

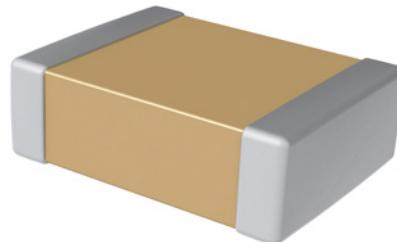
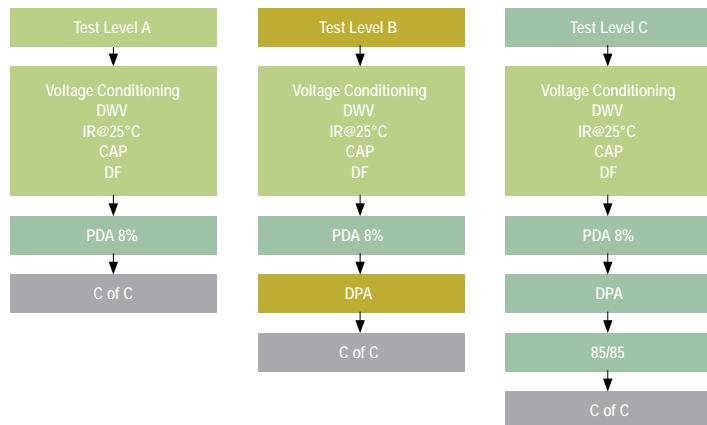
# Commercial Off-The-Shelf (COTS) for Higher Reliability Applications, X7R Dielectric, 6.3 – 250 VDC

## Overview

KEMET's COTS program is an extension of KEMET knowledge of high reliability test regimes and requirements. KEMET regularly supplies "up-screened" products by working with customer drawings and imposing specified design and test requirements. The COTS program offers the same high quality and high reliability components as up-screened products, but at a lower cost to the customer. This is accomplished by eliminating the need for customer-specific drawings to achieve the reliability level required for customer applications. A series of tests and inspections have been selected to provide the accelerated conditioning and 100% screening necessary to eliminate infant mortal failures from the population.

KEMET's X7R dielectric features a 125°C maximum operating temperature and is considered "temperature stable." The Electronics Components, Assemblies & Materials Association (EIA) characterizes X7R dielectric as a Class II material. Components of this classification are fixed, ceramic dielectric capacitors suited for bypass and decoupling applications or for frequency discriminating circuits where Q and stability of capacitance characteristics are not critical. X7R exhibits a predictable change in capacitance with respect to time and voltage and boasts a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to  $\pm 15\%$  from -55°C to +125°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 <sup>1</sup>	Packaging/Grade (C-Spec)
	0402 0603 0805 1206 1210 1805 1808 1812 2220	T = COTS	Two significant digits and number of zeros	J = $\pm 5\%$ K = $\pm 10\%$ M = $\pm 20\%$	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 $\mu$ m min.	See "Packaging C-Spec Ordering Options Table"

<sup>1</sup> 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 <sup>1</sup>	Packaging/Grade Ordering Code (C-Spec)
Bulk Bag/Unmarked	Not required (Blank)
7" Reel/Unmarked	TU
13" Reel/Unmarked	7138

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

<sup>1</sup> 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".

## Packaging C-Spec Ordering Options Table (Gold Termination)

Termination Finish Options	Packaging Type/Options	Packaging Ordering Code (C-Spec)
Standard Packaging – Unmarked <sup>3</sup>		
G = Gold (Au) 100 µin minimum	Bulk Bag	Blank <sup>1</sup>
	Waffle Tray <sup>2</sup>	7292
	7" Reel	TU
	13" Reel	7138
	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

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

<sup>2</sup> "Bulk Bag" packaging option is not available for Gold (Au) termination finish options and case sizes larger than 2225 (5664 Metric).

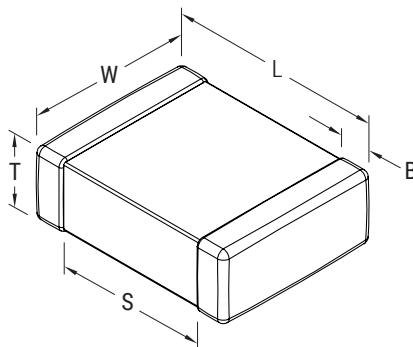
<sup>2</sup> "Waffle Tray" packaging option is not available for case sizes larger than 2225 (5664 Metric).

<sup>3</sup> 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.

<sup>3</sup> 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  $\geq 1.9$  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.

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)	0.50 (0.020)	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)	0.70 (0.028)	
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)	1.50 (0.060)	
1210 <sup>1</sup>	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)	1.50 (0.060)	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)	2.90 (0.114)	
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)	2.90 (0.114)	
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)	2.30 (0.091)	
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)	3.50 (0.138)	

<sup>1</sup> 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%
<sup>1</sup> Aging Rate (Maximum % Capacitance Loss/Decade Hour)	3.0%
<sup>2</sup> Dielectric Withstanding Voltage (DWV)	250% of rated voltage (5±1 seconds and charge/discharge not exceeding 50mA)
<sup>3</sup> Dissipation Factor (DF) Maximum Limit at 25°C	5%(6.3V & 10V), 3.5%(16V & 25V) and 2.5%(50V to 250V)
<sup>4</sup> Insulation Resistance (IR) Minimum Limit at 25°C	See Insulation Resistance Limit Table (Rated voltage applied for 120±5 seconds at 25°C)

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

<sup>2</sup> 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.

