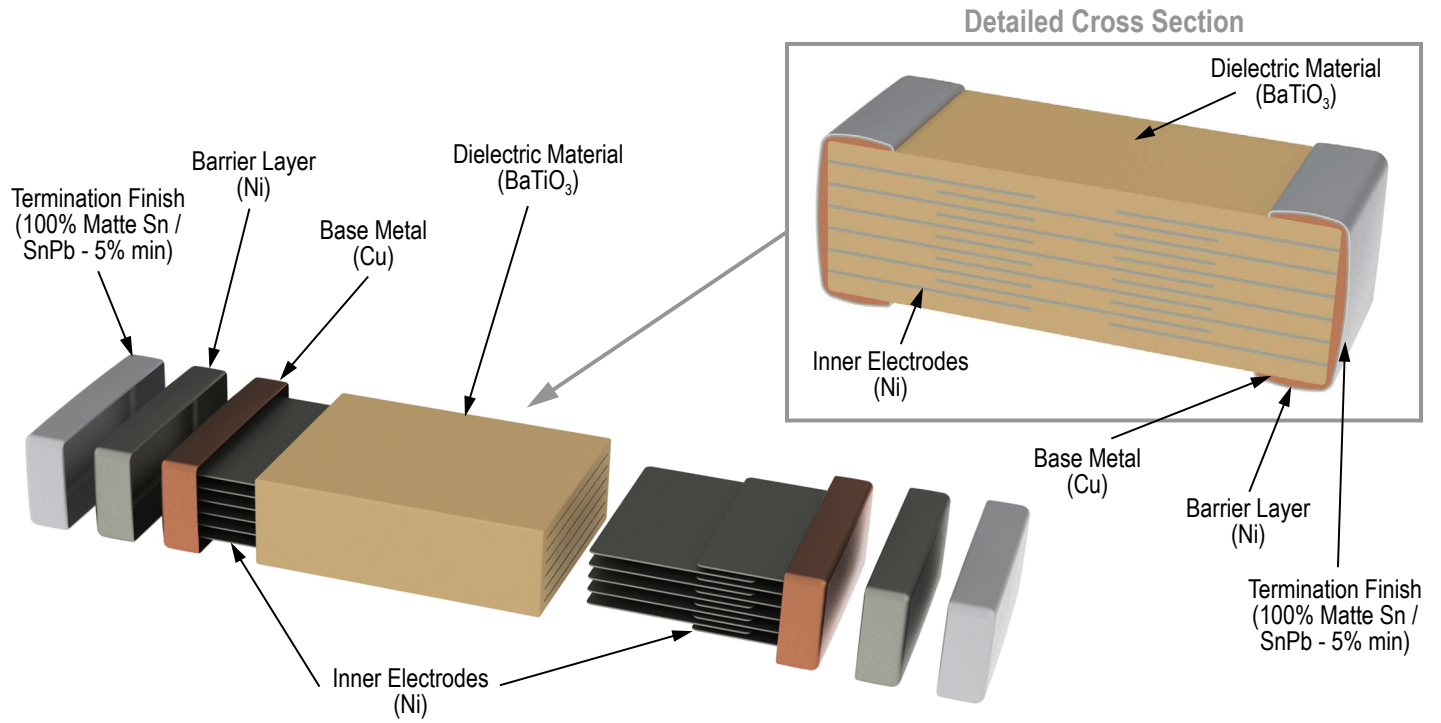
**Table 4 – Performance & Reliability: Test Methods and Conditions**

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 @ 155°C, dry heat @ 235°C
		b) Method B @ 215°C category 3
		c) Method D, category 3 @ 260°C
Temperature Cycling	JESD22 Method JA-104	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 rated voltage. 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.
Moisture Resistance	MIL-STD-202 Method 106	t = 24 hours/cycle. Steps 7a and 7b not required. Unpowered. Measurement at 24 hours +/- 2 hours after test conclusion.
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 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.

