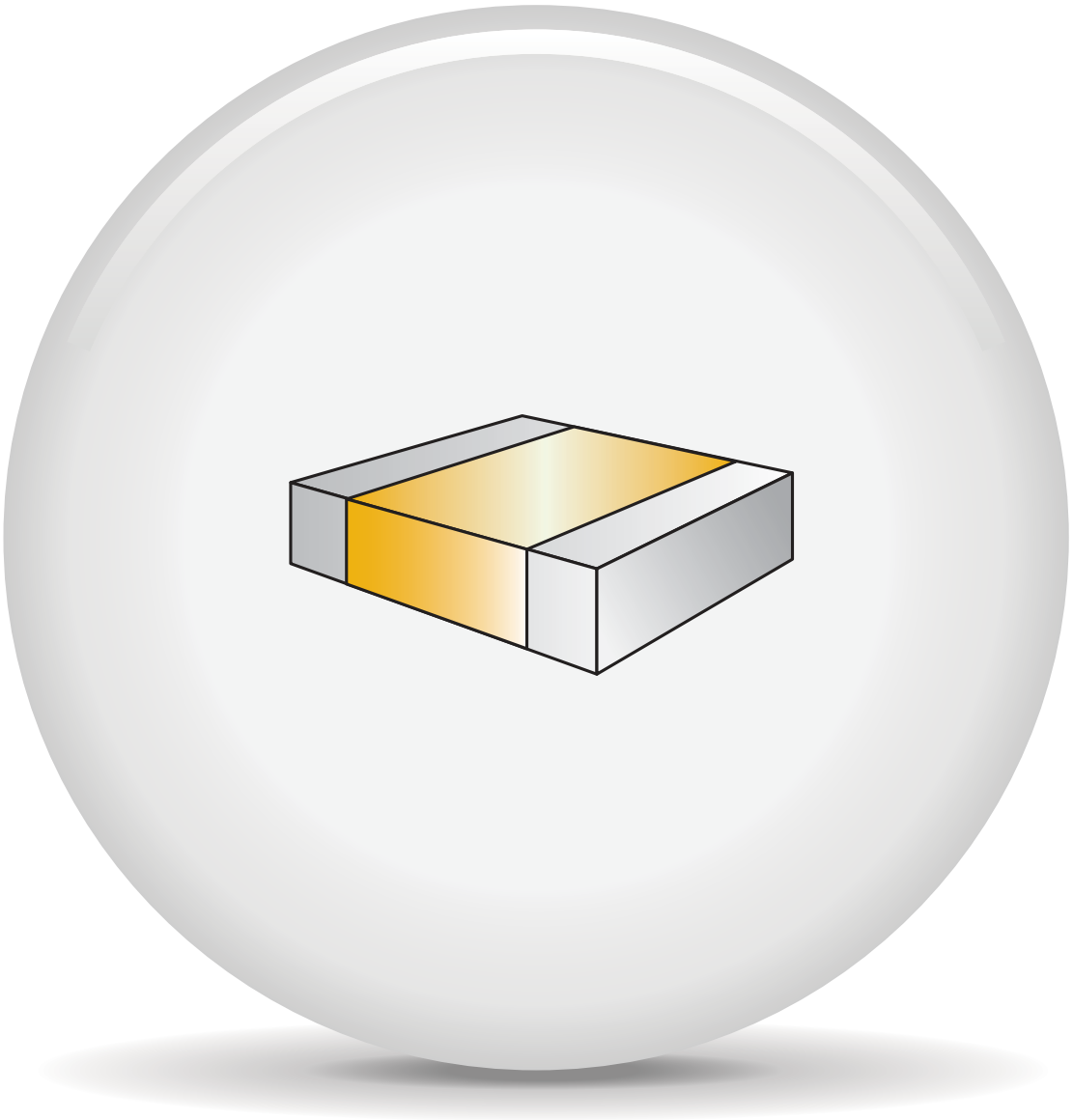
Surface Mount Multilayer Ceramic Capacitors

Commercial Grade



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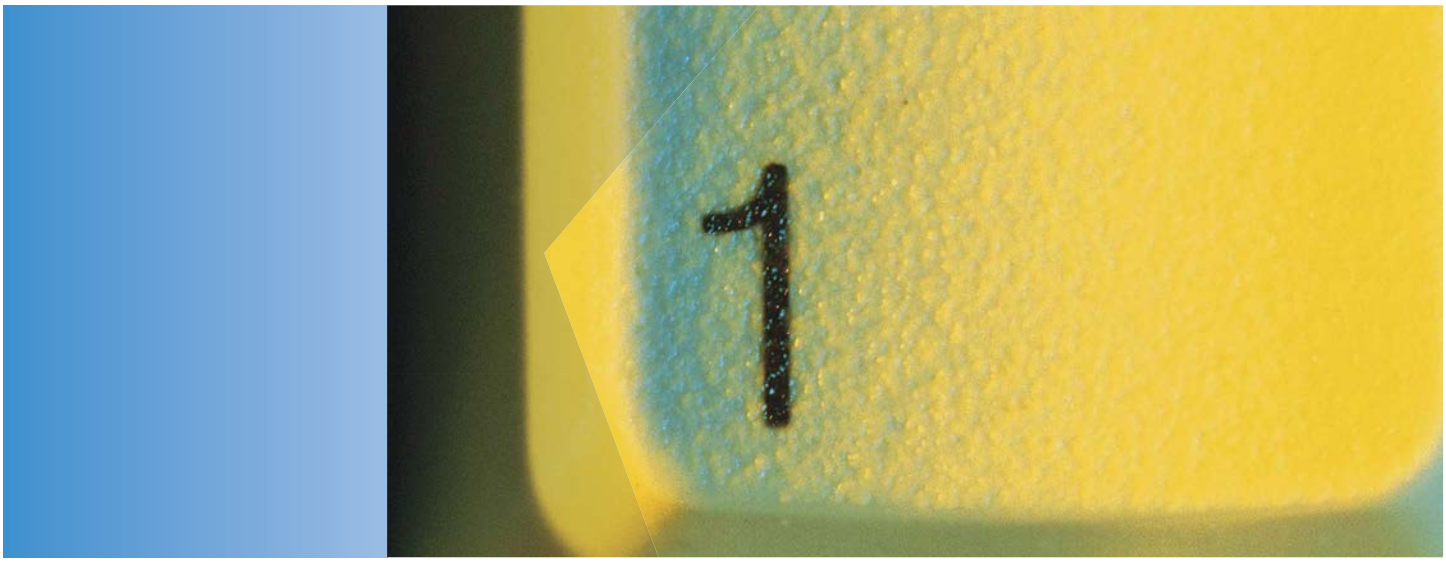

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About KEMET.

KEMET Corporation is a leading global supplier of electronic components. We offer our customers the broadest selection of capacitor technologies in the industry across multiple dielectrics, along with an expanding range of electromechanical devices, and electromagnetic compatibility solutions. Our vision is to be the preferred supplier of electronic component solutions for customers demanding the highest standards of quality, delivery and service.

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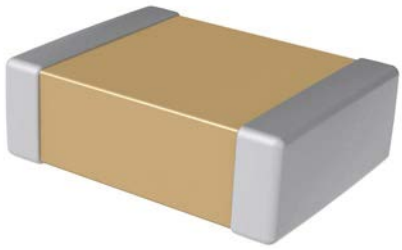
C0G Dielectric, 10 – 250 VDC (Commercial Grade)

Overview

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
- Lead (Pb)-Free, RoHS, and REACH compliant
- EIA 0201, 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%
- No piezoelectric noise
- Extremely low ESR and ESL
- High thermal stability
- High ripple current capability



Ordering Information

C	1206	C	104	J	3	G	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)
	0201 0402 0603 0805 1206 1210 1808 1812 1825 2220 2225	C = Standard	Two significant digits + 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	See "Packaging C-Spec Ordering Options Table" below

[1] Flexible termination option is available. Please see FT-CAP product bulletin C1062_C0G_FT-CAP_SMD

[2] Additional capacitance tolerance offerings may be available. Contact KEMET for details.

[3] Additional termination finish options may be available. Contact KEMET for details.

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Packaging C-Spec Ordering Options Table

Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)
Bulk Bag/Unmarked	Not required (Blank)
7" Reel/Unmarked	TU
13" Reel/Unmarked	7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes)
7" Reel/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'd

- 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
- SnPb plated 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, blocking and energy storage.

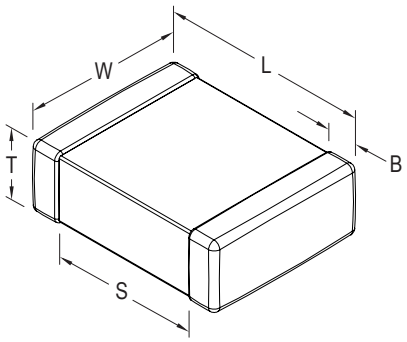
Qualification/Certification

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)



EIA Size Code	Metric Size Code	L Length	W Width	T Thickness	B Bandwidth	S Separation Minimum	Mounting Technique
0201	0603	0.60 (.024) ± 0.03 (.001)	0.30 (.012) ± 0.03 (.001)	See Table 2 for Thickness	0.15 (.006) ± 0.05 (.002)	N/A	Solder Reflow Only
0402	1005	1.00 (.040) ± 0.05 (.002)	0.50 (.020) ± 0.05 (.002)		0.30 (.012) ± 0.10 (.004)	0.30 (.012)	
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	
1210	3225	3.20 (.126) ± 0.20 (.008)	2.50 (.098) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)		Solder Reflow Only
1808	4520	4.70 (.185) ± 0.50 (.020)	2.00 (.079) ± 0.20 (.008)		0.60 (.024) ± 0.35 (.014)		
1812	4532	4.50 (.177) ± 0.30 (.012)	3.20 (.126) ± 0.30 (.012)		0.60 (.024) ± 0.35 (.014)		
1825	4564	4.50 (.177) ± 0.30 (.012)	6.40 (.252) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2220	5650	5.70 (.224) ± 0.40 (.016)	5.00 (.197) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2225	5664	5.60 (.220) ± 0.40 (.016)	6.40 (.248) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		

Electrical Parameters/Characteristics

Item	Parameters/Characteristics
Operating Temperature Range	−55°C to +125°C
Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC)	±30 ppm/°C
Aging Rate (Maximum % Capacitance Loss/Decade Hour)	0%
[1]Dielectric Withstanding Voltage (DWV)	250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA)
[2]Dissipation Factor (DF) Maximum Limit at 25°C	0.1%
[3]Insulation Resistance (IR) Limit at 25°C	1,000 megohm microfarads or 100 GΩ (Rated voltage applied for 120 ±5 seconds at 25°C)

[1] DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.
[2] Capacitance and dissipation factor (DF) measured under the following conditions:

1 MHz ±100 kHz and 1.0 Vrms ±0.2 V if capacitance ≤ 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 (0201 – 1206 Case Sizes)

Cap	Cap Code	Case Size/ Series	C0201C			C0402C							C0603C							C0805C							C1206C						
		Voltage Code	8	4	3	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	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
1.1 pF	119	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
1.2 pF	129	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
1.3 pF	139	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
1.5 pF	159	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
1.6 pF	169	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
1.8 pF	189	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
2.0 pF	209	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
2.2 pF	229	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
2.4 pF	249	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
2.7 pF	279	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
3.0 pF	309	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
3.3 pF	339	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
3.6 pF	369	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
3.9 pF	399	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
4.3 pF	439	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
4.7 pF	479	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
5.1 pF	519	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
5.6 pF	569	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
6.2 pF	629	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
6.8 pF	689	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
7.5 pF	759	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
8.2 pF	829	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
9.1 pF	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	AB[1]	AB[1]	AB[1]	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	AB[2]	AB[2]	AB[2]	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	AB[2]	AB[2]	AB[2]	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	AB[2]	AB[2]	AB[2]	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	AB[2]	AB[2]	AB[2]	BB	BB	BB	BB				CF	CF	CF	CF	CF	CF	CF	DM	DM	DM	DM	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	AB[2]	AB[2]	AB[2]	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	AB[2]	AB[2]	AB[2]	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	AB[2]	AB[2]	AB[2]	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	AB[2]	AB[2]	AB[2]	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	AB[2]	AB[2]	AB[2]	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	AB[2]	AB[2]	AB[2]	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	AB[2]	AB[2]	AB[2]	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	AB[2]	AB[2]	AB[2]	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
Cap	Cap Code	Rated Voltage (VDC)	10	16	25	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	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	C0201C			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).*

xx[1] Available only in D, J, K,M tolerance

xx[2] Available only in J, K, M tolerance.

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

Table 1A – Capacitance Range/Selection Waterfall (0201 – 1206 Case Sizes) cont'd

Cap	Cap Code	Case Size/ Series	C0201C			C0402C							C0603C							C0805C							C1206C						
		Voltage Code	8	4	3	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	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																														
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	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	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
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				
Cap	Cap Code	Rated Voltage (VDC)	10	16	25	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	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	C0201C			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).*
xx¹ Available only in D, J, K,M tolerance
xx² Available only in J, K, M tolerance.
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)

Cap	Cap Code	Case Size/ Series	C1210C							C1808C				C1812C				C1825C				C2220C				C2225C			
		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	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	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 – 301*	F G J K M	FB	FB	FB	FB	FB	FB	FB																				
330 – 430 pF*	331 – 431*	F G J K M	FB	FB	FB	FB	FB	FB	FB	LF	LF	LF	LF																
470 – 910 pF*	471 – 911*	F G J K M	FB	FB	FB	FB	FB	FB	FB	LF	LF	LF	LF	GB	GB	GB	GB												
1,000 pF	102	F G J K M	FB	FB	FB	FB	FB	FB	FB	LF	LF	LF	LF	GB	GB	GB	GB												
1,100 pF	112	F G J K M	FB	FB	FB	FB	FB	FB	FB	LF	LF	LF	LF	GB	GB	GB	GB												
1,200 pF	122	F G J K M	FB	FB	FB	FB	FB	FB	FB	LF	LF	LF	LF	GB	GB	GB	GB												
1,300 pF	132	F G J K M	FB	FB	FB	FB	FB	FC	FC	LF	LF	LF	LF	GB	GB	GB	GB												
1,500 pF	152	F G J K M	FB	FB	FB	FB	FB	FE	FE	LF	LF	LF	LF	GB	GB	GB	GB												
1,600 pF	162	F G J K M	FB	FB	FB	FB	FB	FE	FE	LF	LF	LF	LF	GB	GB	GB	GB												
1,800 pF	182	F G J K M	FB	FB	FB	FB	FB	FE	FE	LF	LF	LF	LF	GB	GB	GB	GB												
2,000 pF	202	F G J K M	FB	FB	FB	FB	FC	FE	FE	LF	LF	LF	LF	GB	GB	GB	GB												
2,200 pF	222	F G J K M	FB	FB	FB	FB	FC	FG	FG	LF	LF	LF	LF	GB	GB	GB	GB												
2,400 pF	242	F G J K M	FB	FB	FB	FB	FC	FC	FC	LF	LF	LF	LF																
2,700 pF	272	F G J K M	FB	FB	FB	FB	FC	FC	FC	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	HB	HB	HB	HB								
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	HB	HB	HB	HB					KE	KE	KE	KE
5,100 pF	512	F G J K M	FB	FB	FB	FB	FG	FG	FG																	KE	KE	KE	KE
5,600 pF	562	F G J K M	FB	FB	FB	FB	FG	FG	FG					GB	GB	GH	GH	HB	HB	HB	HB					KE	KE	KE	KE
6,200 pF	622	F G J K M	FB	FB	FB	FB	FG	FB	FB																	KE	KE	KE	KE
6,800 pF	682	F G J K M	FB	FB	FB	FB	FG	FB	FB					GB	GB	GJ	GJ	HB	HB	HB	HB	JE	JE	JB		KE	KE	KE	KE
7,500 pF	752	F G J K M	FC	FC	FC	FC	FC	FB	FB																	KE	KE	KE	KE
8,200 pF	822	F G J K M	FC	FC	FC	FC	FC	FB	FB					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	FB	FB																	KE	KE	KE	KE
10,000 pF	103	F G J K M	FF	FF	FF	FF	FF	FB	FB					GB	GH	GB	GB	HB	HB	HE	HE	JE	JE	JB		KE	KE	KE	KE
12,000 pF	123	F G J K M	FG	FG	FG	FG	FB	FB	FB					GB	GG	GB	GB	HB	HB	HE	HE	JE	JE	JB		KE	KE	KE	KE
15,000 pF	153	F G J K M	FG	FG	FG	FG	FB	FC	FC					GB	GB	GB	GB	HB	HB			JE	JE	JB		KE	KE	KE	KE
18,000 pF	183	F G J K M	FB	FB	FB	FB	FB	FC	FC					GB	GB	GB	GB	HB	HE			JE	JE	JB		KE	KE		
22,000 pF	223	F G J K M	FB	FB	FB	FB	FB	FF	FF					GB	GB	GB	GB	HB	HE			JE	JB	JB		KE	KE		
27,000 pF	273	F G J K M	FB	FB	FB	FB	FB	FG	FG					GB	GB	GB	GB	HB	HG			JE	JB	JB		KE	KE		
33,000 pF	333	F G J K M	FB	FB	FB	FB	FB	FH	FH					GB	GB	GB	GB					JB	JB	JB		KE			
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					
0.10 µF	104	F G J K M	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	50	100	200	250	50	100	200	250	50	100	200	250	50	100	200	250	50	100	200	250
		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	5	1	2	A
		Case Size/ Series	C1210C							C1808C				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).*
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
AB	0201	0.30 ± 0.03	15,000	0	0	0
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
DM	0805	0.70 ± 0.20	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
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	1706	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 out 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
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
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

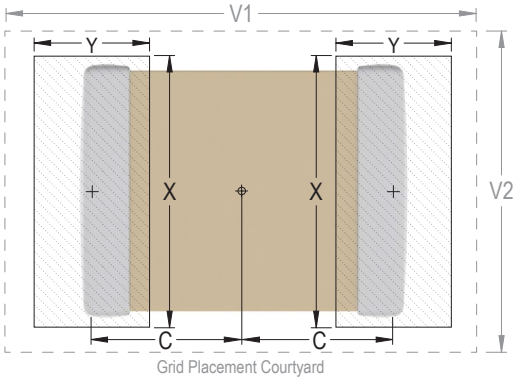
[1] *Only for capacitance values ≥ 22 µF*

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.