<sup>3</sup> 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

<sup>4</sup> 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

**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	6.3	10	16	25	50	6.3	10	16	25	50	100	200	250	6.3	10	16	25	50	100	200	250			
		Rated Voltage (VDC)		6.3	10	16	25	50	6.3	10	16	25	50	6.3	10	16	25	50	100	200	250	6.3	10	16	25	50	100	200	250			
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	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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
12,000 pF	123	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	
15,000 pF	153	J	K	M	BB	BB	BB	BB	BB	CF	CF	CF	CF	CF	CF	CF	DN	DN	DN	DN	DN	DP	DN	DN	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	CF	DN	DN	DN	DN	DN	DP	DN	DN	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	CF	DN	DN	DN	DN	DN	DP	DN	DN	EB	EB	EB	EB	EB	EB	EB	
27,000 pF	273	J	K	M	BB	BB	BB	BB	BB	CF	CF	CF	CF	CF	CF	CF	DN	DN	DN	DN	DN	DP	DE	DN	EB	EB	EB	EB	EB	EB	EB	
33,000 pF	333	J	K	M	BB	BB	BB	BB	BB	CF	CF	CF	CF	CF	CF	CF	DN	DN	DN	DN	DN	DP	DE	DN	EB	EB	EB	EB	EB	EB	EB	
39,000 pF	393	J	K	M	BB	BB	BB	BB	BB	CF	CF	CF	CF	CF	CF	CF	DN	DN	DN	DN	DN	DP	DE	DN	EB	EB	EB	EC	EB	EB	EB	
47,000 pF	473	J	K	M	BB	BB	BB	BB	BB	CF	CF	CF	CF	CF	CF	CF	DN	DN	DN	DN	DN	DE	DG	DN	EB	EB	EB	EC	ED	ED	ED	
56,000 pF	563	J	K	M	BB	BB	BB			CF	CF	CF	CF	CF	CF	CF	DP	DP	DP	DP	DP	DE	DG	DN	EB	EB	EB	EB	ED	ED	ED	
68,000 pF	683	J	K	M	BB	BB	BB			CF	CF	CF	CF	CF	CF	CF	DP	DP	DP	DP	DP	DE		DN	EB	EB	EB	ED	ED	ED	ED	
82,000 pF	823	J	K	M	BB	BB	BB			CF	CF	CF	CF	CF	CF	CF	DP	DP	DP	DP	DP	DE		DN	EB	EB	EB	ED	ED	ED	ED	
0.10 µF	104	J	K	M						CF	CF	CF	CF	CF	CF	CF	DN	DN	DN	DN	DN	DE	DG		EB	EB	EB	EM	EM	EM	EM	
0.12 µF	124	J	K	M						CF	CF	CF	CF	CF	CF	CF	DN	DN	DN	DN	DN	DP	DG		EC	EC	EC	EG	EG	EG	EG	
0.15 µF	154	J	K	M						CF	CF	CF	CF	CF	CF	CF	DN	DN	DN	DN	DN	DP	DG		EC	EC	EC	EG	EG	EG	EG	
0.18 µF	184	J	K	M						CF	CF	CF	CF	CF	CF	CF	DN	DN	DN	DN	DN	DP	DG		EC	EC	EC	EC	EC	EC	EC	
0.22 µF	224	J	K	M						CF	CF	CF	CF	CF	CF	CF	DN	DN	DN	DN	DN	DP	DG		EC	EC	EC	EC	EC	EC	EC	
0.27 µF	274	J	K	M						CF	CF	CF	CF	CF	CF	CF	DP	DP	DP	DP	DP	DE		DN	EB	EB	EB	EC	EM	ED	ED	
0.33 µF	334	J	K	M						CF	CF	CF	CF	CF	CF	CF	DP	DP	DP	DP	DP	DE		DN	EB	EB	EB	EG	EG	EG	EG	
0.39 µF	394	J	K	M						CF	CF	CF	CF	CF	CF	CF	DG	DG	DG	DG	DG	DE		DN	EB	EB	EB	EC	EG	EG	EG	
0.47 µF	474	J	K	M						CF	CF	CF	CF	CF	CF	CF	DP	DP	DP	DP	DP	DE		DN	EC	EC	EC	EC	EG	EG	EG	
0.56 µF	564	J	K	M												DP	DP	DP	DP	DP	DE		DN	ED	ED	ED	ED	EC	ED	ED		
0.68 µF	684	J	K	M												DP	DP	DP	DP	DP	DH		DN	EE	EE	EE	EE	ED	ED	ED		
0.82 µF	824	J	K	M												DP	DP	DP	DP	DP	DH		DN	EF	EF	EF	EF	ED	ED	ED		
1.0 µF	105	J	K	M												DP	DP	DP	DP	DP	DG		DN	EF	EF	EF	EG	ED	ED	ED		
1.2 µF	125	J	K	M												DE	DE	DE						EN	EN	EN	EH					
1.5 µF	155	J	K	M												DG	DG	DG						ED	ED	EF	EH					
1.8 µF	185	J	K	M												DG	DG	DG						ED	ED	ED	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	EH				
6.8 µF	685	J	K	M																					EH	EH	EH	EH				
Capacitance	Cap Code																															