## Construction



## Capacitor Marking (Optional):

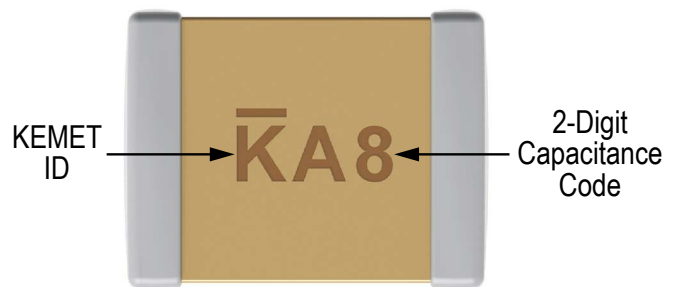
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic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

Laser marking option is not available on:

- COG, Ultra Stable X8R and Y5V dielectric devices
- EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive Grade stacked devices.
- X7R dielectric products in capacitance values outlined below

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

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

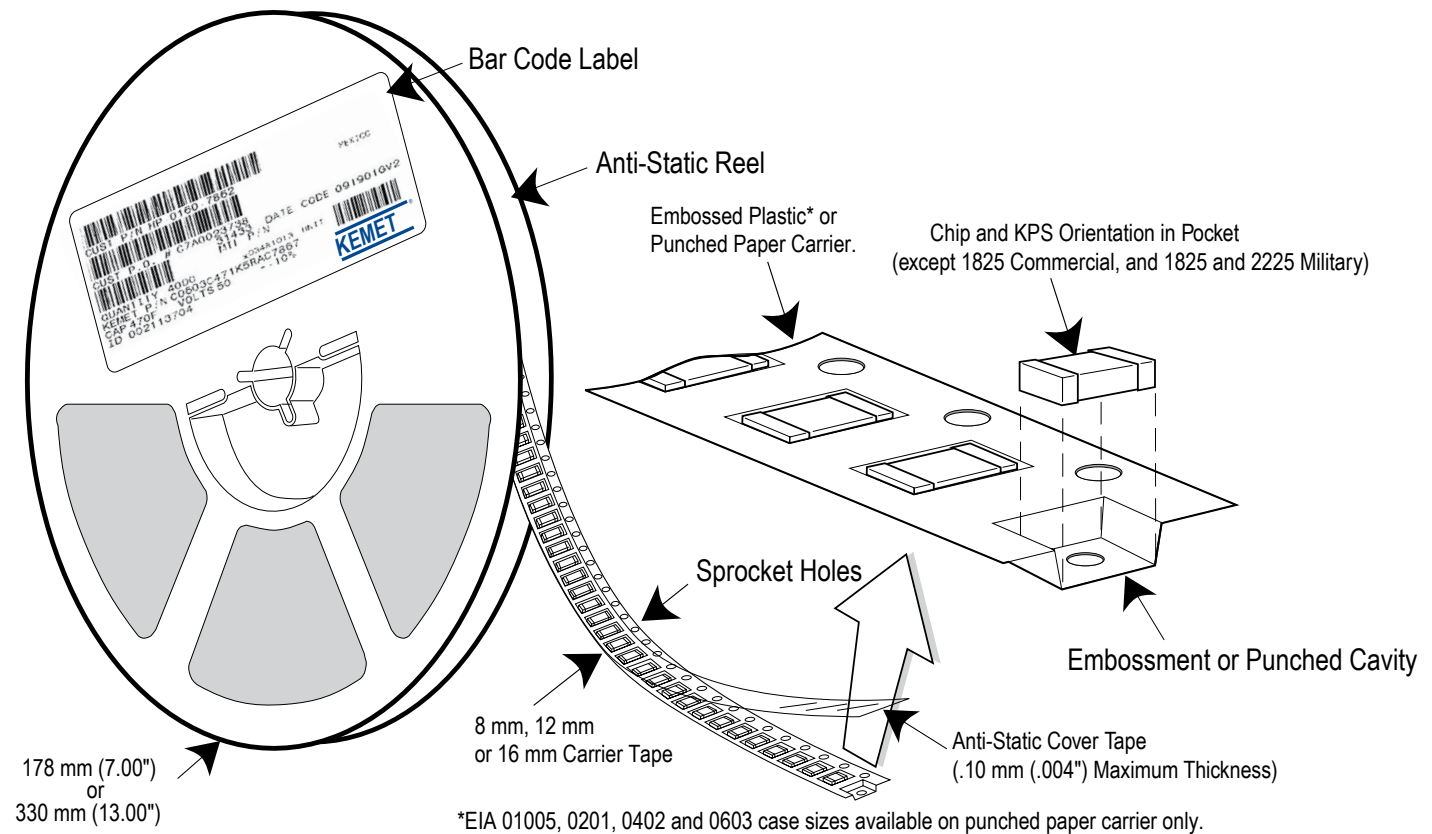


## Capacitor Marking (Optional) cont'd

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	10	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	20	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	30	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	40	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	50	50	500	5,000	50,000	500,000	5,000,000	50,000,000	500,000,000