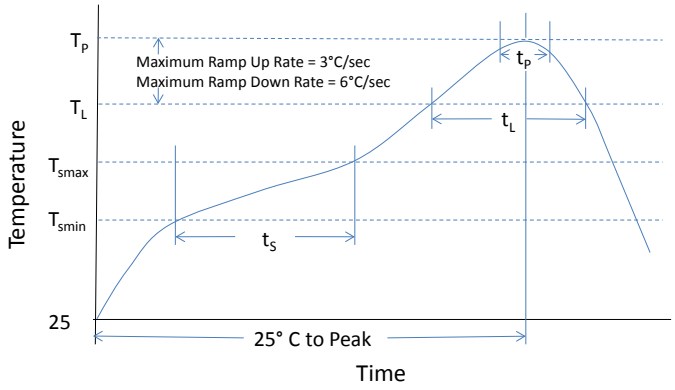


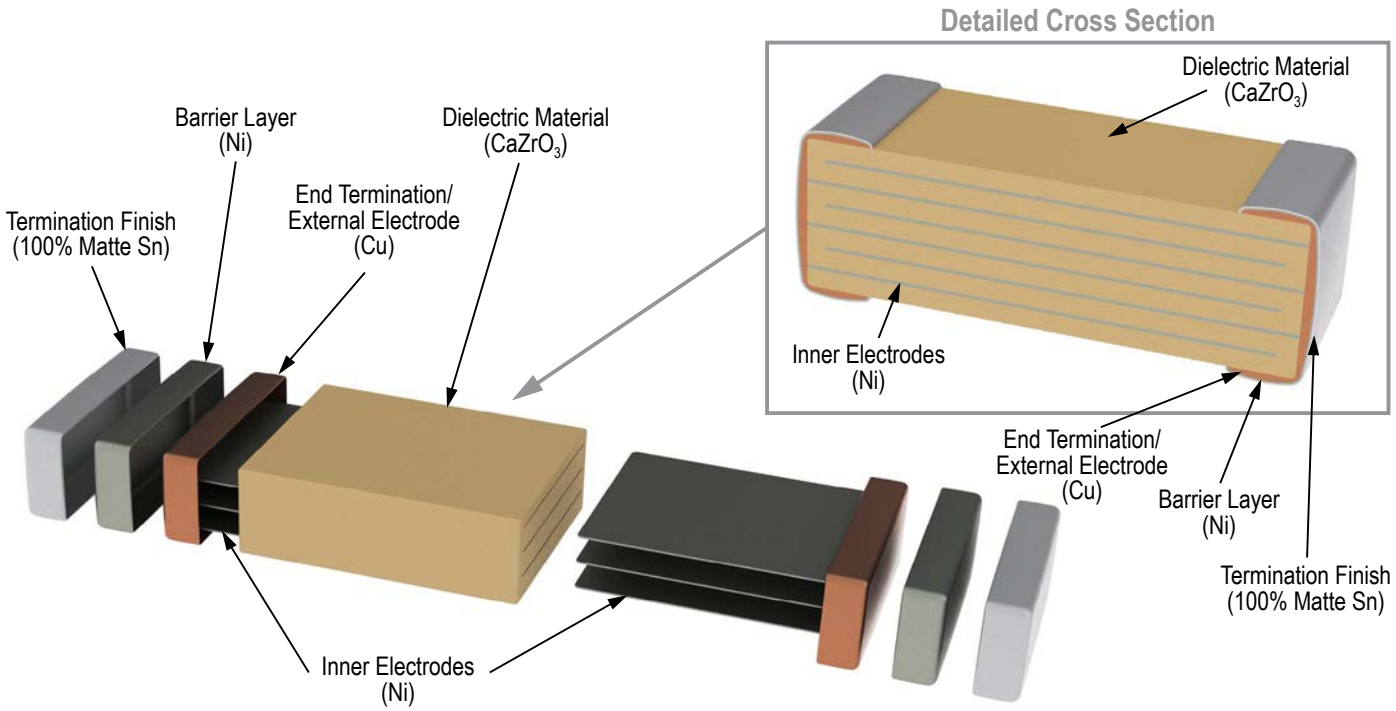
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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 +/- 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.

X7R Dielectric, 6.3 – 250 VDC (Commercial Grade)

Overview

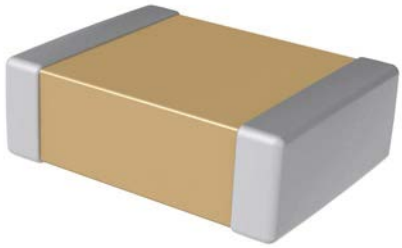
KEMET's X7R dielectric features a 125°C maximum operating temperature and is considered "temperature stable." The Electronics Components, Assemblies & Materials Association (EIA) characterizes X7R dielectric as a Class II material. Components of this classification are fixed, ceramic dielectric capacitors 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.

Benefits

- −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, 2220, and 2225 case sizes
- DC voltage ratings of 6.3 V, 10 V, 16 V, 25 V, 35 V, 50 V, 100 V, 200 V, and 250 V
- Capacitance offerings ranging from 10 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 allowing for excellent solderability
- SnPb termination finish option available upon request (5% Pb minimum)

Applications

Typical applications include decoupling, bypass, filtering and transient voltage suppression.



Ordering Information

C	1206	C	106	M	4	R	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 1808 1812 1825 2220 2225	C = Standard	Two significant digits + 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	C = 100% Matte Sn	See "Packaging C-Spec Ordering Options Table" below

[1] *Flexible termination option is available. Please see FT-CAP product bulletin C1013_X7R_FT-CAP_SMD.*

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

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Packaging C-Spec Ordering Options Table

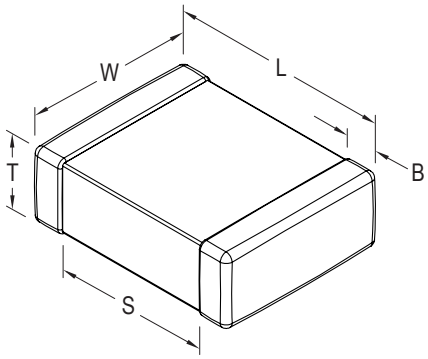
Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)
Bulk Bag/Unmarked	Not required (Blank)
7" Reel/Unmarked	TU
13" Reel/Unmarked	7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes)
7" Reel/Marked	TM
13" Reel/Marked	7040 (EIA 0603 and smaller case sizes) 7215 (EIA 0805 and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

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

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

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

Dimensions – Millimeters (Inches)



EIA Size Code	Metric Size Code	L Length	W Width	T Thickness	B Bandwidth	S Separation Minimum	Mounting Technique
0402	1005	1.00 (0.040) ±0.05 (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
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 ≥ 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.

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 @ 25°C	See Dissipation Factor Limit Table
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (Rated voltage applied for 120 ± 5 secs @ 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."

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

Post Environmental Limits

High Temperature Life, Biased Humidity, Moisture Resistance						
Dielectric	Case Size	Rated DC Voltage	Capacitance Value	Dissipation Factor (Maximum %)	Capacitance Shift	Insulation Resistance
X7R	0402	< 16	All	7.5	± 20%	10% of Initial Limit
		16 / 25		5.0		
		> 25		3.0		
	0603	< 16	< 1.0 µF	7.5		
		16 / 25		5.0		
		> 25		3.0		
		< 16	≥ 1.0 µF	20.0		
		16 / 25				
	0805	< 16	< 2.2 µF	7.5		
		16 / 25		5.0		
		> 25	< 1.0 µF	3.0		
		< 16	≥ 2.2 µF	20.0		
		16 / 25				
		> 25	≥ 1.0 µF			
	1206	< 16	< 10 µF	7.5		
		16 / 25		5.0		
		> 25		3.0		
		35 / 50	≥ 2.2 µF	20.0		
		< 16	≥ 10 µF			
		16 / 25				
	1210	< 16	< 22 µF	7.5		
		16 / 25		5.0		
		> 25		3.0		
		< 16	≥ 22 µF	20.0		
		16 / 25				
	1808-2225	< 16	All	7.5		
		16 / 25		5.0		
		> 25		3.5		

Dissipation Factor (DF) Limit Table

EIA Case Size	Rated DC Voltage	Capacitance	Dissipation Factor (Maximum %)
0402	< 16	All	5.0
	16		3.5
	25	< 0.1 µF	3.5
	25	≥ 0.1 µF	10.0
	> 25	All	2.5
0603	< 16	< 1.0 µF	5.0
	16 / 25		3.5
	> 25		2.5
	< 16	≥ 1.0 µF	10.0
	16 / 25		
0805	< 16	< 2.2 µF	5.0
	16 / 25		3.5
	> 25	< 1.0 µF	2.5
	< 16	≥ 2.2 µF	10.0
	16 / 25		
	> 25	≥ 1.0 µF	
1206	< 16	< 10 µF	5.0
	16 / 25		3.5
	> 25		2.5
	35 / 50	≥ 2.2 µF	10.0
	< 16	≥ 10 µF	10.0
	16 / 25		
1210	< 16	< 22 µF	5.0
	16 / 25		3.5
	> 25		2.5
	< 16	≥ 22 µF	10.0
	16 / 25		
1808-2225	< 16	All	5.0
	16 / 25		3.5
	> 25		2.5

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	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	6.3	10	16	25	35	50	100	200	250	6.3	10	16	25	35	50	100	200	250
		Cap Tolerance	Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions																													
10 - 20 pF*	100 - 200*	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	
22 pF	220	J K M	BB	BB	BB	BB	BB	CF	CF	CF	CF	CF	CF	CF	DM	DM	DM	DM	DM	DM	DN	DN		EB	EB	EB	EB	EB	EB	EB	EB	
24 - 91pF	240 - 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	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	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	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	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	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	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	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	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	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	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	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	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	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		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		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		EB	EB	EB	EB	EB	EB	EC	EB	EB
47000 pF	473	J K M	BB	BB	BB	BB		CF	CF	CF	CF	CJ	CF		DO	DO	DO	DO	DO	DO	DE	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		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			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	BB[1]		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	
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	
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		
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		
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	CG[1]				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						CG[1]	CG[1]	CG[1]	CD[1]				DP	DP	DP	DG	DG[1]	DG[1]				EP	EP	EP	EP	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						CG[1]	CG[1]						DG	DG	DG	DG[1]						EH	EH	EH[1]	EH[1]	EH	EH			
2.7 µF	275	J K M																						EN	EN	EN	EH					
Cap	Cap Code	Rated Voltage (VDC)	6.3	10	16	25	50	6.3	10	16	25	50	100	200	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	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)*

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).

xx[1] Available only in K, M tolerance.

xx[2] Available only in M tolerance.

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

Cap	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	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	6.3	10	16	25	35	50	100	200	250	6.3	10	16	25	35	50	100	200	250
		Cap Tolerance	Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions																													
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													DG[1]	DG[1]	DG[1]							EH[1]	EH[1]	EH[1]	EH[1]	EH[1]	EH[1]			
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													DG[1]	DG[1]								EH	EH	EH	EH[1]					
22 µF	226	J K M																						EH[1]	EH[1]							
Cap	Cap Code	Rated Voltage (VDC)	6.3	10	16	25	50	6.3	10	16	25	50	100	200	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	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								

Table 1B – Capacitance Range/Selection Waterfall (1210 – 2225 Case Sizes)

Cap	Cap Code	Case Size/ Series	C1210C								C1808C			C1812C					C1825C				C2220C					C2225C			
		Voltage Code	9	8	4	3	5	1	2	A	5	1	2	3	5	1	2	A	5	1	2	A	3	5	1	2	A	5	1	2	A
		Rated Voltage (VDC)	6.3	10	16	25	50	100	200	250	50	100	200	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																												
10 - 91 pF*	100 - 910*	J K M	FB	FB	FB	FB	FB	FB	FB																						
11 pF	110	J K M	FB	FB	FB	FB	FB	FB	FB																						
12 pF	120	J K M	FB	FB	FB	FB	FB	FB	FB																						
13 pF	130	J K M	FB	FB	FB	FB	FB	FB	FB																						
15 pF	150	J K M	FB	FB	FB	FB	FB	FB	FB																						
16 pF	160	J K M	FB	FB	FB	FB	FB	FB	FB																						
18 pF	180	J K M	FB	FB	FB	FB	FB	FB	FB																						
20 pF	200	J K M	FB	FB	FB	FB	FB	FB	FB																						
22 pF	220	J K M	FB	FB	FB	FB	FB	FB	FB																						
24 pF	240	J K M	FB	FB	FB	FB	FB	FB	FB																						
27 pF	270	J K M	FB	FB	FB	FB	FB	FB	FB																						
30 pF	300	J K M	FB	FB	FB	FB	FB	FB	FB																						
33 pF	330	J K M	FB	FB	FB	FB	FB	FB	FB																						
36 pF	360	J K M	FB	FB	FB	FB	FB	FB	FB																						
39 pF	390	J K M	FB	FB	FB	FB	FB	FB	FB																						
43 pF	430	J K M	FB	FB	FB	FB	FB	FB	FB																						
47 pF	470	J K M	FB	FB	FB	FB	FB	FB	FB																						
51 pF	510	J K M	FB	FB	FB	FB	FB	FB	FB																						
56 pF	560	J K M	FB	FB	FB	FB	FB	FB	FB																						
Cap	Cap Code	Rated Voltage (VDC)	6.3	10	16	25	50	100	200	250	50	100	200	25	50	100	200	250	50	100	200	250	25	50	100	200	250	50	100	200	250
		Voltage Code	9	8	4	3	5	1	2	A	5	1	2	3	5	1	2	A	5	1	2	A	3	5	1	2	A	5	1	2	A
		Case Size/ Series	C1210C								C1808C			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)*

***Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68 and 82)*

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).

xx[1] Available only in K, M tolerance.

xx[2] Available only in M tolerance.

Table 1B – Capacitance Range/Selection Waterfall (1210 – 2225 Case Sizes) cont'd

Cap	Cap Code	Case Size/ Series	C1210C								C1808C			C1812C					C1825C				C2220C					C2225C			
		Voltage Code	9	8	4	3	5	1	2	A	5	1	2	3	5	1	2	A	5	1	2	A	3	5	1	2	A	5	1	2	A
		Rated Voltage (VDC)	6.3	10	16	25	50	100	200	250	50	100	200	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																												
62 pF	620	J K M	FB	FB	FB	FB	FB	FB	FB																						
68 pF	680	J K M	FB	FB	FB	FB	FB	FB	FB																						
75 pF	750	J K M	FB	FB	FB	FB	FB	FB	FB																						
82 pF	820	J K M	FB	FB	FB	FB	FB	FB	FB																						
91 pF	910	J K M	FB	FB	FB	FB	FB	FB	FB																						
100 - 270 pF**	101 - 271**	J K M	FB	FB	FB	FB	FB	FB	FB																						
110 pF	111	J K M	FB	FB	FB	FB	FB	FB	FB																						
120 pF	121	J K M	FB	FB	FB	FB	FB	FB	FB																						
130 pF	131	J K M	FB	FB	FB	FB	FB	FB	FB																						
150 pF	151	J K M	FB	FB	FB	FB	FB	FB	FB																						
180 pF	181	J K M	FB	FB	FB	FB	FB	FB	FB																						
220 pF	221	J K M	FB	FB	FB	FB	FB	FB	FB																						
270 pF	271	J K M	FB	FB	FB	FB	FB	FB	FB																						
330 pF	331	J K M	FB	FB	FB	FB	FB	FB	FB		LF	LF	LF																		
390 pF	391	J K M	FB	FB	FB	FB	FB	FB	FB		LF	LF	LF																		
470 - 1,200 pF**	471 - 122**	J K M	FB	FB	FB	FB	FB	FB	FB		LF	LF	LF	GB	GB	GB	GB														
560 pF	561	J K M	FB	FB	FB	FB	FB	FB	FB		LF	LF	LF	GB	GB	GB	GB														
680 pF	681	J K M	FB	FB	FB	FB	FB	FB	FB		LF	LF	LF	GB	GB	GB	GB														
820 pF	821	J K M	FB	FB	FB	FB	FB	FB	FB		LF	LF	LF	GB	GB	GB	GB														
1,000 pF	102	J K M	FB	FB	FB	FB	FB	FB	FB		LF	LF	LF	GB	GB	GB	GB														
1,200 pF	122	J K M	FB	FB	FB	FB	FB	FB	FB		LF	LF	LF	GB	GB	GB	GB														
1,500 pF	152	J K M	FB	FB	FB	FB	FB	FB	FE		LF	LF	LF	GB	GB	GB	GB														
1,800 pF	182	J K M	FB	FB	FB	FB	FB	FB	FE		LF	LF	LF	GB	GB	GB	GB														
2,200 pF	222	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LF	LF	LF	GB	GB	GB	GB														
2,700 pF	272	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LF	LF	LF	GB	GB	GB	GB														
3,300 pF	332	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LF	LF		GB	GB	GB	GB														
3,900 pF	392	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LF	LF		GB	GB	GB	GB		HB	HB	HB										
4,700 pF	472	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD	LD	GB	GB	GB	GD		HB	HB	HB							KE	KE	KE	
5,600 pF	562	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD	LD	GB	GB	GB	GH		HB	HB	HB							KE	KE	KE	
6,800 pF	682	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD	LD	GB	GB	GB	GB	GB	HB	HB	HB		JE	JE	JE			KE	KE	KE	
8,200 pF	822	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD	LD	GB	GB	GB	GB	GB	HB	HB	HB		JE	JE	JE			KE	KE	KE	
10,000 pF	103	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD	LD	GB	GB	GB	GB	GB	HB	HB	HE		JE	JE	JE			KE	KE	KE	
12,000 pF	123	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD	LD	GB	GB	GB	GB	GB	HB	HB	HE		JE	JE	JE			KE	KE	KE	
15,000 pF	153	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD	LD	GB	GB	GB	GB	GB	HB	HB			JE	JE	JE			KE	KE	KE	
18,000 pF	183	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD	LD	GB	GB	GB	GB	GB	HB	HE			JE	JE	JE			KE	KE		
22,000 pF	223	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JE	JE	JE			KE	KE		
27,000 pF	273	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JE	JE	JE			KE	KE		
33,000 pF	333	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JB			KE			
39,000 pF	393	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JB						
47,000 pF	473	J K M	FB	FB	FB	FB	FB	FB	FC	FC	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JB						
56,000 pF	563	J K M	FB	FB	FB	FB	FB	FB	FC	FC	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JB						
68,000 pF	683	J K M	FB	FB	FB	FB	FB	FB	FC	FC	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JB						
82,000 pF	823	J K M	FB	FB	FB	FB	FB	FC	FF	FF	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB	JC	JC	JC	JC	JC				
0.10 µF	104	J K M	FB	FB	FB	FB	FB	FD	FG	FG	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	FB	FB	FB	FB	FB	FD	FH	FH	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB	JC	JC	JC	JC	JC	KC	KC	KC	KC
Cap	Cap Code	Rated Voltage (VDC)	6.3	10	16	25	50	100	200	250	50	100	200	25	50	100	200	250	50	100	200	250	25	50	100	200	250	50	100	200	250
		Voltage Code	9	8	4	3	5	1	2	A	5	1	2	3	5	1	2	A	5	1	2	A	3	5	1	2	A	5	1	2	A
		Case Size/ Series	C1210C								C1808C			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)*

***Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68 and 82)*

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).

xx[1] Available only in K, M tolerance.

xx[2] Available only in M tolerance.

Table 1B – Capacitance Range/Selection Waterfall (1210 – 2225 Case Sizes) cont'd

Cap	Cap Code	Case Size/ Series	C1210C								C1808C			C1812C					C1825C				C2220C					C2225C			
		Voltage Code	9	8	4	3	5	1	2	A	5	1	2	3	5	1	2	A	5	1	2	A	3	5	1	2	A	5	1	2	A
		Rated Voltage (VDC)	6.3	10	16	25	50	100	200	250	50	100	200	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																												
0.15 µF	154	J K M	FC	FC	FC	FC	FC	FD	FM	FM	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	FC	FC	FC	FC	FC	FD	FK	FK	LD			GB	GB	GB	GG	GG	HB	HB	HB	HB	JC	JC	JC	JC	JC	KC	KC	KC	KC
0.22 µF	224	J K M	FC	FC	FC	FC	FC	FD	FK	FK				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	FC	FC	FC	FC	FC	FD						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	FD	FD	FD	FD	FD	FD						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	FD	FD	FD	FD	FD	FD						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	FD	FD	FD	FD	FD	FD						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	FD	FD	FD	FD	FD	FF						GC	GC	GG			HB	HD	HD	HD	JC	JC	JC	JD	JD	KB	KC	KD	KD
0.68 µF	684	J K M	FD	FD	FD	FD	FD	FG						GC	GC	GG			HB	HD	HD	HD	JC	JC	JD	JD	JD	KB	KC	KD	KD
0.82 µF	824	J K M	FF	FF	FF	FF	FF	FL						GE	GE	GG			HB	HF	HF	HF	JC	JC	JF	JF	JF	KB	KC	KE	KE
1.0 µF	105	J K M	FH	FH	FH	FH	FH	FM						GE	GE	GG			HB	HF	HF	HF	JC	JC	JF	JF	JF	KB	KD	KE	KE
1.2 µF	125	J K M	FH	FH	FH	FH	FG	FH						GB	GB	GB			HB				JC	JC				KB	KE	KE	KE
1.5 µF	155	J K M	FH	FH	FH	FH	FG	FM						GC	GC	GC			HC				JC	JC				KC			
1.8 µF	185	J K M	FH	FH	FH	FH	FG	FJ						GE	GE	GE			HD				JD	JD				KD			
2.2 µF	225	J K M	FJ	FJ	FJ	FJ	FG	FT[1]						GO	GO	GO[1]			HF				JF	JF				KD			
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																								
4.7 µF	475	J K M	FC	FC	FC	FG	FS							GK	GK								JF	JF							
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	FT[1]	FT[1]	FT[1]	FS[1]	FS[1]							GK									JF	JO							
12 µF	126	J K M																													
15 µF	156	J K M	FM	FM																			JO	JO							
18 µF	186	J K M																													
22 µF	226	J K M	FS	FS	FS[1]	FS[1]																	JO								
47 µF	476	J K M	FS[1]	FS[2]																											
Cap	Cap Code	Rated Voltage (VDC)	6.3	10	16	25	50	100	200	250	50	100	200	25	50	100	200	250	50	100	200	250	25	50	100	200	250	50	100	200	250
		Voltage Code	9	8	4	3	5	1	2	A	5	1	2	3	5	1	2	A	5	1	2	A	3	5	1	2	A	5	1	2	A
		Case Size/ Series	C1210C								C1808C			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)*

***Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68 and 82)*

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).

xx[1] Available only in K, M tolerance.

xx[2] Available only in M tolerance.

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
CG	0603	0.80 ± 0.10*	4,000	15,000	0	0
CD	0603	0.80 ± 0.15	4,000	10,000	0	0
CJ	0603	0.80 ± 0.15*	4,000	15,000	0	0
DM	0805	0.70 ± 0.20*	4,000	15,000	0	0
DN	0805	0.78 ± 0.10*	4,000	15,000	0	0
DO	0805	0.80 ± 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	4,000	10,000	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
EP	1206	1.20 ± 0.20	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
FT	1210	1.90 ± 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	1706	0.90 ± 0.10	0	0	4,000	10,000
NC	1706	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
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'd

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

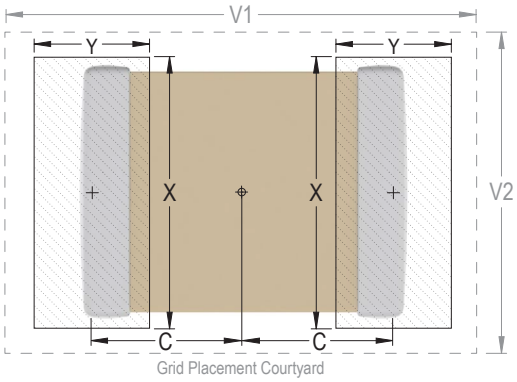
[1] *Only for capacitance values ≥ 22 µF*

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.

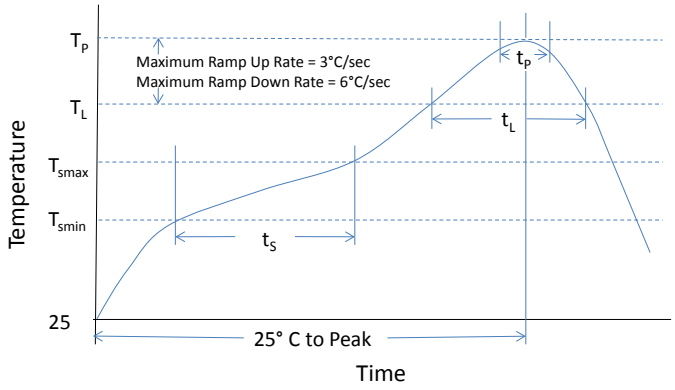


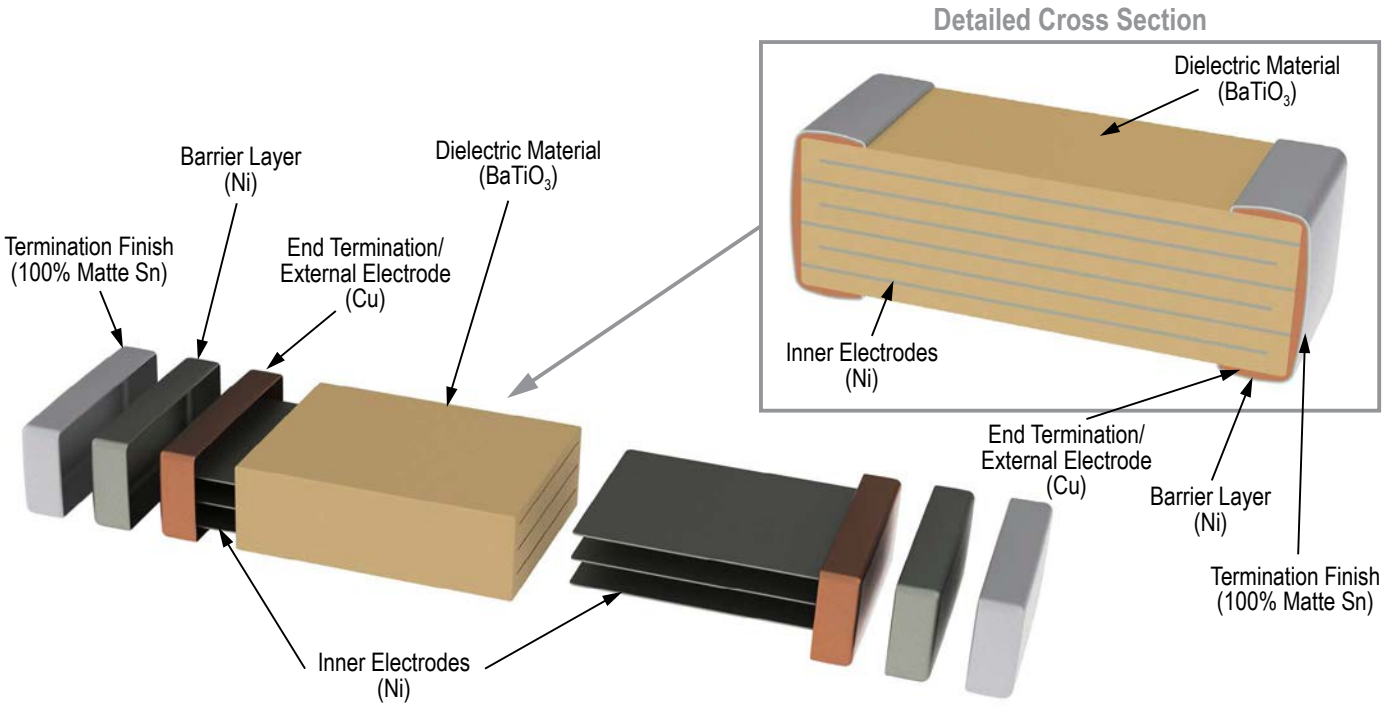
Table 4 – Performance & Reliability: Test Methods and Conditions

<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 125°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>0603 & 0805</td><td>≥ 1.0 µF</td><td rowspan="2">1.5 X</td></tr>
<tr><td>1206 & 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 & 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)



X5R Dielectric, 4 – 50 VDC (Commercial Grade)

Overview

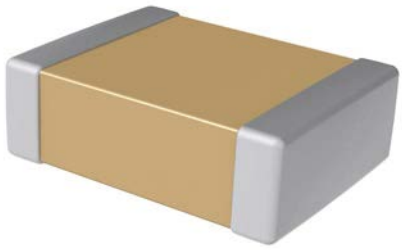
KEMET's X5R dielectric features an 85°C maximum operating temperature and is considered "semi-stable." The Electronics Components, Assemblies & Materials Association (EIA) characterizes X5R dielectric as a Class II material. Components of this classification are fixed, ceramic dielectric capacitors suited 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
- Lead (Pb)-Free, RoHS and REACH compliant
- Temperature stable dielectric
- EIA 0201, 0402, 0603, 0805, 1206, 1210, and 1812 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 0.01 µF to 100 µF
- Available capacitance tolerances of ±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, and filtering.



Ordering Information

C	1206	C	107	M	9	P	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)
	0201 0402 0603 0805 1206 1210	C = Standard	Two significant digits + 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	C = 100% Matte Sn	See "Packaging C-Spec Ordering Options Table" below

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

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Packaging C-Spec Ordering Options Table

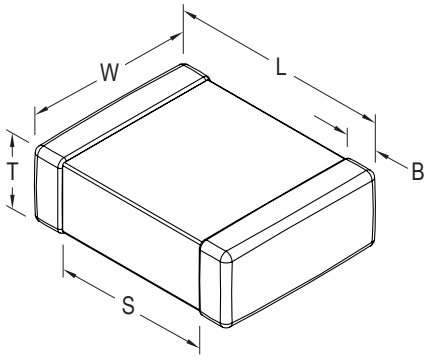
Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)
Bulk Bag/Unmarked	Not required (Blank)
7" Reel/Unmarked	TU
13" Reel/Unmarked	7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes)
7" Reel/Marked	TM
13" Reel/Marked	7040 (EIA 0603 and smaller case sizes) 7215 (EIA 0805 and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

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

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

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

Dimensions – Millimeters (Inches)



EIA Size Code	Metric Size Code	L Length	W Width	T Thickness	B Bandwidth	S Separation Minimum	Mounting Technique
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[1]	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[2]	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[3]	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

[1] For capacitance values ≥ 4.7 µF add 0.15 (0.006) to the width and length tolerance dimensions.

[2] For capacitance values ≥ 22 µF add 0.10 (0.004) to the positive bandwidth tolerance dimension.

[3] For capacitance values ≥ 22 µF add 0.10 (0.004) to the length and width tolerance dimension and add 0.15 (0.006) to the positive bandwidth 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.

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 @ 25°C	See Dissipation Factor Limit Table
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (Rated voltage applied for 120 ± 5 secs @ 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
X5R	> 25	All	3.0	±20%	10% of Initial Limit
	25	< 2.2 µF	7.5		
		≥ 2.2 µF	20.0		
	< 25	< 0.56 µF	7.5		
	< 25	≥ 0.56 µF	20.0		

Dissipation Factor Limit Table

Rated DC Voltage	Capacitance	Dissipation Factor (Maximum %)
> 25	All	2.5
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
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

Table 1 – Capacitance Range/Selection Waterfall (0201 – 0805 Case Sizes)

Capacitance	Capacitance Code	Case Size/ Series		C0201C				C0402C						C0603C						C0805C					
		Voltage Code		7	9	8	4	7	9	8	4	3	5	7	9	8	4	3	5	7	9	8	4	3	5
		Rated Voltage (VDC)		4	6.3	10	16	4	6.3	10	16	25	50	4	6.3	10	16	25	50	4	6.3	10	16	25	50
		Capacitance Tolerance		Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions																					
10,000 pF	103	K	M	AB	AB	AB	AB	BB	BB	BB	BB														
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	AB	AB			BB	BB	BB	BB			CG	CG	CG	CG	CG							
0.12 µF	124	K	M																						
0.15 µF	154	K	M																						
0.18 µF	184	K	M																						
0.22 µF	224	K	M					BB	BB					CG	CG	CG	CG								
0.27 µF	274	K	M											CG	CG	CG	CG								
0.33 µF	334	K	M											CG	CG	CG	CG								
0.39 µF	394	K	M											CG	CG	CG	CG								
0.47 µF	474	K	M					BB	BB					CG	CG	CG	CG	CG		DG	DG	DG	DG	DG	
0.56 µF	564	K	M											CG	CG	CG	CG			DP	DP	DP	DP	DP	
0.68 µF	684	K	M											CG	CG	CG	CG			DP	DP	DP	DP	DE	
0.82 µF	824	K	M											CG	CG	CG	CG			DF	DF	DF	DF	DF	
1.0 µF	105	K	M					BB	BB	BB	BB			CG	CG	CG	CG	CJ		DP	DP	DP	DP	DG	DG
1.2 µF	125	K	M																	DN	DN	DN	DN		
1.5 µF	155	K	M																	DN	DN	DN	DN		
1.8 µF	185	K	M																	DP	DP	DP	DP		
2.2 µF	225	K	M					BB	BB	BB[1]				CG	CG	CG	CG			DG	DG	DG	DG	DG	
2.7 µF	275	K	M																	DL	DL	DL	DL		
3.3 µF	335	K	M					BB[1]						CG	CG					DL	DL	DL	DG		
3.9 µF	395	K	M																	DG	DG	DG	DG		
4.7 µF	475	K	M					BE[1]	BE[1]					CG	CG	CG				DG	DG	DG	DG	DG	
5.6 µF	565	K	M																	DG	DG	DG			
6.8 µF	685	K	M																	DG	DG	DG			
8.2 µF	825	K	M																						
10 µF	106	K	M					BF[1]	BF[1]					CG[1]	CG[1]	CG[1]				DG	DG	DG	DG	DH	
12 µF	126	K	M																						
15 µF	156	K	M																						
18 µF	186	K	M																						
22 µF	226	K	M																	DG	DG	DH[1]			
47 µF	476	K	M																	DH[1]	DH[1]				
Capacitance	Capacitance Code	Rated Voltage (VDC)		4	6.3	10	16	4	6.3	10	16	25	50	4	6.3	10	16	25	50	4	6.3	10	16	25	50
		Voltage Code		7	9	8	4	7	9	8	3	5	4	7	9	8	4	3	5	7	9	8	4	3	5
		Case Size/Series		C0201C				C0402C						C0603C						C0805C					

xx[1] Available only in M tolerance.