**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 pF 10 pF	825 106	J J	K K	M M																					EH EH	EH 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												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	FB	NC	NC	NC	LF	LF	LF
100 - 180 pF**	101 - 181**	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NC	NC	NC	LF	LF	LF
220 pF	221	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NC	NC	NC	LF	LF	LF
270 pF	271	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NC	NC	NC	LF	LF	LF
330 pF	331	J	K	M	FB	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	FB	NC	NC	NC	LF	LF	LF
470 - 820 pF**	471 - 821**	J	K	M	FB	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	FB	NC	NC	NC	LF	LF	LF
1,200 pF	122	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NC	NC	NC	LF	LF	LF
1,500 pF	152	J	K	M	FB	FB	FB	FB	FB	FB	FB	FE	NC	NC	NC	LF	LF	LF
1,800 pF	182	J	K	M	FB	FB	FB	FB	FB	FB	FB	FE	NC	NC	NC	LF	LF	LF
2,200 pF	222	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NC	NC	NC	LF	LF	LF
2,700 pF	272	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA	NA	LF	LF	LF
3,300 pF	332	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA	NA	LF	LF	LF
3,900 pF	392	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA	NA	LF	LF	LF
4,700 pF	472	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA	NA	LD	LD	LD
5,600 pF	562	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA	NA	LD	LD	LD
6,800 pF	682	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA	NA	LD	LD	LD
8,200 pF	822	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA	NA	LD	LD	LD
10,000 pF	103	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA	NA	LD	LD	LD
12,000 pF	123	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA	NA	LD	LD	LD
15,000 pF	153	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA	NA	LD	LD	LD
18,000 pF	183	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA	NA	LD	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	NA	LD	LD	
27,000 pF	273	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA	NA	LD	LD	
33,000 pF	333	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA	NA	LD	LD	
39,000 pF	393	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA	NA	LD	LD	
47,000 pF	473	J	K	M	FB	FB	FB	FB	FB	FB	FB	FB	NA	NA	NA	LD	LD	
56,000 pF	563	J	K	M	FB	FB	FB	FB	FB	FB	FB	FC	FC	NA	NA	LD	LD	
68,000 pF	683	J	K	M	FB	FB	FB	FB	FB	FB	FB	FC	FC	NA	NA	LD	LD	
82,000 pF	823	J	K	M	FB	FB	FB	FB	FB	FB	FC	FF	FF	NA	NA	LD	LD	
0.10 µF	104	J	K	M	FB	FB	FB	FB	FB	FB	FD	FG	FG	NA	NA	LD	LD	
0.12 µF	124	J	K	M	FB	FB	FB	FB	FB	FB	FD	FH	FH	NA	NA	LD	LD	
0.15 µF	154	J	K	M	FC	FC	FC	FC	FC	FC	FD	FM	FM	NA	NA	LD	LD	
0.18 µF	184	J	K	M	FC	FC	FC	FC	FC	FC	FK	FK	NA	NA	NA	LD	LD	
0.22 µF	224	J	K	M	FC	FC	FC	FC	FC	FC	FD	FK	FK	NA	NA	LD	LD	
0.27 µF	274	J	K	M	FC	FC	FC	FC	FC	FC	FD	FG	FG	NA	NA	LD	LD	
0.33 µF	334	J	K	M	FD	FD	FD	FD	FD	FD	FD	FD	FD	NA	NA	LD	LD	
0.39 µF	394	J	K	M	FD	FD	FD	FD	FD	FD	FD	FD	FD	NA	NA	LD	LD	
0.47 µF	474	J	K	M	FD	FD	FD	FD	FD	FD	FD	FD	FD	NA	NA	LD	LD	
0.56 µF	564	J	K	M	FD	FD	FD	FD	FD	FD	FF	FF	FF	NA	NA	LD	LD	
0.68 µF	684	J	K	M	FD	FD	FD	FD	FD	FD	FD	FG	FG	NA	NA	LD	LD	
0.82 µF	824	J	K	M	FF	FF	FF	FF	FF	FF	FF	FL	FL	NA	NA	LD	LD	
1.0 µF	105	J	K	M	FH	FH	FH	FH	FH	FH	FH	FM	FM	NA	NA	LD	LD	
1.2 µF	125	J	K	M	FH	FH	FH	FH	FH	FH	FG	FG	FG	NA	NA	LD	LD	
1.5 µF	155	J	K	M	FH	FH	FH	FH	FH	FH	FG	FG	FG	NA	NA	LD	LD	
1.8 µF	185	J	K	M	FH	FH	FH	FH	FH	FH	FG	FG	FG	NA	NA	LD	LD	
2.2 µF	225	J	K	M	FJ	FJ	FJ	FJ	FJ	FJ	FG	FG	FG	NA	NA	LD	LD	
2.7 µF	275	J	K	M	FE	FE	FE	FE	FE	FE	FG	FG	FG	NA	NA	LD	LD	
3.3 µF	335	J	K	M	FF	FF	FF	FF	FF	FF	FM	FM	FM	NA	NA	LD	LD	
3.9 µF	395	J	K	M	FG	FG	FG	FG	FG	FG	FK	FK	FK	NA	NA	LD	LD	
4.7 µF	475	J	K	M	FC	FC	FC	FC	FC	FC	FS	FS	FS	NA	NA	LD	LD	
5.6 µF	565	J	K	M	FF	FF	FF	FF	FF	FF	FH	FH	FH	NA	NA	LD	LD	
6.8 µF	685	J	K	M	FG	FG	FG	FG	FG	FG	FM	FM	FM	NA	NA	LD	LD	
8.2 µF	825	J	K	M	FH	FH	FH	FH	FH	FH	FK	FK	FK	NA	NA	LD	LD	