m	0.6	60	60	600	6,000	60,000	600,000	6,000,000	60,000,000	600,000,000
n	0.7	70	70	700	7,000	70,000	700,000	7,000,000	70,000,000	700,000,000
t	0.8	80	80	800	8,000	80,000	800,000	8,000,000	80,000,000	800,000,000
y	0.9	90	90	900	9,000	90,000	900,000	9,000,000	90,000,000	900,000,000

## Tape & Reel Packaging Information

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



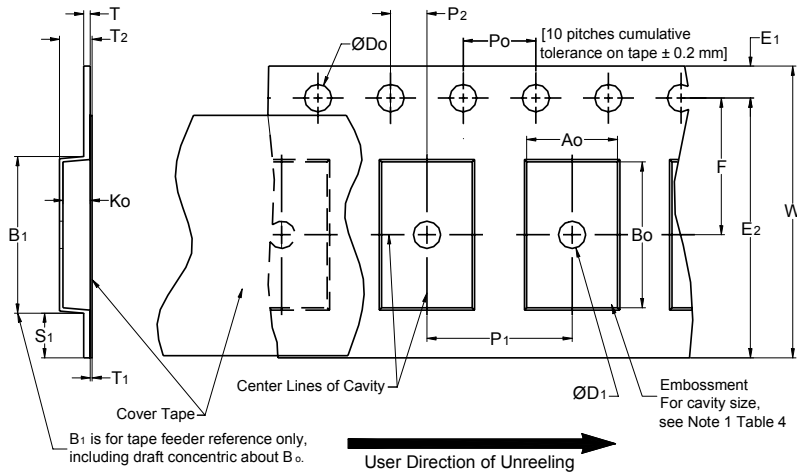
**Table 5 – Carrier Tape Configuration – Embossed Plastic & Punched Paper (mm)**

EIA Case Size	Tape Size (W)*	Pitch (P <sub>1</sub> )*
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 Figures 1 & 2 for W and P<sub>1</sub> carrier tape reference locations.

\*Refer to Tables 6 & 7 for tolerance specifications.

**Figure 1 – Embossed (Plastic) Carrier Tape Dimensions**



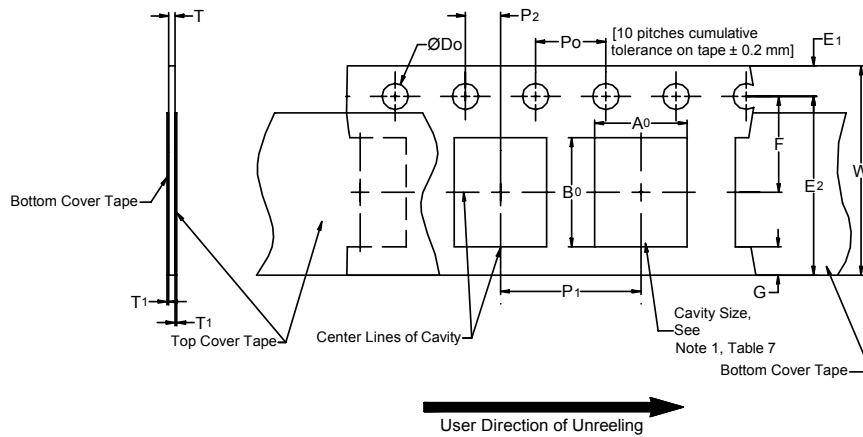
**Table 6 – Embossed (Plastic) Carrier Tape Dimensions**