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

Capacitance	Capacitance Code	Case Size/ Series		C1206C					C1210C						C1812C		
		Voltage Code		9	8	4	3	5	9	8	4	3	6	5	3	6	5
		Rated Voltage (VDC)		6.3	10	16	25	50	6.3	10	16	25	35	50	25	35	50
		Cap Tolerance		Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions													
0.27 µF	274	K	M	EB	EB	EB	EB										
0.33 µF	334	K	M	EB	EB	EB	EB										
0.39 µF	394	K	M	EB	EB	EB	EB		FD	FD	FD	FD	FD				
0.47 µF	474	K	M	EC	EC	EC	EC		FD	FD	FD	FD	FD				
0.56 µF	564	K	M	ED	ED	ED	ED		FD	FD	FD	FD	FD				
0.68 µF	684	K	M	EE	EE	EE	EE		FD	FD	FD	FD	FD				
0.82 µF	824	K	M	EF	EF	EF	EF		FF	FF	FF	FF	FF				
1.0 µF	105	K	M	EP	EP	EP	EP		FH	FH	FH	FH	FH	FH			
1.2 µF	125	K	M	EC	EC	EC	EC		FD	FD	FD	FD					
1.5 µF	155	K	M	EC	EC	EC	EC		FD	FD	FD	FD					
1.8 µF	185	K	M	EC	EC	EC	EC		FD	FD	FD	FD					
2.2 µF	225	K	M	EC	EC	EC	EC		FJ	FJ	FJ	FJ					
2.7 µF	275	K	M	EF	EF	EF	EF		FG	FG	FG	FG					
3.3 µF	335	K	M	EH	EH	EH	EH		FH	FH	FH	FH					
3.9 µF	395	K	M	ED	ED	ED	ED		FJ	FJ	FJ	FJ					
4.7 µF	475	K	M	EH	EH	EH	EH	EH	FT	FT	FT	FT					
5.6 µF	565	K	M	EK	EK	EH			FG	FG	FG	FE					
6.8 µF	685	K	M	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	EH		FT	FT	FT	FT	FT	FS	GK		
12 µF	126	K	M						FD	FD	FG						
15 µF	156	K	M						FF	FF	FG						
18 µF	186	K	M						FG	FG	FH						
22 µF	226	K	M	EH	EH[1]	EH[1]			FS	FS	FS	FS					
47 µF	476	K	M	EH[1]	EH[1]				FS[1]	FS[1]	FS[1]						
100 µF	107	K	M	EH[1]					FS[1]	FS[1]	FS[1]						
Capacitance	Capacitance Code	Rated Voltage (VDC)		6.3	10	16	25	50	6.3	10	16	25	35	50	25	35	50
		Voltage Code		9	8	4	3	5	9	8	4	3	6	5	3	6	5
		Case Size/Series		C1206C					C1210C						C1812C		

xx[1] Available only in M tolerance.

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
AB	0201	0.30 ± 0.03	15,000	0	0	0
BB	0402	0.50 ± 0.05	10,000	50,000	0	0
BE	0402	0.50 ± 0.15	10,000	50,000	0	0
BF	0402	0.50 ± 0.20	10,000	50,000	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
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	4,000	10,000	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
EP	1206	1.20 ± 0.20	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
FJ	1210	1.85 ± 0.20	0	0	2,000	8,000
FT	1210	1.90 ± 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
GK	1812	1.60 ± 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 out 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
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
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

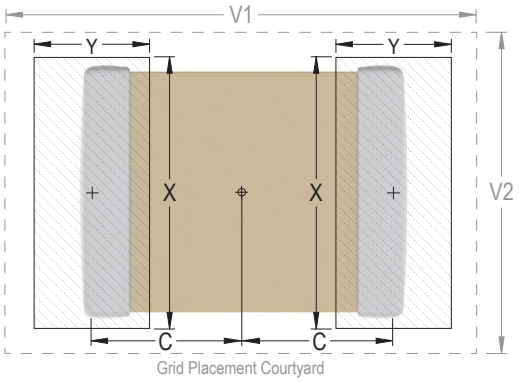
[1] *Only for capacitance values ≥ 22 µF*

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.

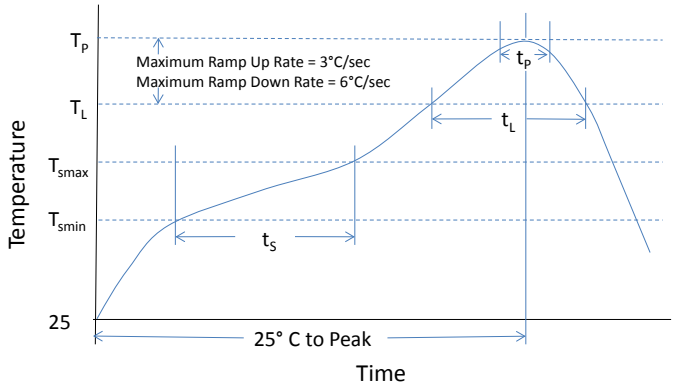


Table 4 – Performance & Reliability: Test Methods and Conditions

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 85°C with 2 X rated voltage applied excluding the following:

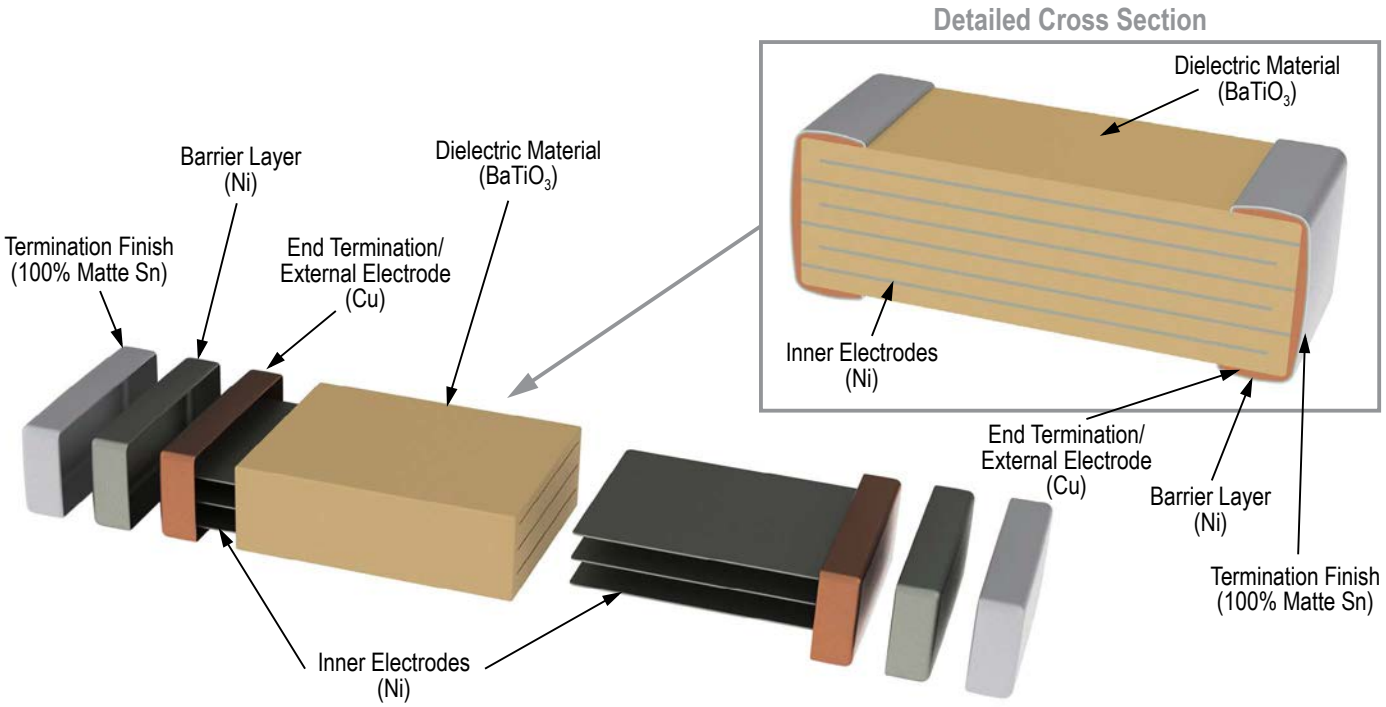
Case Size	Capacitance	Applied Voltage
0402	≥ 0.22 µF	1.5 X
0603	≥ 1.0 µF	
0805	≥ 4.7 µF	
1206	≥ 2.2 µF	
1210	≥ 10 µF	

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 (Typical)



Z5U Dielectric, 50 – 100 VDC (Commercial Grade)

Overview

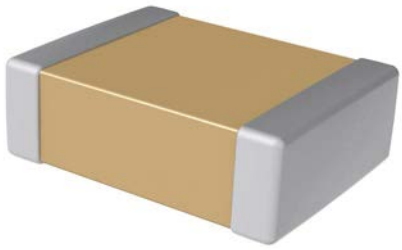
KEMET's Z5U dielectric features an 85°C maximum operating temperature and is considered "general-purpose." The Electronics Components, Assemblies & Materials Association (EIA) characterizes Z5U dielectric as a Class III material. Components of this classification are fixed, ceramic dielectric capacitors suited for bypass and decoupling or other applications in which dielectric losses, high insulation resistance and capacitance stability are not of major importance. Z5U exhibits a predictable change in capacitance with respect to time and voltage and displays wide variations in capacitance with reference to ambient temperature. Capacitance change is limited to +22%, −56% from +10°C to +85°C.

Benefits

- +10°C to +85°C operating temperature range
- Lead (Pb)-Free, RoHS and REACH compliant
- EIA 0805, 1206, 1210, 1812, 1825, and 2225 case sizes
- DC voltage ratings of 50 and 100 V
- Capacitance offerings ranging from 6,800 pF to 2.2 µF
- Available capacitance tolerances of ±20% and +80%/-20%
- Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish allowing for excellent solderability

Applications

Typical applications include limited temperature, decoupling and bypass.



Ordering Information

C	1825	C	225	M	5	U	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 1825 2225	C = Standard	Two significant digits + number of zeros	M = ±20% Z = +80%/-20	5 = 50 1 = 100	U = Z5U	A = N/A	C = 100% Matte Sn	See "Packaging C-Spec Ordering Options Table" below

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

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Packaging C-Spec Ordering Options Table

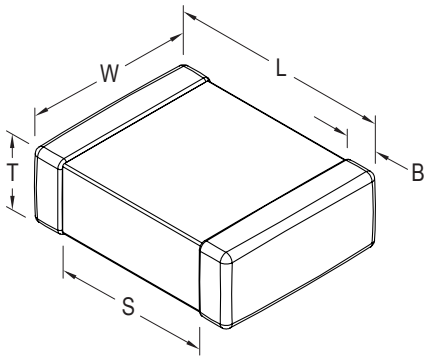
Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)
Bulk Bag/Unmarked	Not required (Blank)
7" Reel/Unmarked	TU
13" Reel/Unmarked	7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes)
7" Reel/Marked	TM
13" Reel/Marked	7040 (EIA 0603 and smaller case sizes) 7215 (EIA 0805 and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

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

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

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

Dimensions – Millimeters (Inches)



EIA Size Code	Metric Size Code	L Length	W Width	T Thickness	B Bandwidth	S Separation Minimum	Mounting Technique
0805	2012	2.00 (.079) ± 0.20 (.008)	1.25 (.049) ± 0.20 (.008)	See Table 2 for Thickness	0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	Solder Wave or Solder Reflow
1206	3216	3.20 (.126) ± 0.20 (.008)	1.60 (.063) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)	N/A	
1210	3225	3.20 (.126) ± 0.20 (.008)	2.50 (.098) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)		Solder Reflow Only
1812	4532	4.50 (.177) ± 0.30 (.012)	3.20 (.126) ± 0.30 (.012)		0.60 (.024) ± 0.35 (.014)		
1825	4564	4.50 (.177) ± 0.30 (.012)	6.40 (.252) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2225	5664	5.60 (.220) ± 0.40 (.016)	6.40 (.248) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.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.

Electrical Parameters/Characteristics

Item	Parameters/Characteristics
Operating Temperature Range	-10°C to +85°C
Capacitance Change with Reference to +25°C and 0 Vdc Applied (TCC)	+22%, -56%
[1]Aging Rate (Maximum % Capacitance Loss/Decade Hour)	7.0%
[2]Dielectric Withstanding Voltage (DWV)	250% of rated voltage (5 ± 1 seconds and charge/discharge not exceeding 50mA)
[3]Dissipation Factor (DF) Maximum Limit @ 25°C	4.0%
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	100 megohm microfarads or 10GΩ (Rated voltage applied for 120 ± 5 secs @ 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:

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
Z5U	> 25	All	5.0	±30%	10% of Initial Limit
	25		7.5		

Table 1 – Capacitance Range/Selection Waterfall (0805 – 2225 Case Sizes)

Capacitance	Capacitance Code	Case Size/ Series		C0805C		C1206C		C1210C		C1812C		C1825C		C2225C	
		Voltage Code		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
		Capacitance Tolerance		Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions											
6,800 pF	682	M	Z	DN	DN										
8,200 pF	822	M	Z	DN	DN										
10,000 pF	103	M	Z	DN	DN	EB	EB								
12,000 pF	123	M	Z	DN		EB	EB								
15,000 pF	153	M	Z	DN		EB	EB								
18,000 pF	183	M	Z	DN		EB	EB								
22,000 pF	223	M	Z	DN		EB	EB								
27,000 pF	273	M	Z	DN		EB	EB								
33,000 pF	333	M	Z	DN		EB	EB								
39,000 pF	393	M	Z	DN		EB	EC								
47,000 pF	473	M	Z	DN		EB	EC	FB	FB						
56,000 pF	563	M	Z	DP		EB	EB	FB	FB						
68,000 pF	683	M	Z	DP		EB	EB	FB	FB						
82,000 pF	823	M	Z	DP		EB	EB	FB	FC	GB	GB				
0.10 µF	104	M	Z	DN		EB	EB	FB	FD	GB	GB				
0.12 µF	124	M	Z			EC		FB	FD	GB	GB				
0.15 µF	154	M	Z			EC		FC	FD	GB	GB				
0.18 µF	184	M	Z			EC		FC		GB		HB	HB		
0.22 µF	224	M	Z			EC		FC		GB		HB	HB		
0.27 µF	274	M	Z					FC		GB		HB	HB		
0.33 µF	334	M	Z					FD		GB		HB	HB	KB	KC
0.39 µF	394	M	Z					FD		GB		HB	HB	KB	KC
0.47 µF	474	M	Z					FD		GB		HB		KB	KC
0.56 µF	564	M	Z					FD		GC		HB		KB	
0.68 µF	684	M	Z					FD		GC		HB		KB	
0.82 µF	824	M	Z					FF		GE		HB		KB	
1.0 µF	105	M	Z					FH		GE		HB		KB	
1.2 µF	125	M	Z									HB		KB	
1.5 µF	155	M	Z									HC		KC	
1.8 µF	185	M	Z									HD		KD	
2.2 µF	225	M	Z									HF		KD	
Capacitance	Capacitance Code	Rated Voltage (VDC)		50	100	50	100	50	100	50	100	50	100	50	100
		Voltage Code		5	1	5	1	5	1	5	1	5	1	5	1
		Case Size/Series		C0805C		C1206C		C1210C		C1812C		C1825C		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
DN	0805	0.78 ± 0.10	4,000	15,000	0	0
DP	0805	0.90 ± 0.10	4,000	15,000	0	0
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
FF	1210	1.10 ± 0.10	0	0	2,500	10,000
FH	1210	1.55 ± 0.15	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
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
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
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 out 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	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
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

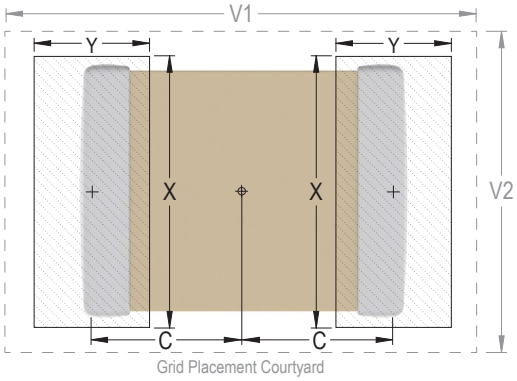
[1] *Only for capacitance values ≥ 22 µF*

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.