10 µF	106	J	K	M	FH	FH	FH	FH	FS	FS	NA	NA	NA	NA	NA	LD	LD	
22 µF	226	J	K	M	FS	FS	FS	FS	FS	FS	NA	NA	NA	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 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										
8,200 pF	822	J	K	M	GB	GB	GB	GB	GB										
10,000 pF	103	J	K	M	GB	GB	GB	GB	GB										
12,000 pF	123	J	K	M	GB	GB	GB	GB	GB										
15,000 pF	153	J	K	M	GB	GB	GB	GB	GB										
18,000 pF	183	J	K	M	GB	GB	GB	GB	GB										
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		
0.10 µF	104	J	K	M	GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JC	JC		
0.12 µF	124	J	K	M	GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JC	JC		
0.15 µF	154	J	K	M	GB	GB	GB	GE	GE	HB	HB	HB	HB	JB	JB	JC	JC		
0.18 µF	184	J	K	M	GB	GB	GB	GG	GG	HB	HB	HB	HB	JB	JB	JC	JC		
0.22 µF	224	J	K	M	GB	GB	GB	GG	GG	HB	HB	HB	HB	JB	JB	JC	JC		
0.27 µF	274	J	K	M	GB	GB	GG	GG	GG	HB	HB	HB	HB	JC	JC	JC	JC		
0.33 µF	334	J	K	M	GB	GB	GG	GG	GG	HB	HB	HB	HB	JC	JC	JC	JC		
0.39 µF	394	J	K	M	GB	GB	GG	GG	GG	HD	HD	HD	HD	JC	JC	JC	JC		
0.47 µF	474	J	K	M	GB	GB	GG	GJ	GJ	HD	HD	HD	HD	JC	JC	JC	JC		
0.56 µF	564	J	K	M	GC	GC	GG			HD	HD	HD	HD	JC	JD	JD	JD		
0.68 µF	684	J	K	M	GC	GC	GG			HD	HD	HD	HD	JC	JD	JD	JD		
0.82 µF	824	J	K	M	GE	GE	GG			HF	HF	HF	HF	JC	JF	JF	JF		
1.0 µF	105	J	K	M	GE	GE	GG			HF	HF	HF	HF	JC	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								JF	JF				
4.7 µF	475	J	K	M	GK	GK													
10 µF	106	J	K	M	GK									JO	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	Thickness $\pm$ Range (mm)	Paper Quantity		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
BB	0402	0.50 $\pm$ 0.05	10,000	50,000	0	0
CF	0603	0.80 $\pm$ 0.07	4,000	15,000	0	0
DN	0805	0.78 $\pm$ 0.10	4,000	15,000	0	0
DP	0805	0.90 $\pm$ 0.10	4,000	15,000	0	0
DE	0805	1.00 $\pm$ 0.10	0	0	2,500	10,000
DG	0805	1.25 $\pm$ 0.15	0	0	2,500	10,000
DH	0805	1.25 $\pm$ 0.20	0	0	2,500	10,000
EB	1206	0.78 $\pm$ 0.10	0	0	4,000	10,000
EC	1206	0.90 $\pm$ 0.10	0	0	4,000	10,000
EN	1206	0.95 $\pm$ 0.10	0	0	4,000	10,000
ED	1206	1.00 $\pm$ 0.10	0	0	2,500	10,000
EE	1206	1.10 $\pm$ 0.10	0	0	2,500	10,000
EF	1206	1.20 $\pm$ 0.15	0	0	2,500	10,000
EM	1206	1.25 $\pm$ 0.15	0	0	2,500	10,000
EG	1206	1.60 $\pm$ 0.15	0	0	2,000	8,000
EH	1206	1.60 $\pm$ 0.20	0	0	2,000	8,000
FB	1210	0.78 $\pm$ 0.10	0	0	4,000	10,000
FC	1210	0.90 $\pm$ 0.10	0	0	4,000	10,000
FD	1210	0.95 $\pm$ 0.10	0	0	4,000	10,000
FE	1210	1.00 $\pm$ 0.10	0	0	2,500	10,000
FF	1210	1.10 $\pm$ 0.10	0	0	2,500	10,000
FG	1210	1.25 $\pm$ 0.15	0	0	2,500	10,000
FL	1210	1.40 $\pm$ 0.15	0	0	2,000	8,000
FH	1210	1.55 $\pm$ 0.15	0	0	2,000	8,000
FM	1210	1.70 $\pm$ 0.20	0	0	2,000	8,000
FJ	1210	1.85 $\pm$ 0.20	0	0	2,000	8,000
FK	1210	2.10 $\pm$ 0.20	0	0	2,000	8,000
FS	1210	2.50 $\pm$ 0.30	0	0	1,000	4,000
NA	1805	0.90 $\pm$ 0.10	0	0	4,000	10,000
NC	1805	1.00 $\pm$ 0.15	0	0	4,000	10,000
LD	1808	0.90 $\pm$ 0.10	0	0	2,500	10,000
LF	1808	1.00 $\pm$ 0.15	0	0	2,500	10,000
GB	1812	1.00 $\pm$ 0.10	0	0	1,000	4,000
GC	1812	1.10 $\pm$ 0.10	0	0	1,000	4,000
GD	1812	1.25 $\pm$ 0.15	0	0	1,000	4,000
GE	1812	1.30 $\pm$ 0.10	0	0	1,000	4,000
GH	1812	1.40 $\pm$ 0.15	0	0	1,000	4,000
GG	1812	1.55 $\pm$ 0.10	0	0	1,000	4,000
GK	1812	1.60 $\pm$ 0.20	0	0	1,000	4,000
GJ	1812	1.70 $\pm$ 0.15	0	0	1,000	4,000
GO	1812	2.50 $\pm$ 0.20	0	0	500	2,000
HB	1825	1.10 $\pm$ 0.15	0	0	1,000	4,000
HD	1825	1.30 $\pm$ 0.15	0	0	1,000	4,000
HF	1825	1.50 $\pm$ 0.15	0	0	1,000	4,000
JB	2220	1.00 $\pm$ 0.15	0	0	1,000	4,000
JC	2220	1.10 $\pm$ 0.15	0	0	1,000	4,000
JD	2220	1.30 $\pm$ 0.15	0	0	1,000	4,000
JE	2220	1.40 $\pm$ 0.15	0	0	1,000	4,000
JF	2220	1.50 $\pm$ 0.15	0	0	1,000	4,000
JO	2220	2.40 $\pm$ 0.15	0	0	500	2,000
Thickness Code	Case Size <sup>1</sup>	Thickness $\pm$ Range (mm)	7" Reel	13" Reel	7" Reel	13" Reel
			Paper Quantity <sup>1</sup>		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 <sup>1</sup>	N/A <sup>2</sup>		
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		