Metric will govern

Constant Dimensions — Millimeters (Inches)									
Tape Size	D <sub>0</sub>	D <sub>1</sub> Minimum Note 1	E <sub>1</sub>	P <sub>0</sub>	P <sub>2</sub>	R Reference Note 2	S <sub>1</sub> Minimum Note 3	T Maximum	T <sub>1</sub> 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 <sub>1</sub> Maximum Note 4	E <sub>2</sub> Minimum	F	P <sub>1</sub>	T <sub>2</sub> Maximum	W Maximum	A <sub>0</sub> , B <sub>0</sub> & K <sub>0</sub>	
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)		

- 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.
- The tape with or without components shall pass around R without damage (see Figure 6).
- If S<sub>1</sub> < 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).
- B<sub>1</sub> dimension is a reference dimension for tape feeder clearance only.
- The cavity defined by A<sub>0</sub>, B<sub>0</sub> and K<sub>0</sub> shall surround the component with sufficient clearance that:
  - the component does not protrude above the top surface of the carrier tape.
  - the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.
  - 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).
  - 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).
  - for KPS Series product, A<sub>0</sub> and B<sub>0</sub> are measured on a plane 0.3 mm above the bottom of the pocket.
  - 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)	$1.75 \pm 0.10$ (0.069 ±0.004)	$4.0 \pm 0.10$ (0.157 ±0.004)	$2.0 \pm 0.05$ (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)	$3.5 \pm 0.05$ (0.138 ±0.002)	$2.0 \pm 0.05$ (0.079 ±0.002)	1.1 (0.098)	8.3 (0.327)	Note 1
8 mm	Single (4 mm)			$4.0 \pm 0.10$ (0.157 ±0.004)			

- The cavity defined by  $A_0$ ,  $B_0$  and  $T$  shall surround the component with sufficient clearance that:
  - the component does not protrude beyond either surface of the carrier tape.
  - the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.
  - rotation of the component is limited to 20° maximum (see Figure 3).
  - lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4).
  - see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.
- The tape with or without components shall pass around R without damage (see Figure 6).



## Packaging Information Performance Notes

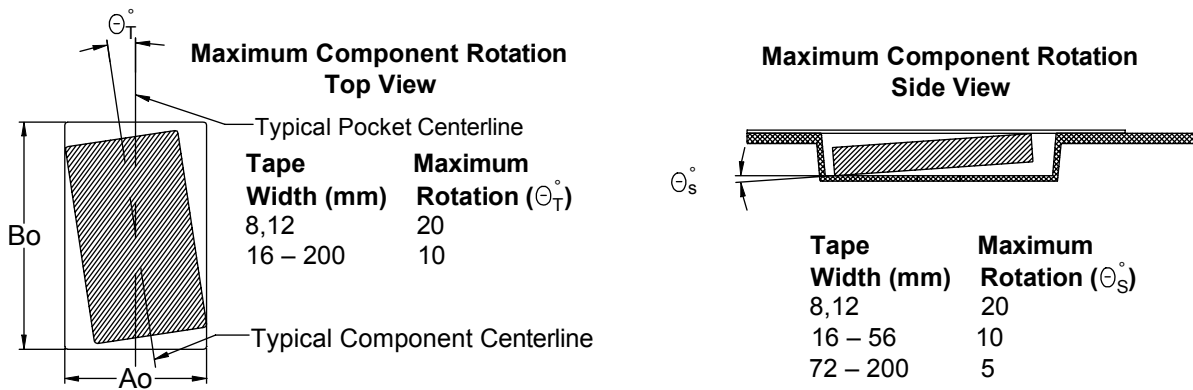
- 1. Cover Tape Break Force:** 1.0 Kg minimum.
- 2. Cover Tape Peel Strength:** The total peel strength of the cover tape from the carrier tape shall be:

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)

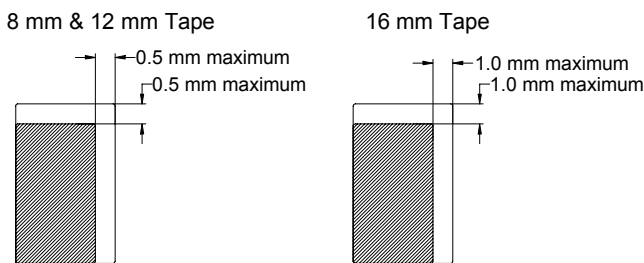
The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ±10 mm/minute.