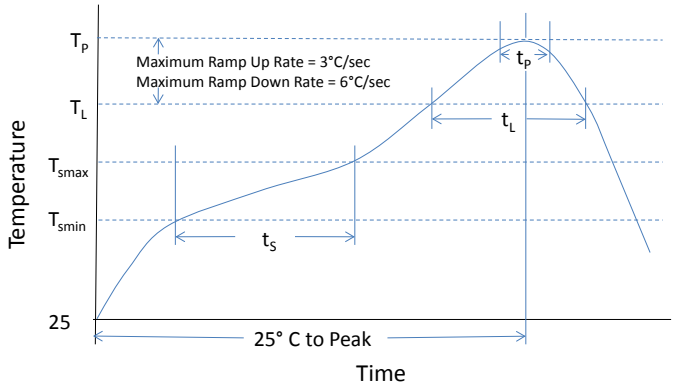


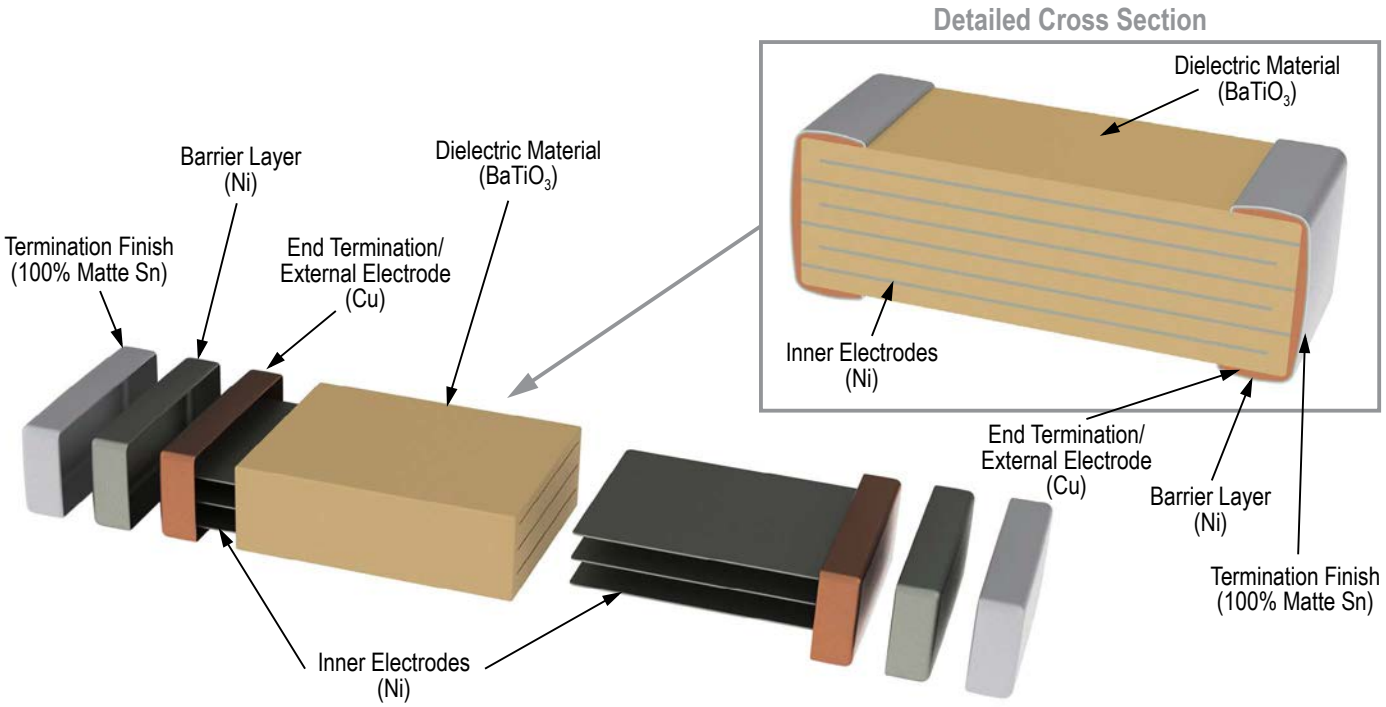
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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 +/- 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 (Typical)



Y5V Dielectric, 6.3 – 50 VDC (Commercial Grade)

Overview

KEMET's Y5V dielectric features an 85°C maximum operating temperature and is considered "general-purpose." The Electronics Components, Assemblies & Materials Association (EIA) characterizes Y5V dielectric as a Class III material. Components of this classification are fixed, ceramic dielectric capacitors suited for bypass and decoupling or other applications in which dielectric losses, high insulation resistance and capacitance stability are not of major importance. Y5V exhibits a predictable change in capacitance with respect to time and voltage and displays wide variations in capacitance with reference to ambient temperature. Capacitance change is limited to +22%, −82% from −30°C to +85°C.

Benefits

- −30°C to +85°C operating temperature range
- Lead (Pb)-Free, RoHS and REACH compliant
- EIA 0402, 0603, 0805, 1206, and 1210 case sizes
- DC voltage ratings of 6.3 V, 10 V, 16 V, 25 V, and 50 V
- Capacitance offerings ranging from 0.022 µF to 22 µF
- Available capacitance tolerance of +80%/−20%
- Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish that allowing for excellent solderability

Applications

Typical applications include limited temperature, decoupling and bypass.

Ordering Information

C	1210	C	226	Z	4	V	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	C = Standard	Two significant digits + number of zeros	Z = +80%/-20% M = ±20%	9 = 6.3 8 = 10 4 = 16 3 = 25 5 = 50	V = Y5V	A = N/A	C = 100% Matte Sn	See "Packaging C-Spec Ordering Options Table" below

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

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Packaging C-Spec Ordering Options Table

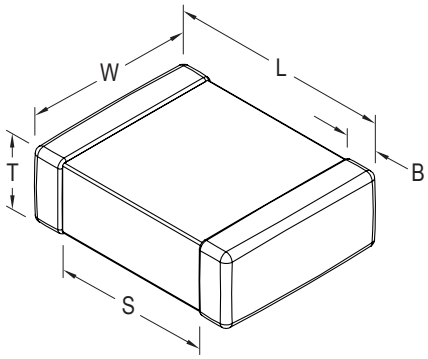
Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)
Bulk Bag/Unmarked	Not required (Blank)
7" Reel/Unmarked	TU
13" Reel/Unmarked	7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes)
7" Reel/Marked	TM
13" Reel/Marked	7040 (EIA 0603 and smaller case sizes) 7215 (EIA 0805 and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

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

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

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

Dimensions – Millimeters (Inches)



EIA Size Code	Metric Size Code	L Length	W Width	T Thick-ness	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

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.

Electrical Parameters/Characteristics

Item	Parameters/Characteristics
Operating Temperature Range	-30°C to +85°C
Capacitance Change with Reference to +25°C and 0 Vdc Applied (TCC)	+22%, -82%
[1]Aging Rate (Maximum % Capacitance Loss/Decade Hour)	7.0%
[2]Dielectric Withstanding Voltage (DWV)	250% of rated voltage (5 ± 1 seconds and charge/discharge not exceeding 50mA)
[3]Dissipation Factor (DF) Maximum Limit @ 25°C	10% (6.3V & 10V), 7% (16V & 25V) and 5% (50V)
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (Rated voltage applied for 120 ± 5 secs @ 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:

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
Y5V	> 25	All	7.5	±30%	10% of Initial Limit
	16/25		10.0		
	< 16		15.0		

Insulation Resistance Limit Table

EIA Case Size	100 Megohm Microfarads or 10 GΩ	50 Megohm Microfarads or 10 GΩ
All	≥ 16 V	≤ 10 V

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

Capacitance	Capacitance Code	Case Size/ Series		C0402C			C0603C				C0805C					C1206C					C1210C				
		Voltage Code		9	8	4	9	8	4	3	9	8	4	3	5	9	8	4	3	5	9	8	4	3	5
		Rated Voltage (VDC)		6.3	10	16	6.3	10	16	25	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																					
22,000 pF	223	M	Z	BB	BB	BB	CF	CF	CF	CF	DN	DN	DN	DN	DN										
27,000 pF	273	M	Z	BB	BB	BB	CF	CF	CF	CF	DN	DN	DN	DN	DN										
33,000 pF	333	M	Z	BB	BB	BB	CF	CF	CF	CF	DN	DN	DN	DN	DN										
39,000 pF	393	M	Z	BB	BB	BB	CF	CF	CF	CF	DP	DP	DP	DP	DP										
47,000 pF	473	M	Z	BB	BB	BB	CF	CF	CF	CF	DO	DO	DO	DO	DO										
56,000 pF	563	M	Z	BB	BB	BB	CF	CF	CF	CF	DP	DP	DP	DP	DP										
68,000 pF	683	M	Z	BB	BB	BB	CF	CF	CF	CF	DP	DP	DP	DP	DP										
82,000 pF	823	M	Z	BB	BB	BB	CF	CF	CF	CF	DP	DP	DP	DP	DP										
0.10 µF	104	M	Z	BB	BB	BB	CG	CG	CG	CG	DN	DN	DN	DN	DN										
0.12 µF	124	M	Z				CG	CG	CG	CG	DN	DN	DN	DN											
0.15 µF	154	M	Z				CG	CG	CG	CG	DN	DN	DN	DN											
0.18 µF	184	M	Z				CG	CG	CG	CG	DN	DN	DN	DN											
0.22 µF	224	M	Z	BB			CG	CG	CG	CG	DN	DN	DN	DN	DG	EC	EC	EC	EC		FD	FD	FD	FD	FD
0.27 µF	274	M	Z				CG	CG	CG	CG	DN	DN	DN	DN		EB	EB	EB	EB		FD	FD	FD	FD	FD
0.33 µF	334	M	Z				CG	CG	CG	CG	DG	DG	DG	DG		EB	EB	EB	EB		FD	FD	FD	FD	FD
0.39 µF	394	M	Z				CG	CG	CG		DN	DN	DN	DN		EB	EB	EB	EB		FD	FD	FD	FD	FD
0.47 µF	474	M	Z	BB			CG	CG	CG		DG	DG	DG	DG		EC	EC	EC	EC		FD	FD	FD	FD	FD
0.56 µF	564	M	Z				CG	CG			DP	DP	DP	DP		EB	EB	EB	EB		FD	FD	FD	FD	FD
0.68 µF	684	M	Z				CG	CG			DP	DP	DP	DG		EB	EB	EB	EB		FD	FD	FD	FD	FD
0.82 µF	824	M	Z				CG	CG			DG	DG	DG	DG		EB	EB	EB	EB		FF	FF	FF	FF	FF
1.0 µF	105	M	Z	BB	BB		CG	CG	CG	CG	DP	DP	DP	DG	DG	EP	EP	EP	EP		FH	FH	FH	FH	FH
1.2 µF	125	M	Z								DN	DN	DN			EC	EC	EC			FD	FD	FD		
1.5 µF	155	M	Z								DN	DN	DN			EC	EC	EC			FD	FD	FD		
1.8 µF	185	M	Z								DP	DP	DP			ED	ED	ED			FD	FD	FD		
2.2 µF	225	M	Z	BB	BB						DG	DG	DG			EC	EC	EC			FJ	FJ	FJ		
3.3 µF	335	M	Z								DL	DL	DG			EH	EH	EH			FE	FE	FE		
4.7 µF	475	M	Z								DG	DG	DG			EM²	EM²	EM²			FT	FT	FT		
5.6 µF	565	M	Z								DF	DF				EJ	EJ	EJ			FG	FG	FG		
6.8 µF	685	M	Z								DG	DG				EJ	EJ				FH	FH	FH		
10 µF	106	M	Z								DG	DG				EH	EH	EH	EH		FH²	FH²	FH²		
15 µF	156	M	Z																		FH	FH	FH		
22 µF	226	M	Z													EH	EH				FT²	FT²	FS	FS	
Capacitance	Capacitance Code	Rated Voltage (VDC)		6.3	10	16	6.3	10	16	25	6.3	10	16	25	50	6.3	10	16	25	50	6.3	10	16	25	50
		Voltage Code		9	8	4	9	8	4	3	9	8	4	3	5	9	8	4	3	5	9	8	4	3	5
		Case Size/ Series		C0402C			C0603C				C0805C					C1206C					C1210C				

xx² Only available in Z tolerance.

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
CG	0603	0.80 ± 0.10*	4,000	15,000	0	0
DN	0805	0.78 ± 0.10*	4,000	15,000	0	0
DO	0805	0.80 ± 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
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
EP	1206	1.20 ± 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
EJ	1206	1.70 ± 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
FJ	1210	1.85 ± 0.20	0	0	2,000	8,000
FT	1210	1.90 ± 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 out 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

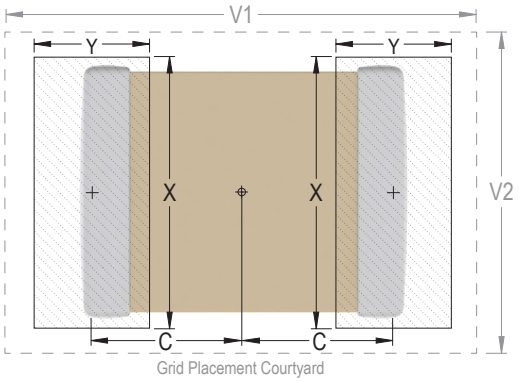
[1] *Only for capacitance values ≥ 22 µF*

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.

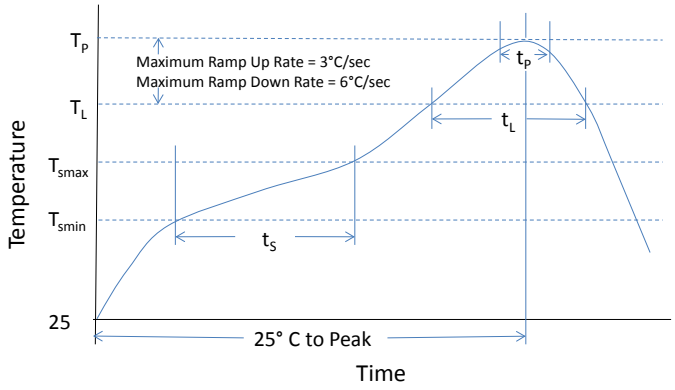


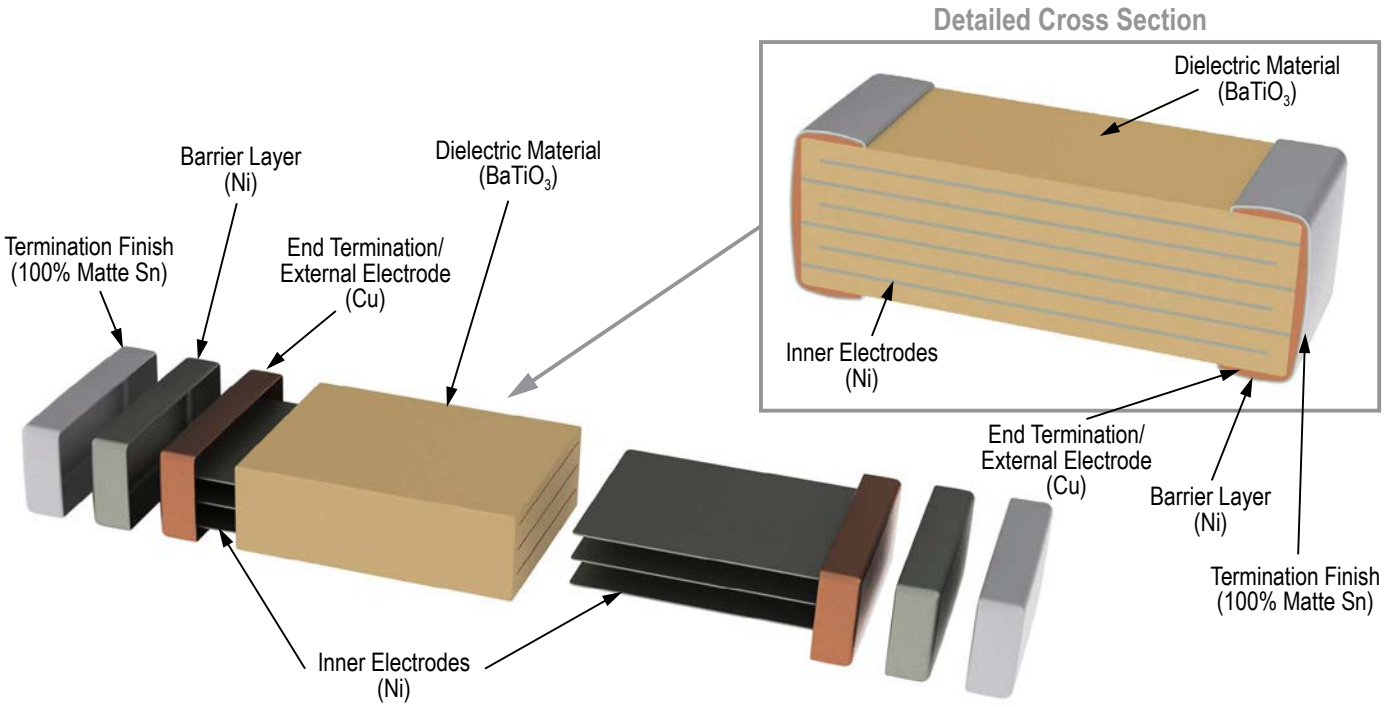
Table 4 – Performance & Reliability: Test Methods and Conditions

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 +/- 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 (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.

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

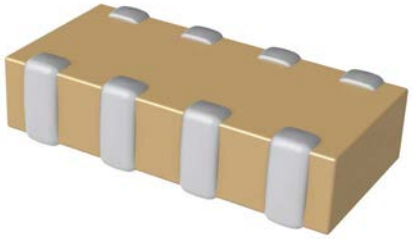
Overview

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 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 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.

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)
	05 = 0508 06 = 0612	2 = 2 4 = 4	X = Flexible Termination	Two significant digits + 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" below

[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.