<sup>1</sup> 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.

<sup>2</sup> 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 <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
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

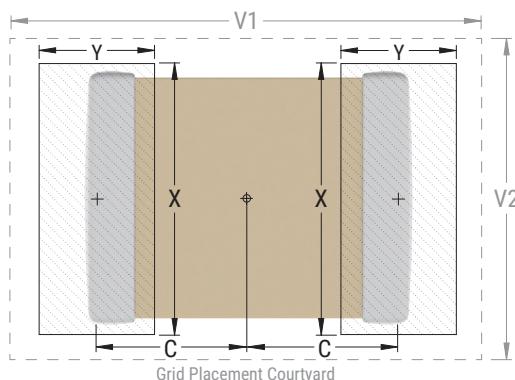
<sup>1</sup> Only for capacitance values  $\geq 22 \mu\text{F}$

**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

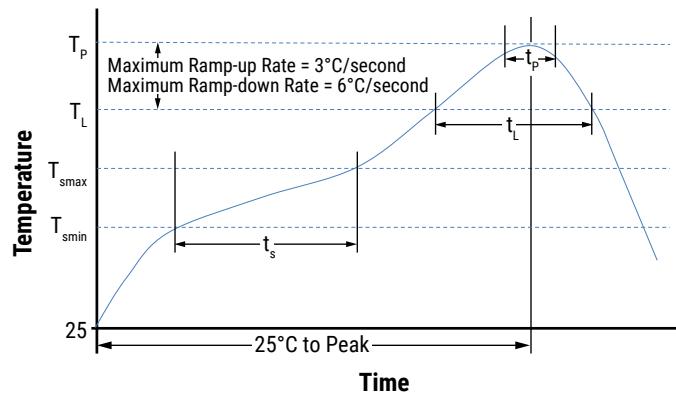
### Recommended Soldering Technique:

- 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.

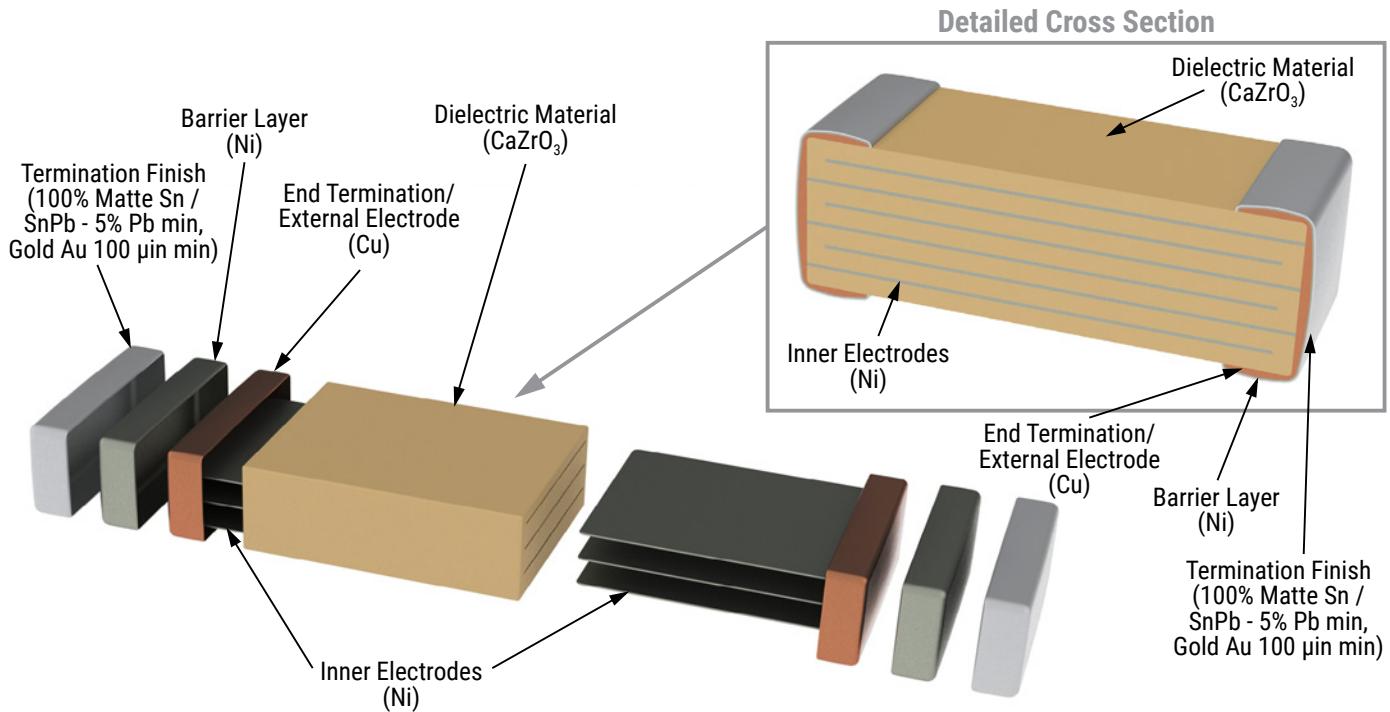
**Table 4 – Performance & Reliability: Test Methods and Conditions**