- 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.

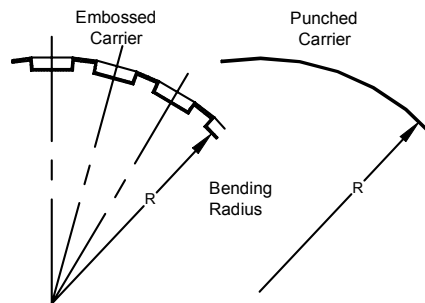
### Figure 3 – Maximum Component Rotation



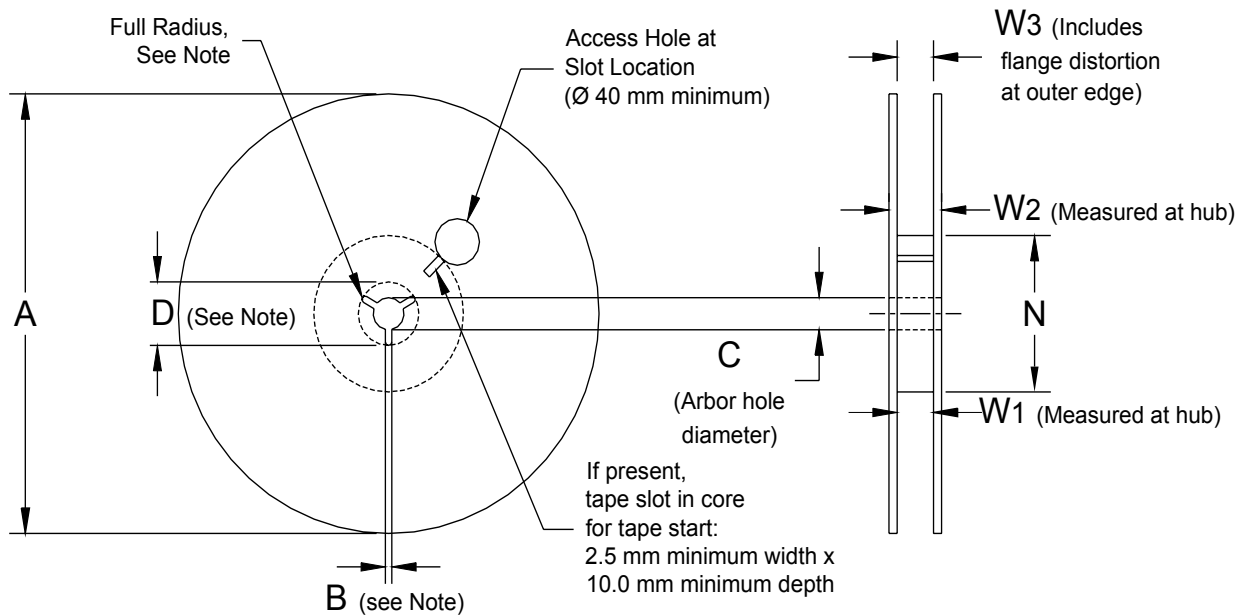
### Figure 4 – Maximum Lateral Movement



### Figure 5 – Bending Radius



**Figure 6 – Reel Dimensions**



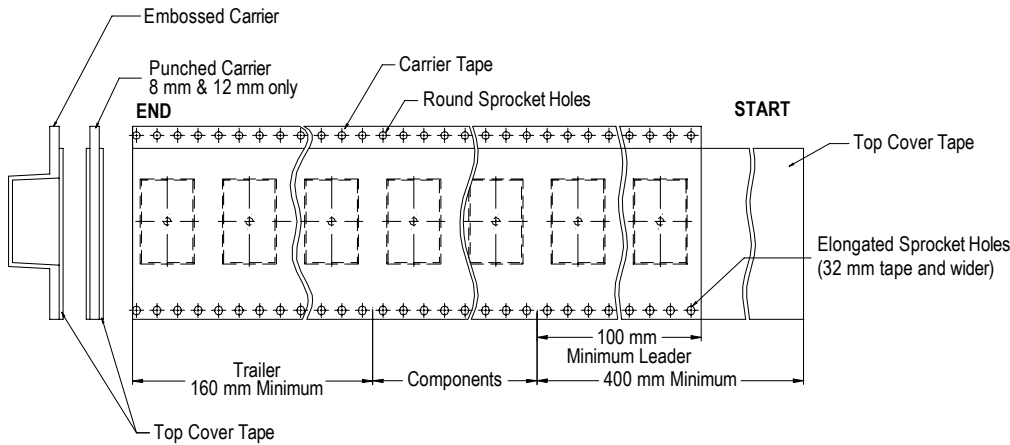
Note: Drive spokes optional; if used, dimensions B and D shall apply.