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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 (Embossed Plastic Tape) / Unmarked	7210
Automotive Grade[2]	
7" Reel	AUTO
13" Reel/Embossed Plastic/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
- EIA 0508 (2-element) and 0612 (4-element) case sizes
- DC voltage ratings of 10 V, 16 V, 25 V, 50 V, 100 V, and 200 V
- Capacitance offerings ranging from 10 pF to 2,200 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's 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:

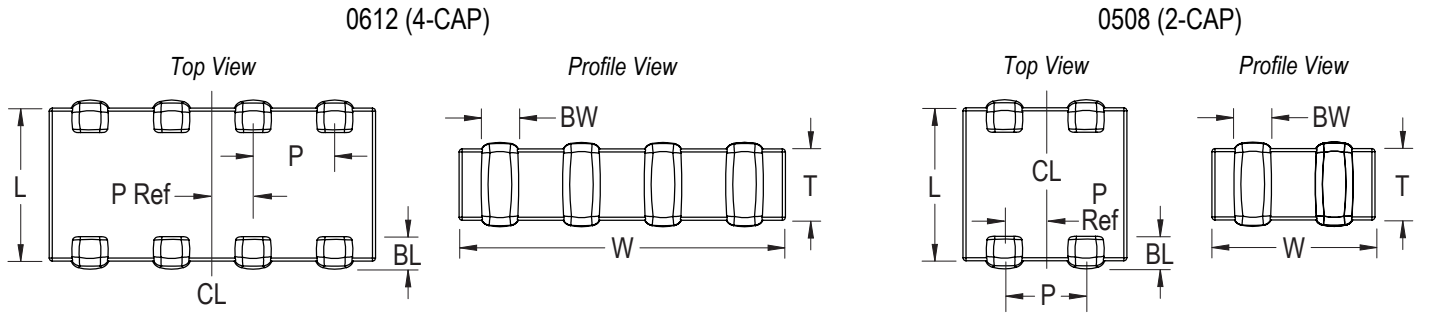
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design record and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that 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	BW Bandwidth	BL Bandlength	T Thickness	P Pitch	P Reference
0508	1220	1.30 (0.051) ±0.15 (0.006)	2.10 (0.083) ±0.15 (0.006)	0.53 (0.021) ±0.08 (0.003)	0.30 (0.012) ±0.20 (0.008)	See Table 2 for Thickness	1.00 (0.039) ±0.10 (0.004)	0.50 (0.020) ±0.10 (0.004)
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)		0.80 (0.031) ±0.10 (0.004)	0.40 (0.016) ±0.05 (0.002)

Qualification/Certification

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

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 @ 25°C	0.1%
[3]Insulation Resistance (IR) Limit @ 25°C	1,000 megohm microfarads or 100 GΩ (Rated voltage applied for 120 ±5 seconds @ 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 (0508 – 0612 Case Sizes)

Capacitance	Capacitance Code	Case Size/Series			C0508X (CA052X 2-Cap Case Size)					C0612X (CA064X 4-Cap Case Size)					
		Voltage Code			8	4	3	5	1	8	4	3	5	1	2
		Rated Voltage (VDC)			10	16	25	50	100	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	PA	PA	PA	PA	PA	MA	MA	MA	MA	MA	
120 pF	121	J	K	M	PA	PA	PA	PA	PA	MA	MA	MA	MA	MA	
150 pF	151	J	K	M	PA	PA	PA	PA	PA	MA	MA	MA	MA	MA	
180 pF	181	J	K	M	PA	PA	PA	PA	PA	MA	MA	MA	MA	MA	
220 pF	221	J	K	M	PA	PA	PA	PA	PA	MA	MA	MA	MA		
270 pF	271	J	K	M	PA	PA	PA	PA	PA	MA	MA	MA	MA		
330 pF	331	J	K	M	PA	PA	PA	PA	PA	MA	MA	MA	MA		
390 pF	391	J	K	M	PA	PA	PA	PA	PA	MA	MA	MA	MA		
470 pF	471	J	K	M	PA	PA	PA	PA	PA	MA	MA	MA	MA		
560 pF	561	J	K	M	PA	PA	PA	PA	PA						
680 pF	681	J	K	M	PA	PA	PA	PA	PA						
820 pF	821	J	K	M	PA	PA	PA	PA	PA						
1,000 pF	102	J	K	M	PA	PA	PA	PA	PA						
1,100 pF	112	J	K	M	PA	PA	PA	PA	PA						
1,200 pF	122	J	K	M	PA	PA	PA	PA	PA						
1,300 pF	132	J	K	M	PA	PA	PA	PA	PA						
1,500 pF	152	J	K	M	PA	PA	PA	PA	PA						
1,600 pF	162	J	K	M	PA	PA	PA	PA	PA						
1,800 pF	182	J	K	M	PA	PA	PA	PA	PA						
2,000 pF	202	J	K	M	PA	PA	PA	PA	PA						
2,200 pF	222	J	K	M	PA	PA	PA	PA	PA						
Capacitance	Capacitance Code	Rated Voltage (VDC)			10	16	25	50	100	10	16	25	50	100	200
		Voltage Code			8	4	3	5	1	8	4	3	5	1	2
		Case Size/Series			C0508X (CA052X 2-Cap Case Size)					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 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
PA	0508	0.80 ± 0.10	0	0	4,000	10,000
MA	0612	0.80 ± 0.10	0	0	4,000	10,000

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		

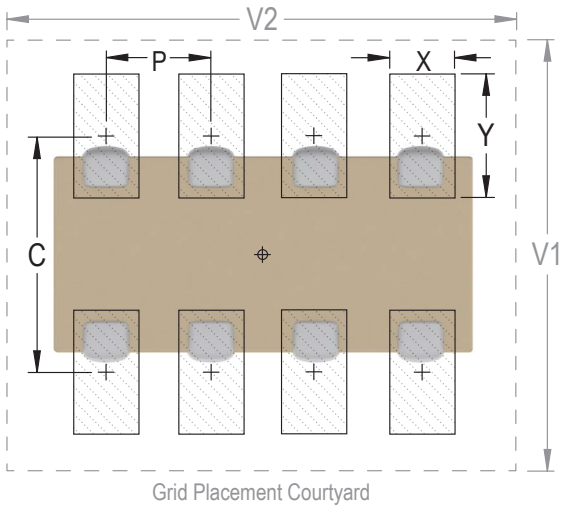
[1] The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial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

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
0508/CA052	1220	1.60	1.00	0.55	1.00	3.50	3.30	1.50	0.90	0.50	1.00	2.90	2.80	1.40	0.75	0.45	1.00	2.40	2.50
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 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.

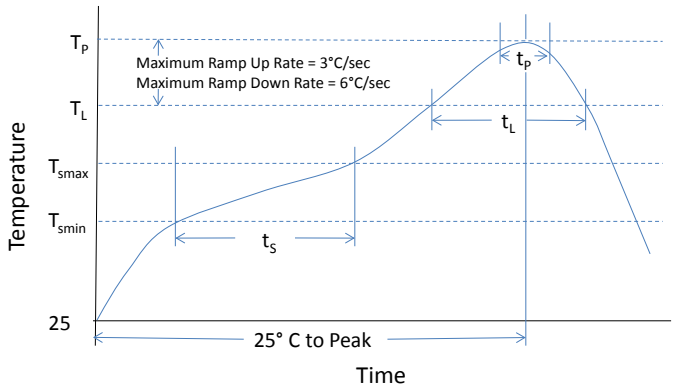


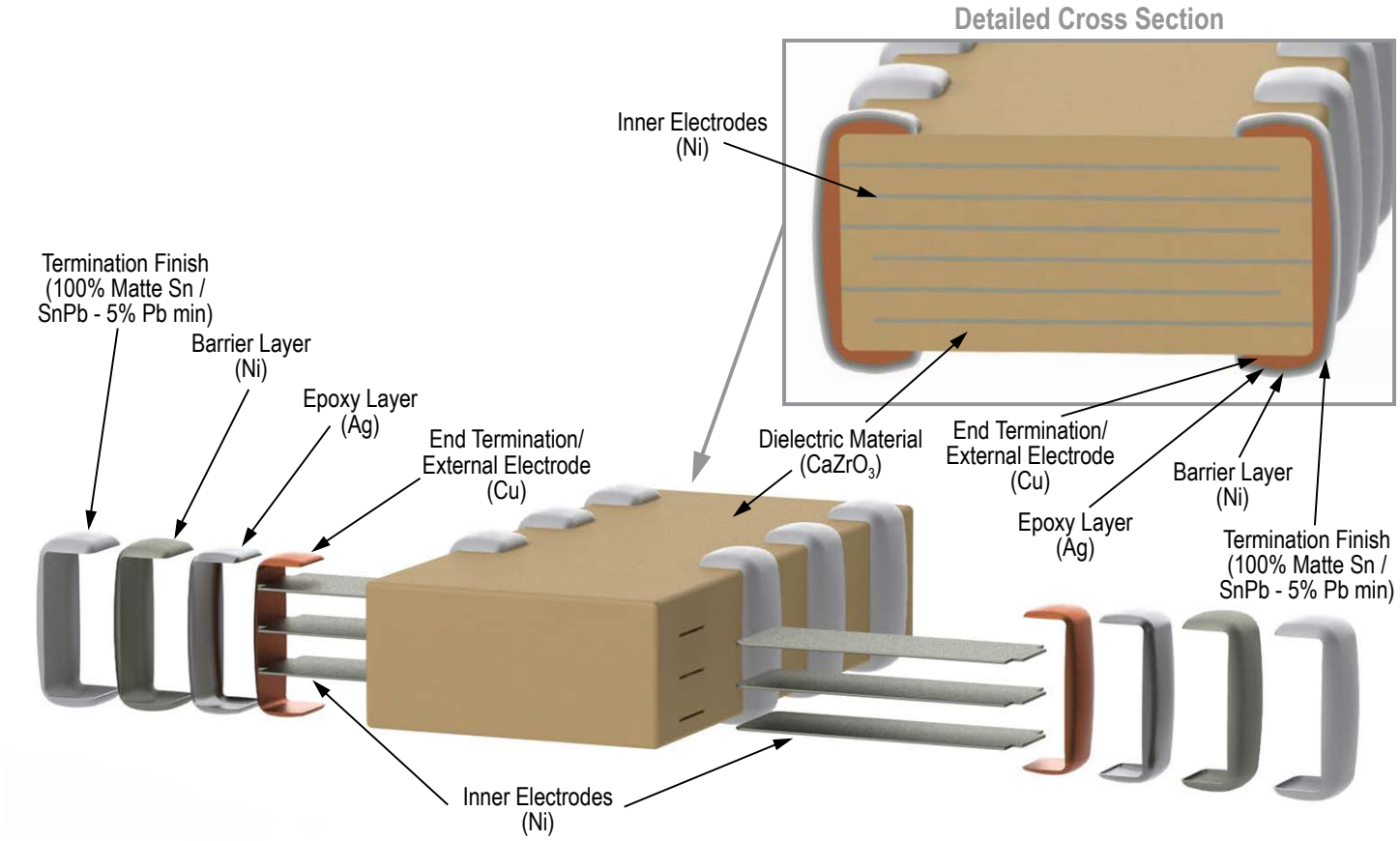
Table 4 – Performance & Reliability: Test Methods and Conditions

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 +/- 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):

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.

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

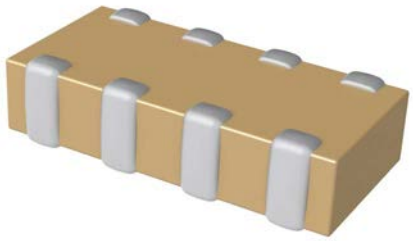
Overview

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)
	05 = 0508 06 = 0612	2 = 2 4 = 4	X = Flexible Termination	Two significant digits + 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" below

[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.

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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 (Embossed Plastic Tape) / Unmarked	7210
Automotive Grade[2]	
7" Reel	AUTO
13" Reel/Embossed Plastic/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
- EIA 0508 (2-element) and 0612 (4-element) case sizes
- DC voltage ratings of 10 V, 16 V, 25 V, 50 V, 100 V, and 200 V
- Capacitance offerings ranging from 330 pF – 0.22 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)
- 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's 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

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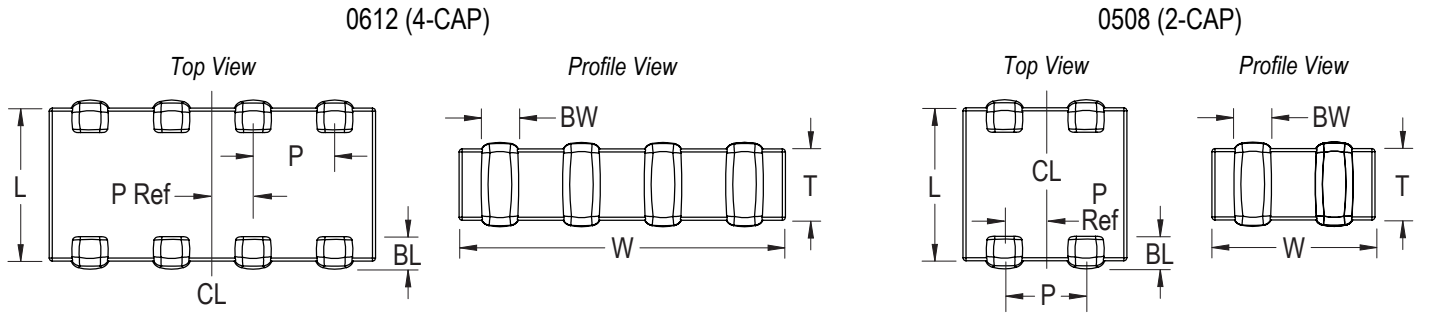
- To provide the evidence that all customer engineering design record and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part

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)



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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 @ 25°C	See Dissipation Factor Limit Table
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	1,000 megohm microfarads or 100GΩ (Rated voltage applied for 120 ± 5 secs @ 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	< 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 (0508 – 0612 Case Sizes)

Capacitance	Capacitance Code	Case Size/Series			C0508C/X (CA052C/X 2-Cap Case Size)					C0612C/X (CA064C/X 4-Cap Case Size)					
		Voltage Code			8	4	3	5	1	8	4	3	5	1	2
		Rated Voltage (VDC)			10	16	25	50	100	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	PA	PA	PA	PA	PA	MA	MA	MA	MA	MA	MA
390 pF	391	J	K	M	PA	PA	PA	PA	PA	MA	MA	MA	MA	MA	MA
470 pF	471	J	K	M	PA	PA	PA	PA	PA	MA	MA	MA	MA	MA	MA
560 pF	561	J	K	M	PA	PA	PA	PA	PA	MA	MA	MA	MA	MA	MA
680 pF	681	J	K	M	PA	PA	PA	PA	PA	MA	MA	MA	MA	MA	MA
820 pF	821	J	K	M	PA	PA	PA	PA	PA	MA	MA	MA	MA	MA	MA
1,000 pF	102	J	K	M	PA	PA	PA	PA	PA	MA	MA	MA	MA	MA	MA
1,200 pF	122	J	K	M	PA	PA	PA	PA	PA	MA	MA	MA	MA	MA	MA
1,500 pF	152	J	K	M	PA	PA	PA	PA	PA	MA	MA	MA	MA	MA	MA
1,800 pF	182	J	K	M	PA	PA	PA	PA	PA	MA	MA	MA	MA	MA	MA
2,200 pF	222	J	K	M	PA	PA	PA	PA	PA	MA	MA	MA	MA	MA	MA
2,700 pF	272	J	K	M	PA	PA	PA	PA	PA	MA	MA	MA	MA	MA	MA
3,300 pF	332	J	K	M	PA	PA	PA	PA	PA	MA	MA	MA	MA	MA	MA
3,900 pF	392	J	K	M	PA	PA	PA	PA	PA	MA	MA	MA	MA	MA	MA
4,700 pF	472	J	K	M	PA	PA	PA	PA	PA	MA	MA	MA	MA	MA	MA
5,600 pF	562	J	K	M	PA	PA	PA	PA		MA	MA	MA	MA	MA	MA
6,800 pF	682	J	K	M	PA	PA	PA	PA		MA	MA	MA	MA	MA	MA
8,200 pF	822	J	K	M	PA	PA	PA	PA		MA	MA	MA	MA	MA	MA
10,000 pF	103	J	K	M	PA	PA	PA	PA		MA	MA	MA	MA	MA	MA
12,000 pF	123	J	K	M	PA	PA	PA	PA		MA	MA	MA	MA	MA	
15,000 pF	153	J	K	M	PA	PA	PA	PA		MA	MA	MA	MA	MA	
18,000 pF	183	J	K	M	PA	PA	PA	PA		MA	MA	MA	MA	MA	
22,000 pF	223	J	K	M	PA	PA	PA	PA		MA	MA	MA	MA	MA	
27,000 pF	273	J	K	M	PA	PA	PA	PA		MA	MA	MA	MA		
33,000 pF	333	J	K	M	PA	PA	PA	PA		MA	MA	MA	MA		
39,000 pF	393	J	K	M	PA	PA	PA	PA		MA	MA	MA	MA		
47,000 pF	473	J	K	M	PA	PA	PA	PA		MA	MA	MA	MA		
56,000 pF	563	J	K	M	PA	PA	PA	PA		MA	MA	MA			
68,000 pF	683	J	K	M	PA	PA	PA	PA		MA	MA				
82,000 pF	823	J	K	M	PA	PA	PA	PA		MA	MA				
0.10 µF	104	J	K	M	PA	PA	PA	PA		MA	MA				
0.15 µF	154	J	K	M	PA										
0.22 µF	224	J	K	M	PA										
Capacitance	Capacitance Code	Rated Voltage (VDC)			10	16	25	50	100	10	16	25	50	100	200
		Voltage Code			8	4	3	5	1	8	4	3	5	1	2
		Case Size/Series			C0508C/X (CA052C/X 2-Cap Case Size)					C0612C/X (CA064C/X 4-Cap Case Size)					

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
PA	0508	0.80 ± 0.10	0	0	4,000	10,000
MA	0612	0.80 ± 0.10	0	0	4,000	10,000

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		

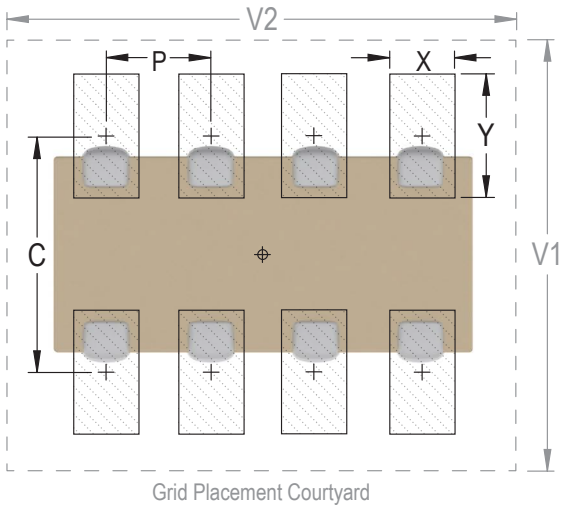
[1] The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial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

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
0508/CA052	1220	1.60	1.00	0.55	1.00	3.50	3.30	1.50	0.90	0.50	1.00	2.90	2.80	1.40	0.75	0.45	1.00	2.40	2.50
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 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.