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 COG. Flexible termination system – 3.0 mm (minimum).
Solderability	J-STD-002	Magnification 50 X. Conditions:
		a) Method B, 4 hours at 155°C, dry heat at 235°C
		b) Method B at 215°C category 3
		c) Method D, category 3 at 260°C
Temperature Cycling	JESD22 Method JA-104	1,000 Cycles (-55°C to +125°C). Measurement at 24 hours +/-4 hours after test conclusion.
Biased Humidity	MIL-STD-202 Method 103	Load Humidity: 1,000 hours 85°C/85% RH and rated voltage. Add 100 K ohm resistor. Measurement at 24 hours +/-4 hours after test conclusion.
		Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. 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 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.

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  $\mu$ F. Orientation of marking is vendor optional.



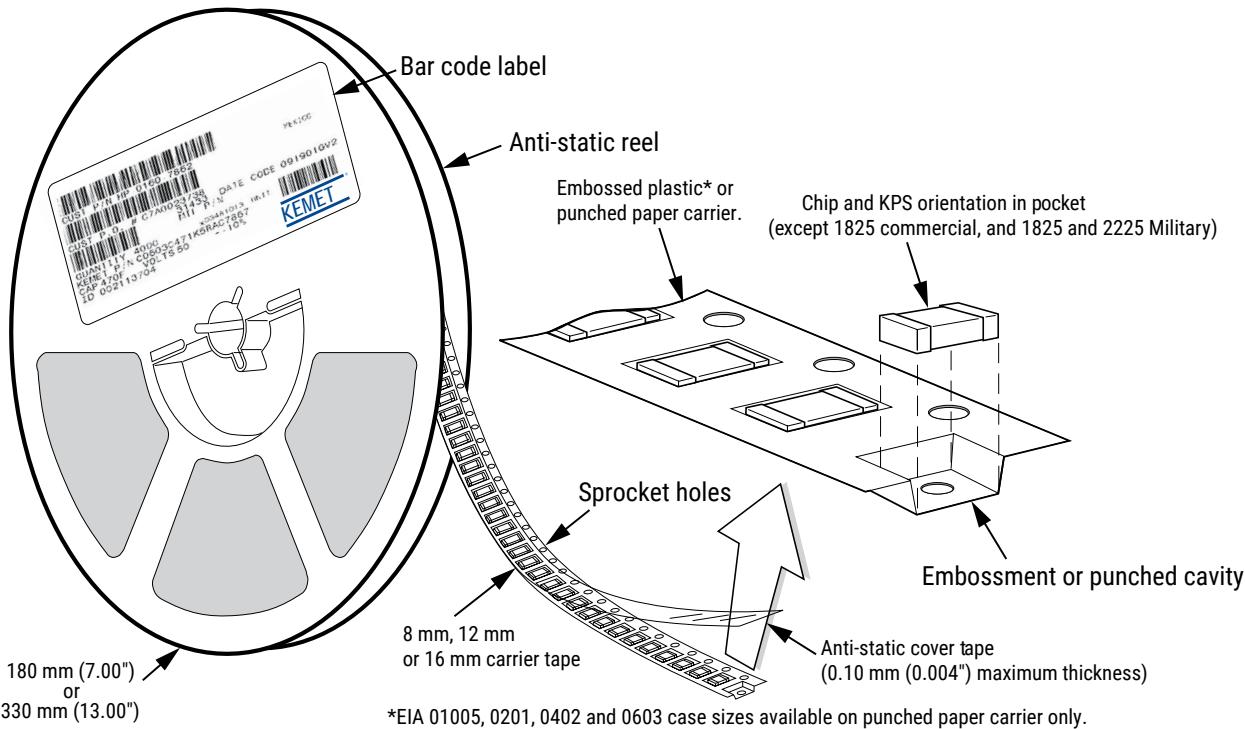
EIA Case Size	Metric Size Code	Capacitance
0603	1608	$\leq 170 \text{ pF}$
0805	2012	$\leq 150 \text{ pF}$
1206	3216	$\leq 910 \text{ pF}$
1210	3225	$\leq 2,000 \text{ pF}$
1808	4520	$\leq 3,900 \text{ pF}$
1812	4532	$\leq 6,700 \text{ pF}$
1825	4564	$\leq 0.018 \mu\text{F}$
2220	5650	$\leq 0.027 \mu\text{F}$
2225	5664	$\leq 0.033 \mu\text{F}$

## Capacitor Marking (Optional) cont.

Alpha Character	Capacitance (pF) For Various Alpha/Numeral Identifiers									
	Numeral									
	9	0	1	2	3	4	5	6	7	8
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.