**Table 8 – Reel Dimensions**

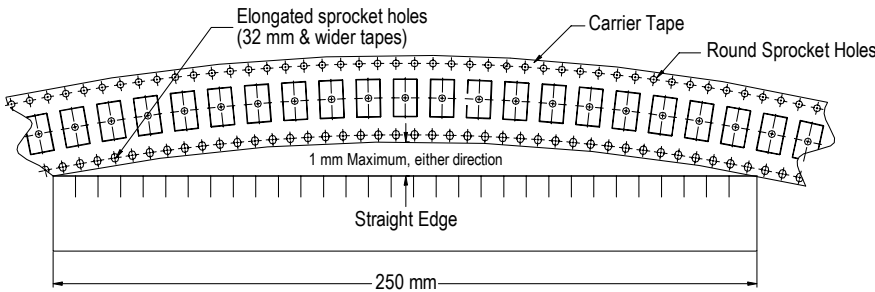
Metric will govern

Constant Dimensions — Millimeters (Inches)				
Tape Size	A	B Minimum	C	D Minimum
8 mm	178 ±0.20 (7.008 ±0.008)	1.5 (0.059)	13.0 +0.5/-0.2 (0.521 +0.02/-0.008)	20.2 (0.795)
12 mm	or			
16 mm	330 ±0.20 (13.000 ±0.008)			
Variable Dimensions — Millimeters (Inches)				
Tape Size	N Minimum	W <sub>1</sub>	W <sub>2</sub> Maximum	W <sub>3</sub>
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**



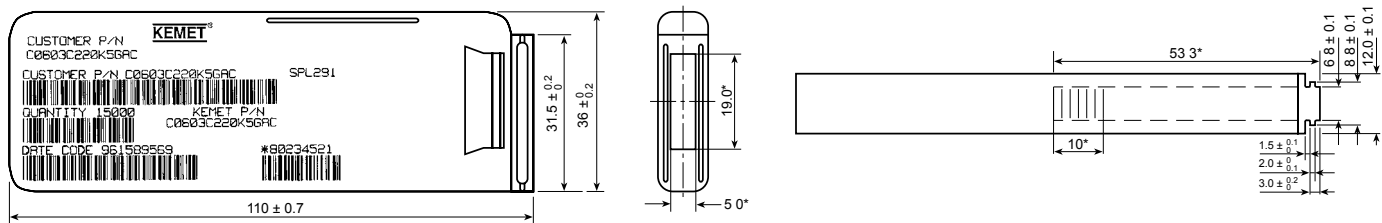
**Figure 8 – Maximum Camber**



**Figure 9 – Bulk Cassette Packaging (Ceramic Chips Only)**

Meets Dimensional Requirements IEC-286 and EIAJ 7201

Unit mm \*Reference



**Table 9 – Capacitor Dimensions for Bulk Cassette**

Cassette Packaging – Millimeters

EIA Size Code	Metric Size Code	L Length	W Width	B Bandwidth	S Separation Minimum	T Thickness	Number of Pieces/Cassette
0402	1005	1.0 ± 0.05	0.5 ± 0.05	0.2 to 0.4	0.3	0.5 ± 0.05	50,000
0603	1608	1.6 ± 0.07	0.8 ± 0.07	0.2 to 0.5	0.7	0.8 ± 0.07	15,000

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[CCR07CG473KR](#) [CCR05CG820JP](#) [TKC-TMC1206-05-1501-J??](#) [TKC-TMC1206-05-1801-J](#) [TKC-TMC1206-05-20R0-F](#) [TKC-](#)  
[TMC1206-05-3901-J](#) [TKC-TMC1206-05-44R2-F](#) [TKC-TMC1206-05-4703-J??](#)