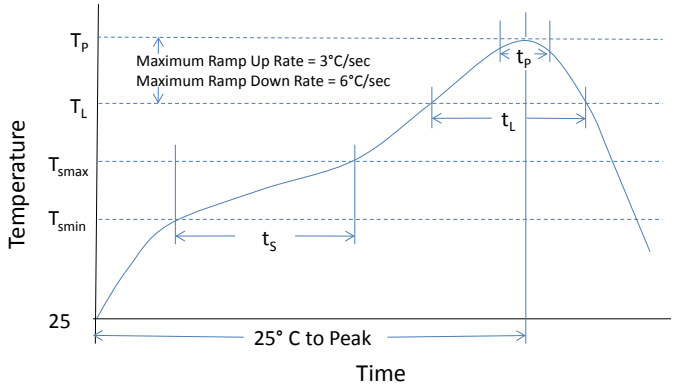


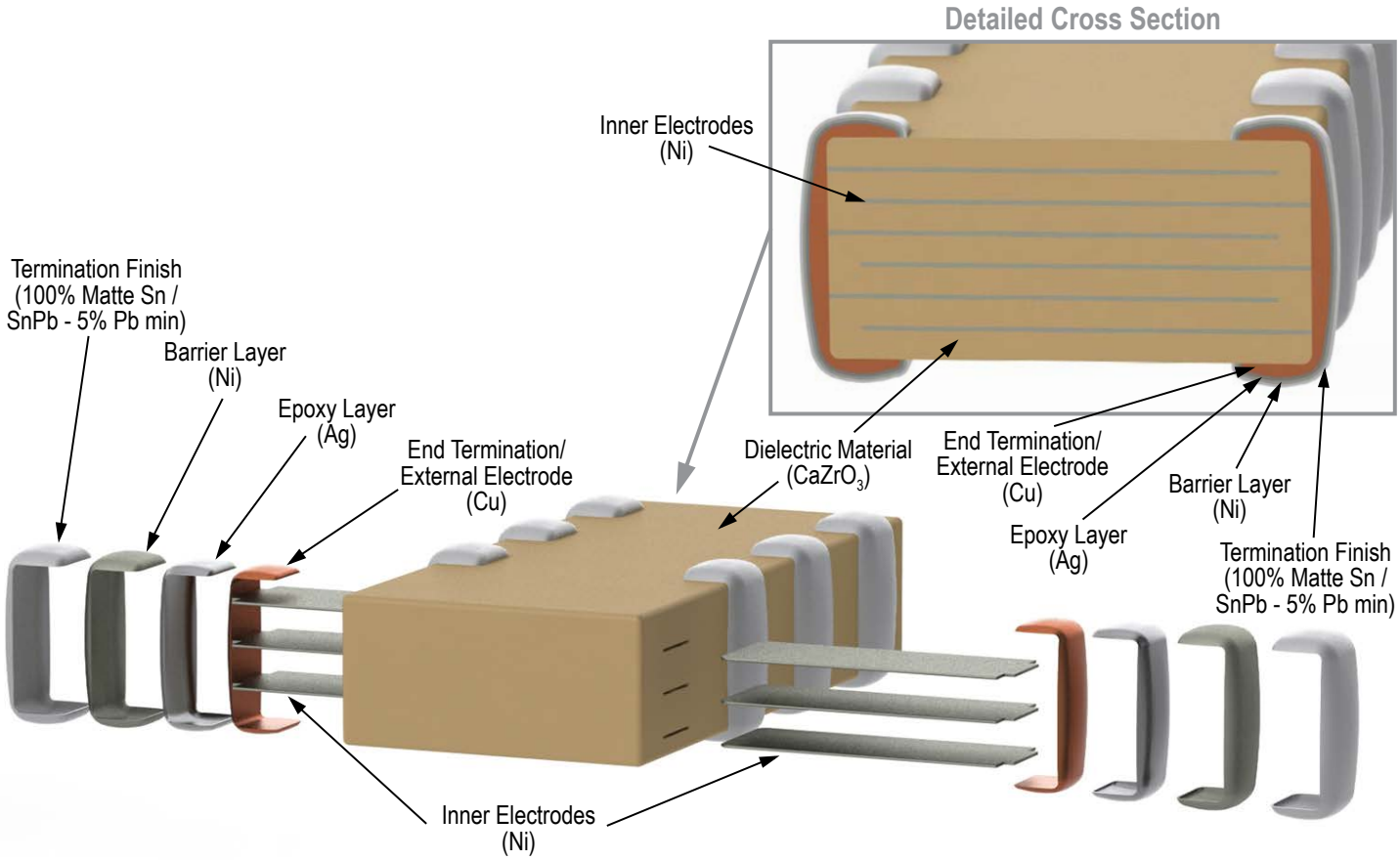
Table 4 – Performance & Reliability: Test Methods and Conditions

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 +/- 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.

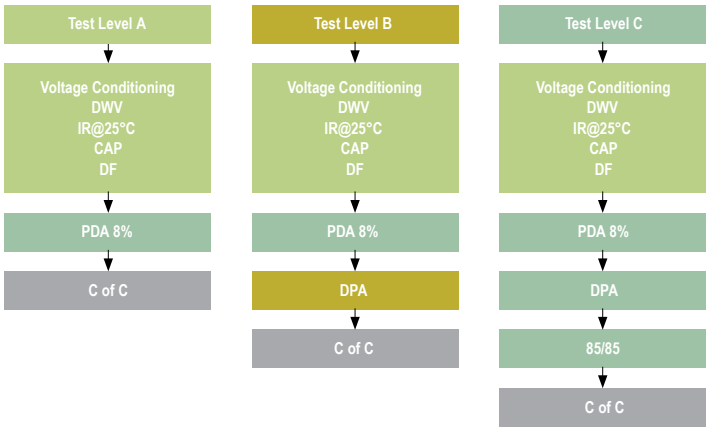
Construction



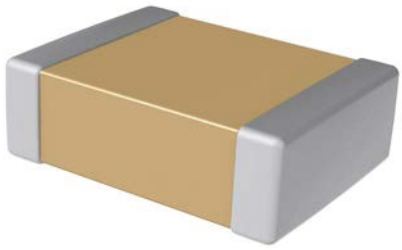
Commercial Off-The-Shelf (COTS) for Higher Reliability Applications, C0G Dielectric, 10 – 250 VDC

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 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	Failure Rate/Design	Termination Finish[2]	Packaging/Grade (C-Spec)
	0402 0603 0805 1206 1210 1812 2220	T = COTS	Two significant digits + 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 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)	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.*

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Packaging C-Spec Ordering Options Table

Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)
Bulk Bag/Unmarked	Not required (Blank)
7" Reel/Unmarked	TU
13" Reel/Unmarked	7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes)
7" Reel/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".

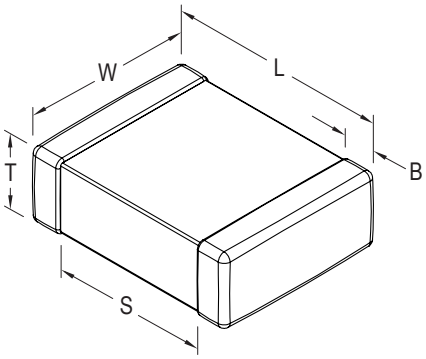
Benefits

- −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.

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	
1210	3225	3.20 (.126) ± 0.20 (.008)	2.50 (.098) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)		Solder Reflow Only
1812	4532	4.50 (.177) ± 0.30 (.012)	3.20 (.126) ± 0.30 (.012)		0.60 (.024) ± 0.35 (.014)		
2220	5650	5.70 (.224) ± 0.40 (.016)	5.00 (.197) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.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 @ 25°C	0.1%
[3]Insulation Resistance (IR) Limit @ 25°C	1,000 megohm microfarads or 100 GΩ (Rated voltage applied for 120 ±5 seconds @ 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	402	0.50 ± 0.05	10000	50000	0	0
BD	402	0.55 ± 0.05	10000	50000	0	0
CF	603	0.80 ± 0.07	4000	15000	0	0
CH	603	0.85 ± 0.07	4000	10000	0	0
DN	805	0.78 ± 0.10	4000	15000	0	0
DP	805	0.90 ± 0.10	4000	15000	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
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 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 out 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

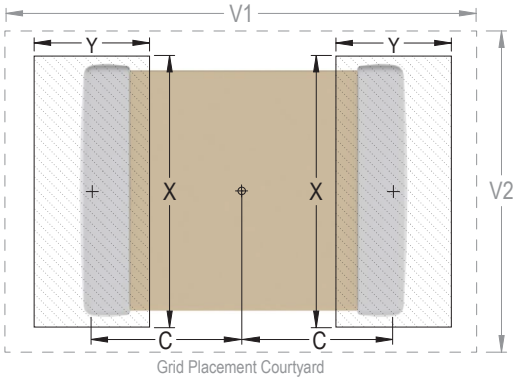
[1] *Only for capacitance values ≥ 22 µF*

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.

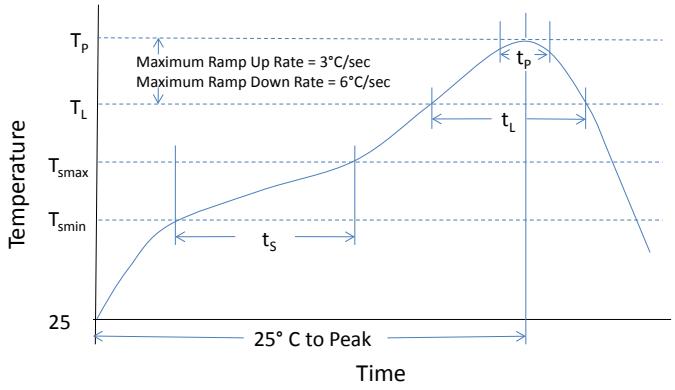


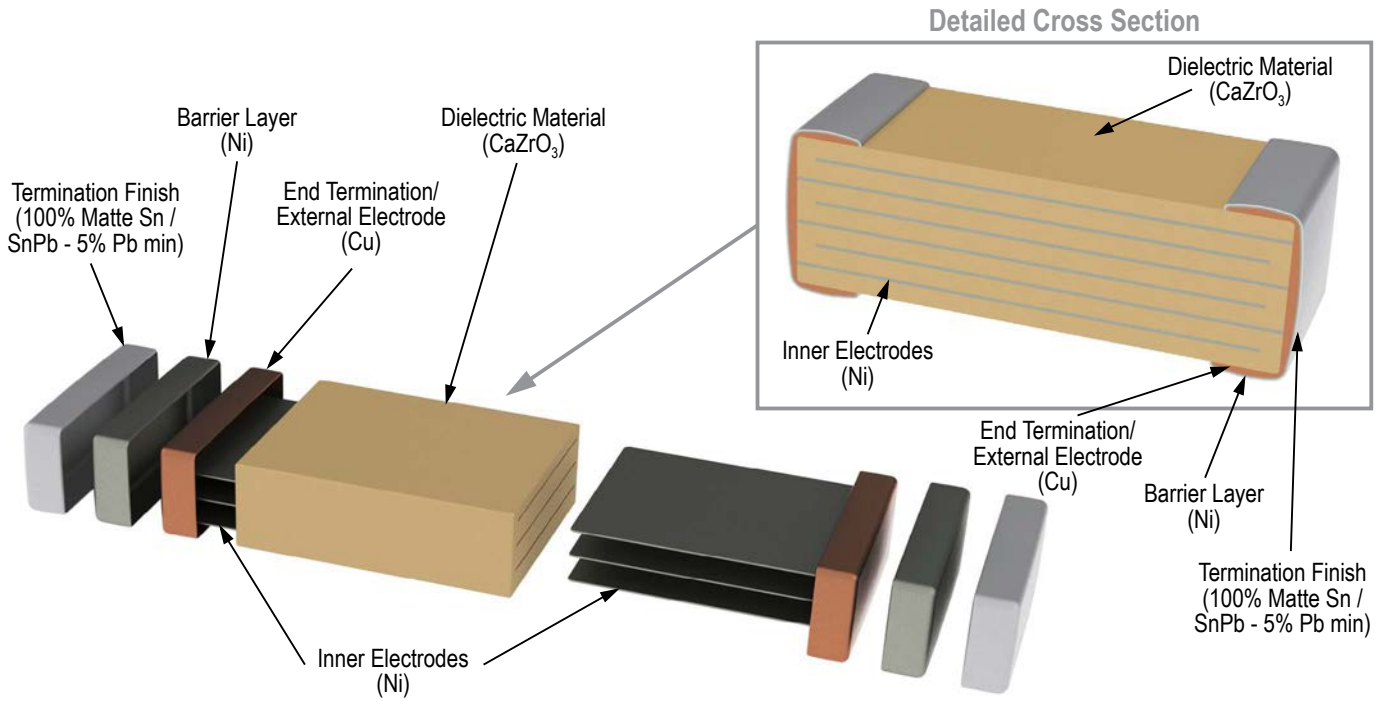
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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 +/- 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.

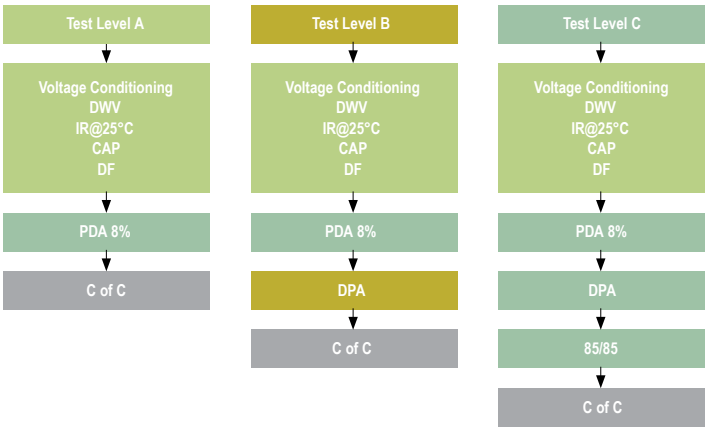
Commercial Off-The-Shelf (COTS) for Higher Reliability Applications, X7R Dielectric, 6.3 – 250 VDC

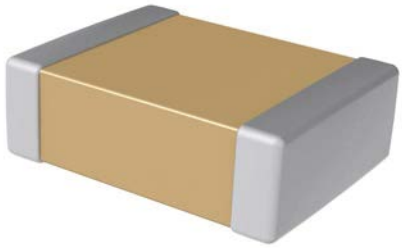
Overview

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 ±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	Failure Rate/Design	Termination Finish[1]	Packaging/Grade (C-Spec)
	0402 0603 0805 1206 1210 1812 2220	T = COTS	Two significant digits + 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)	See "Packaging C-Spec Ordering Options Table" below

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

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Packaging C-Spec Ordering Options Table

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

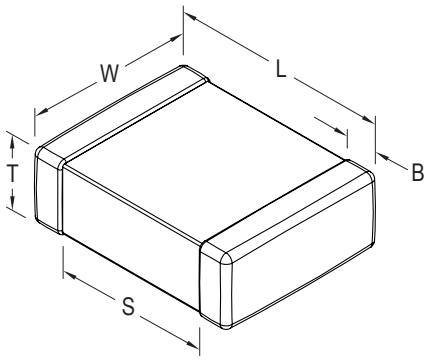
Benefits

- −55°C to +125°C operating temperature range
- 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.