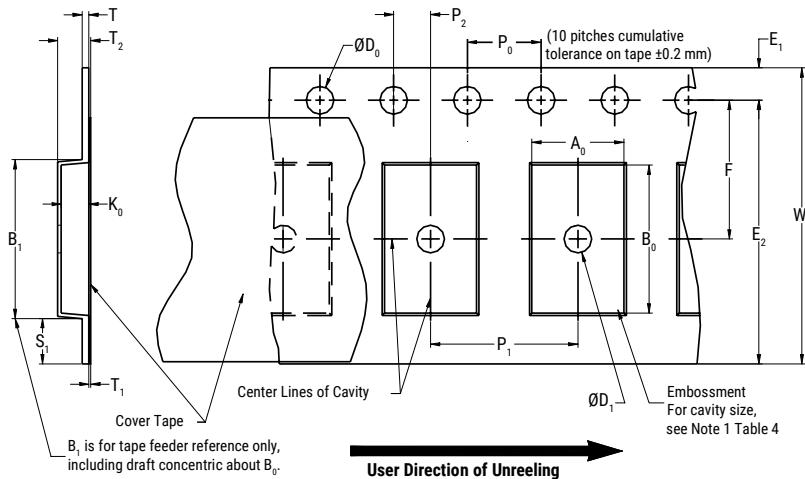
**Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)**

EIA Case Size	Tape Size (W)*	Embossed Plastic		Punched Paper	
		7" Reel	13" Reel	7" Reel	13" Reel
		Pitch (P <sub>1</sub> )*		Pitch (P <sub>1</sub> )*	
01005 – 0402	8			2	2
0603	8			4	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<sub>1</sub> carrier tape reference locations.

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

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



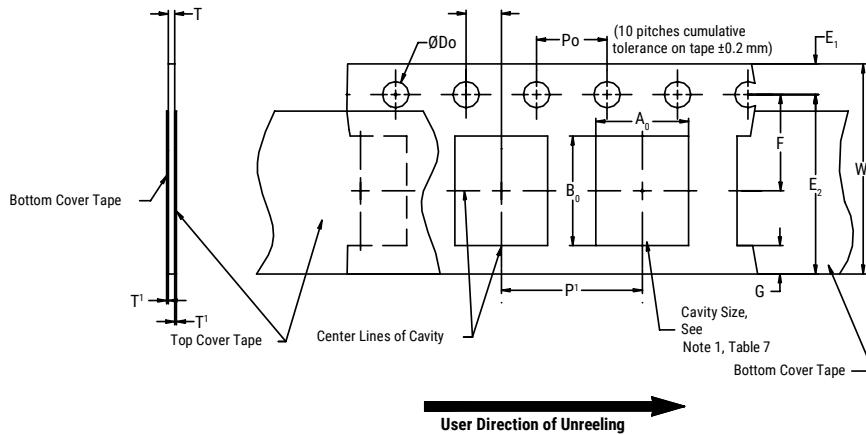
## Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

Constant Dimensions – Millimeters (Inches)										
Tape Size	$D_0$	$D_1$ 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	$A_0, B_0 & K_0$		
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 <sub>0</sub>	E <sub>1</sub>	P <sub>0</sub>	P <sub>2</sub>	T <sub>1</sub> 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 <sub>1</sub>	T Maximum	W Maximum	A <sub>0</sub> B <sub>0</sub>
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)	1.1 (0.043)	8.3 (0.327)	Note 1

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  $20^\circ$  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.

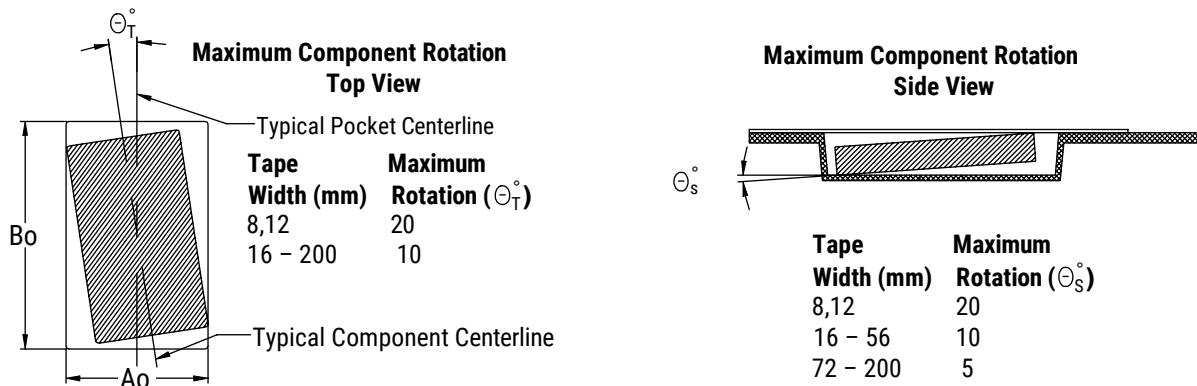
**2. Cover Tape Peel Strength:** The total peel strength of the cover tape from the carrier tape shall be:

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)

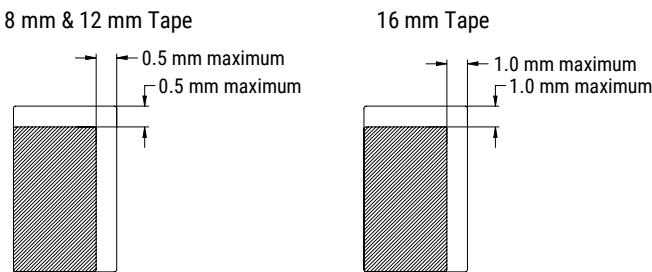
The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ±10 mm/minute.

**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.

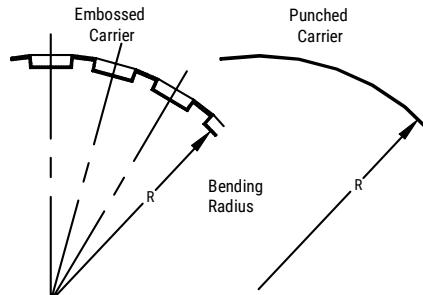
**Figure 3 – Maximum Component Rotation**



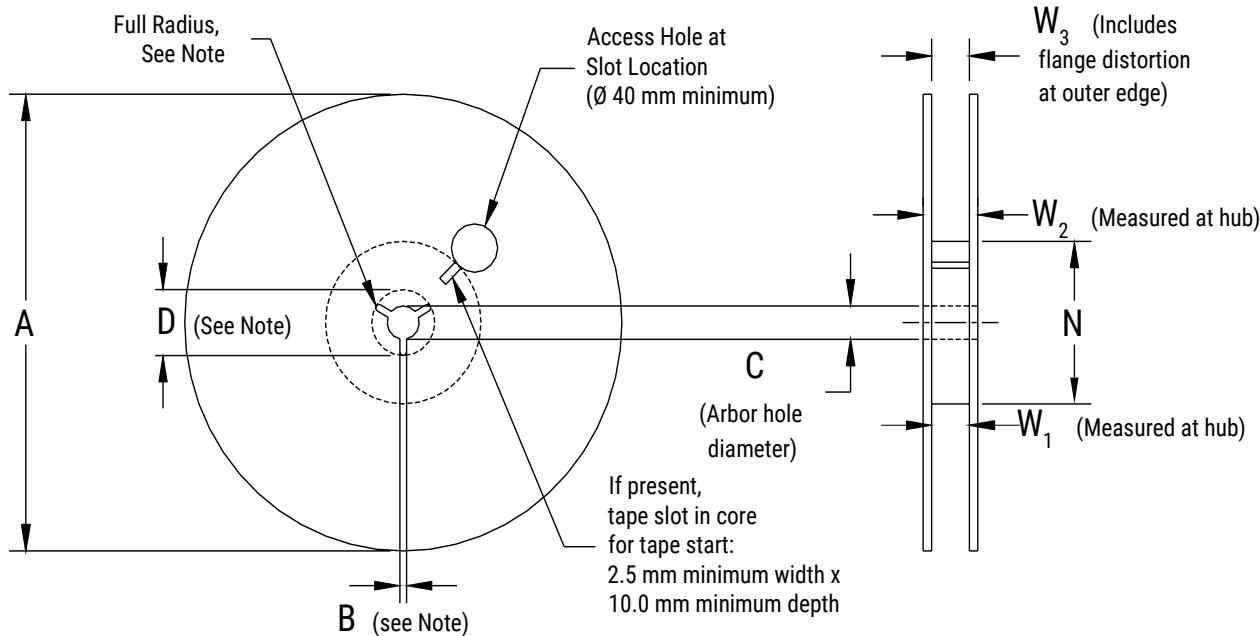
**Figure 4 – Maximum Lateral Movement**



**Figure 5 – Bending Radius**



## Figure 6 – Reel Dimensions



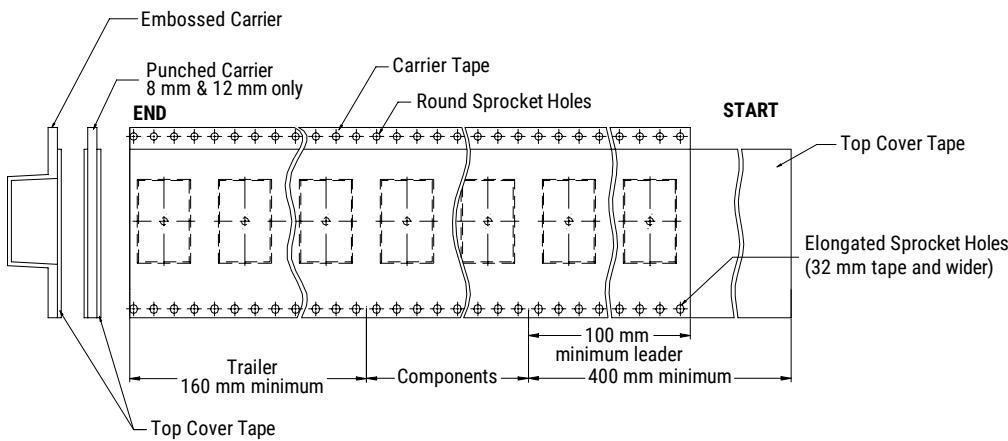
Note: Drive spokes optional; if used, dimensions B and D shall apply.

## Table 8 – Reel Dimensions

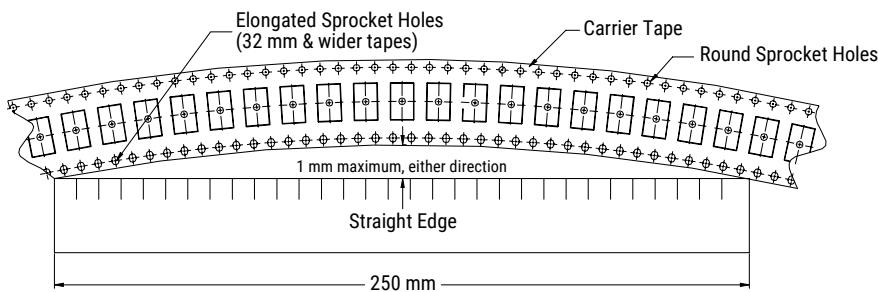
Metric will govern

Constant Dimensions – Millimeters (Inches)				
Tape Size	A	B Minimum	C	D Minimum
8 mm	$178 \pm 0.20$ ( $7.008 \pm 0.008$ ) or $330 \pm 0.20$ ( $13.000 \pm 0.008$ )	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 <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**



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