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	
1210[1]	3225	3.20 (.126) ± 0.20 (.008)	2.50 (.098) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)		Solder Reflow Only
1812	4532	4.50 (.177) ± 0.30 (.012)	3.20 (.126) ± 0.30 (.012)		0.60 (.024) ± 0.35 (.014)		
2220	5650	5.70 (.224) ± 0.40 (.016)	5.00 (.197) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		

[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 @ 25°C	5%(6.3V & 10V), 3.5%(16V & 25V) and 2.5%(50V to 250V)
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (Rated voltage applied for 120 ± 5 secs @ 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
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	C0402T					C0603T							C0805T								C1206T							
		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	C0402T					C0603T							C0805T								C1206T							

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'd

Capacitance	Cap Code	Case Size/ Series	C0402T					C0603T							C0805T								C1206T							
		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	C0402T					C0603T							C0805T								C1206T							

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)

Capacitance	Cap Code	Case Size/ Series	C1210T								C1808T			C1812T					C1825T				C2220T				
		Voltage Code	9	8	4	3	5	1	2	A	5	1	2	3	5	1	2	A	5	1	2	A	3	5	1	2	A
		Rated Voltage (VDC)	6.3	10	16	25	50	100	200	250	50	100	200	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																								
10 - 91 pF*	100 - 910*	J K M	FB	FB	FB	FB	FB	FB	FB																		
100 - 270 pF**	101 - 391**	J K M	FB	FB	FB	FB	FB	FB	FB																		
330 pF	331	J K M	FB	FB	FB	FB	FB	FB	FB		LF	LF	LF														
390 pF	391	J K M	FB	FB	FB	FB	FB	FB	FB		LF	LF	LF														
470 - 820 pF**	471 - 821**	J K M	FB	FB	FB	FB	FB	FB	FB		LF	LF	LF	GB	GB	GB	GB										
1,000 pF	102	J K M	FB	FB	FB	FB	FB	FB	FB		LF	LF	LF	GB	GB	GB	GB										
1,200 pF	122	J K M	FB	FB	FB	FB	FB	FB	FB		LF	LF	LF	GB	GB	GB	GB										
1,500 pF	152	J K M	FB	FB	FB	FB	FB	FB	FE		LF	LF	LF	GB	GB	GB	GB										
1,800 pF	182	J K M	FB	FB	FB	FB	FB	FB	FE		LF	LF	LF	GB	GB	GB	GB										
2,200 pF	222	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LF	LF	LF	GB	GB	GB	GB										
2,700 pF	272	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LF	LF	LF	GB	GB	GB	GB										
3,300 pF	332	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LF	LF		GB	GB	GB	GB										
3,900 pF	392	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LF	LF		GB	GB	GB	GB										
4,700 pF	472	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GD										
5,600 pF	562	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GH										
6,800 pF	682	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB					JE	JE	JE		
8,200 pF	822	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB					JE	JE	JE		
10,000 pF	103	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB					JE	JE	JE		
12,000 pF	123	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB					JE	JE	JE		
15,000 pF	153	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB					JE	JE	JE		
18,000 pF	183	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB					JE	JE	JE		
22,000 pF	223	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JE	JE	JE		
27,000 pF	273	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JE	JE	JE		
Capacitance	Cap Code	Rated Voltage (VDC)	6.3	10	16	25	50	100	200	250	50	100	200	25	50	100	200	250	50	100	200	250	25	50	100	200	250
		Voltage Code	9	8	4	3	5	1	2	A	5	1	2	3	5	1	2	A	5	1	2	A	3	5	1	2	A
		Case Size/ Series	C1210T								C1808T			C1812T					C1825T				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)
***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'd

Capacitance	Cap Code	Case Size/ Series	C1210T								C1808T			C1812T					C1825T				C2220T				
		Voltage Code	9	8	4	3	5	1	2	A	5	1	2	3	5	1	2	A	5	1	2	A	3	5	1	2	A
		Rated Voltage (VDC)	6.3	10	16	25	50	100	200	250	50	100	200	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																								
33,000 pF	333	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JB		
39,000 pF	393	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JB		
47,000 pF	473	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JB		
56,000 pF	563	J K M	FB	FB	FB	FB	FB	FB	FC	FC	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JB		
68,000 pF	683	J K M	FB	FB	FB	FB	FB	FB	FC	FC	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JB		
82,000 pF	823	J K M	FB	FB	FB	FB	FB	FC	FF	FF	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JC	JC	JC
0.10 µF	104	J K M	FB	FB	FB	FB	FB	FD	FG	FG	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JC	JC	JC
0.12 µF	124	J K M	FB	FB	FB	FB	FB	FD	FH	FH	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JC	JC	JC
0.15 µF	154	J K M	FC	FC	FC	FC	FC	FD	FM	FM	LD			GB	GB	GB	GE	GE	HB	HB	HB	HB	JB	JB	JC	JC	JC
0.18 µF	184	J K M	FC	FC	FC	FC	FC	FD	FK	FK	LD			GB	GB	GB	GG	GG	HB	HB	HB	HB	JB	JB	JC	JC	JC
0.22 µF	224	J K M	FC	FC	FC	FC	FC	FD	FK	FK				GB	GB	GB	GG	GG	HB	HB	HB	HB	JB	JB	JC	JC	JC
0.27 µF	274	J K M	FC	FC	FC	FC	FC	FD						GB	GB	GG	GG	GG	HB	HB	HB	HB	JC	JC	JC	JC	JC
0.33 µF	334	J K M	FD	FD	FD	FD	FD	FD						GB	GB	GG	GG	GG	HB	HB	HB	HB	JC	JC	JC	JC	JC
0.39 µF	394	J K M	FD	FD	FD	FD	FD	FD						GB	GB	GG	GG	GG	HD	HD	HD	HD	JC	JC	JC	JC	JC
0.47 µF	474	J K M	FD	FD	FD	FD	FD	FD						GB	GB	GG	GJ	GJ	HD	HD	HD	HD	JC	JC	JC	JC	JC
0.56 µF	564	J K M	FD	FD	FD	FD	FD	FF						GC	GC	GG			HD	HD	HD	HD	JC	JD	JD	JD	JD
0.68 µF	684	J K M	FD	FD	FD	FD	FD	FG						GC	GC	GG			HD	HD	HD	HD	JC	JD	JD	JD	JD
0.82 µF	824	J K M	FF	FF	FF	FF	FF	FL						GE	GE	GG			HF	HF	HF	HF	JC	JF	JF	JF	JF
1.0 µF	105	J K M	FH	FH	FH	FH	FH	FM						GE	GE	GG			HF	HF	HF	HF	JC	JF	JF	JF	JF
1.2 µF	125	J K M	FH	FH	FH	FH	FG																JC	JC			
1.5 µF	155	J K M	FH	FH	FH	FH	FG																JC	JC			
1.8 µF	185	J K M	FH	FH	FH	FH	FG																JD	JD			
2.2 µF	225	J K M	FJ	FJ	FJ	FJ	FG							GO	GO								JF	JF			
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							GK	GK								JF	JF			
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								GK									JF	JO			
12 µF	126	J K M																									
15 µF	156	J K M																					JO				
18 µF	186	J K M																									
22 µF	226	J K M	FS	FS																			JO				
Capacitance	Cap Code	Rated Voltage (VDC)	6.3	10	16	25	50	100	200	250	50	100	200	25	50	100	200	250	50	100	200	250	25	50	100	200	250
		Voltage Code	9	8	4	3	5	1	2	A	5	1	2	3	5	1	2	A	5	1	2	A	3	5	1	2	A
		Case Size/ Series	C1210T								C1808T			C1812T					C1825T				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)*
***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	4,000	10,000	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
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 out 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

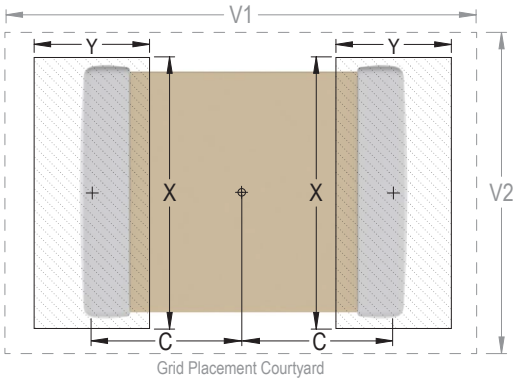
[1] *Only for capacitance values ≥ 22 µF*

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.

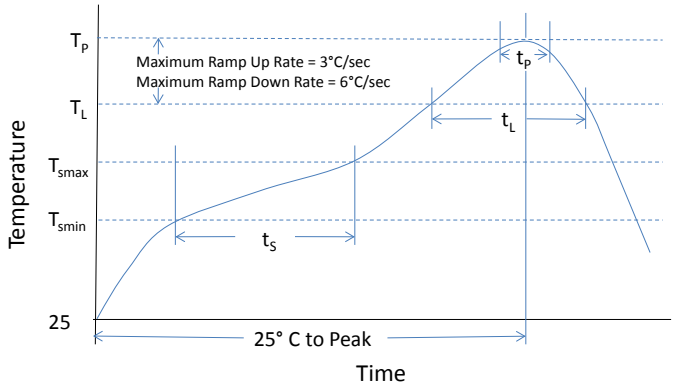


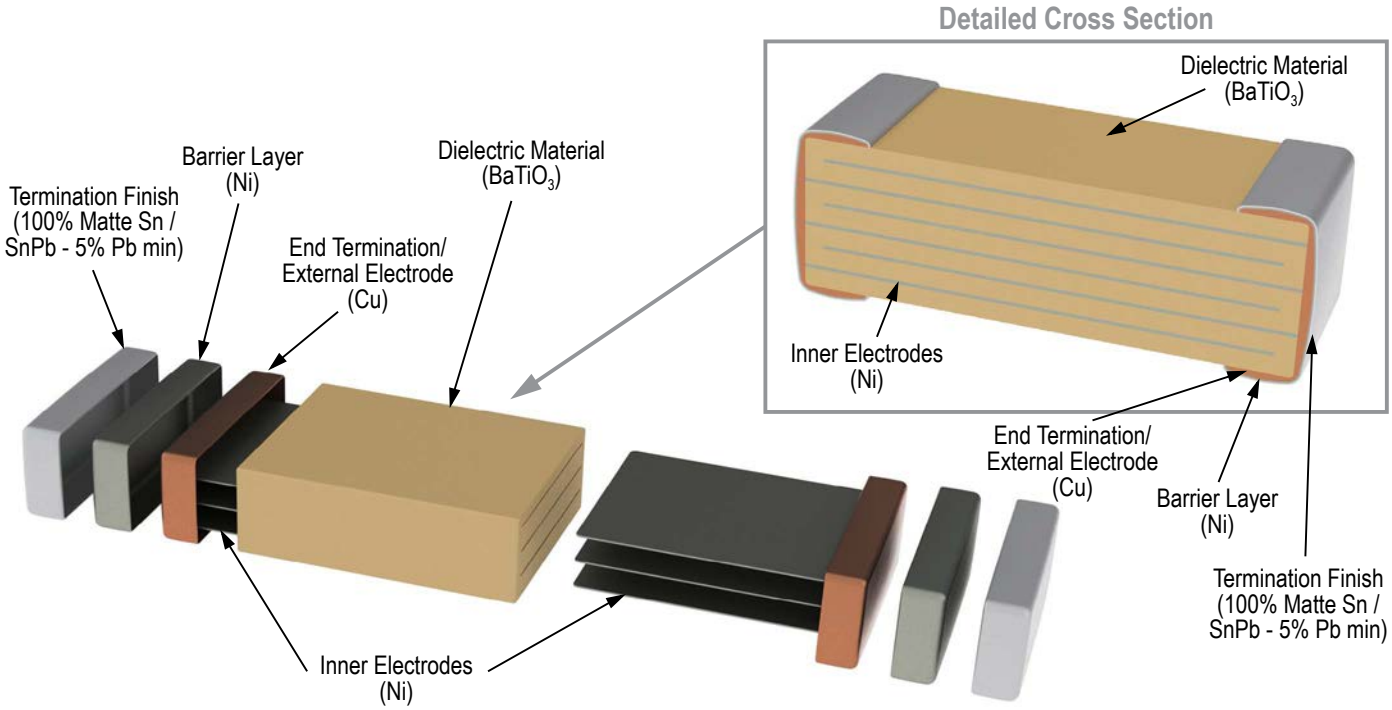
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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 +/- 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



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

Overview

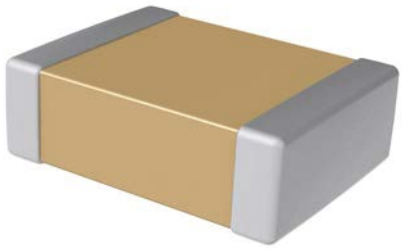
KEMET's 250V DC Tip and Ring MLCCs in X7R dielectric are designed and rated for telecommunication ringer circuits where the capacitor is used to block -48V to -52V DC of line voltage and pass a 16-25 Hz AC signal pulse of 70 Vrms to 90 Vrms. Serving as an excellent replacement for high voltage leaded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

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 0805, 1206, 1210, 1812, 1825, 2220, and 2225 case sizes
- DC voltage rating of 250 V
- Capacitance offerings ranging from 1,000 pF to 6.8 µF
- Available capacitance tolerances of ±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



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)
	0805 1206 1210 1812 1825 2220 2225	C = Standard X = Flexible Termination	Two significant digits + number of zeros	J = ±5% K = ±10% M = ±20%	A = 250	R = X7R	A = N/A	C = 100% Matte Sn L = SnPb (5% Pb minimum)	See "Packaging C-Spec Ordering Options Table" below

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

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Packaging C-Spec Ordering Options Table

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

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.

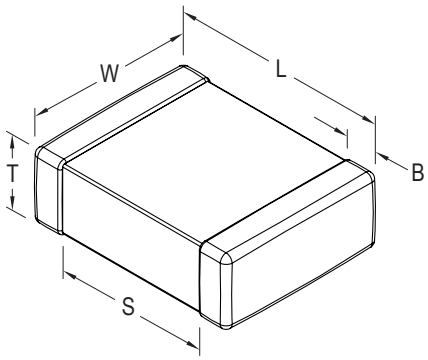
Qualification/Certification

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).

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 (.079) ± 0.20 (.008)	1.25 (.049) ± 0.20 (.008)	See Table 2 for Thickness	0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	Solder Wave or Solder Reflow
1206	3216	3.20 (.126) ± 0.20 (.008)	1.60 (.063) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)	N/A	
1210	3225	3.20 (.126) ± 0.20 (.008)	2.50 (.098) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)		Solder Reflow Only
1812	4532	4.50 (.177) ± 0.30 (.012)	3.20 (.126) ± 0.30 (.012)		0.60 (.024) ± 0.35 (.014)		
1825	4564	4.50 (.177) ± 0.30 (.012)	6.40 (.252) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2220	5650	5.70 (.224) ± 0.40 (.016)	5.00 (.197) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2225	5664	5.60 (.220) ± 0.40 (.016)	6.40 (.248) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.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 (.079) ± 0.30 (.012)	1.25 (.049) ± 0.30 (.012)	See Table 2 for Thickness	0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	Solder Wave or Solder Reflow
1206	3216	3.30 (.130) ± 0.40 (.016)	1.60 (.063) ± 0.35(.013)		0.60 (.024) ± 0.25 (.010)	N/A	
1210	3225	3.30 (.130) ± 0.40 (.016)	2.60(.102) ± 0.30(.012)		0.60 (.024) ± 0.25 (.010)		Solder Reflow Only
1812	4532	4.50 (.178) ± 0.40 (.016)	3.20 (.126) ± 0.30 (.012)		0.70 (.028) ± 0.35 (.014)		
1825	4564	4.60 (.181) ± 0.40 (.016)	6.40 (.252) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		
2220	5650	5.90 (.232) ± 0.75 (.030)	5.00 (.197) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		
2225	5664	5.90 (.232) ± 0.75 (.030)	6.40 (.248) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.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 @ 25°C	5%(6.3V & 10V), 3.5%(16V & 25V) and 2.5%(50V to 250V)
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (Rated voltage applied for 120 ± 5 secs @ 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
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 1 – Capacitance Range/Selection Waterfall (0805 – 2225 Case Sizes)

Capacitance	Capacitance Code	Case Size/ Series			C0805C	C1206C	C1210C	C1812C	C1825C	C2220C	C2225C
		Voltage Code			A	A	A	A	A	A	A
		Rated Voltage (VDC)			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	DR	EQ					
1,200 pF	122	J	K	M	DR	EQ					
1,500 pF	152	J	K	M	DR	EQ					
1,800 pF	182	J	K	M	DR	EQ					
2,200 pF	222	J	K	M	DR	EQ	FN				
2,700 pF	272	J	K	M	DR	EQ	FN				
3,300 pF	332	J	K	M	DR	EQ	FN				
3,900 pF	392	J	K	M	DR	EQ	FN				
4,700 pF	472	J	K	M	DR	EQ	FN				
5,600 pF	562	J	K	M	DR	EQ	FN				
6,800 pF	682	J	K	M	DR	EQ	FN	GB			
8,200 pF	822	J	K	M	DR	EQ	FN	GB			
10,000 pF	103	J	K	M	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		EQ	FN	GB	HB		
33,000 pF	333	J	K	M		EQ	FN	GB	HB		
39,000 pF	393	J	K	M		EQ	FN	GB	HB		
47,000 pF	473	J	K	M		ES	FQ	GB	HB		KC
56,000 pF	563	J	K	M		ES	FQ	GB	HB		KC
68,000 pF	683	J	K	M		ES	FQ	GB	HB		KC
82,000 pF	823	J	K	M		ES	FA	GB	HB	JC	KC
0.10 µF	104	J	K	M		EM	FZ	GB	HB	JC	KC
0.12 µF	124	J	K	M			FU	GB	HB	JC	KC
0.15 µF	154	J	K	M			FM	GE	HB	JC	KC
0.18 µF	184	J	K	M			FK	GG	HB	JC	KC
0.22 µF	224	J	K	M			FK	GG	HB	JC	KC
0.27 µF	274	J	K	M				GG	HB	JC	KC
0.33 µF	334	J	K	M				GG	HB	JC	KC
0.39 µF	394	J	K	M				GG	HD	JC	KC
0.47 µF	474	J	K	M				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
		Voltage Code			A	A	A	A	A	A	A
		Case Size/Series			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
DR	0805	0.78 ± 0.20	0	0	4,000	10,000
EQ	1206	0.78 ± 0.20	4,000	10,000	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
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
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
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 out 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.

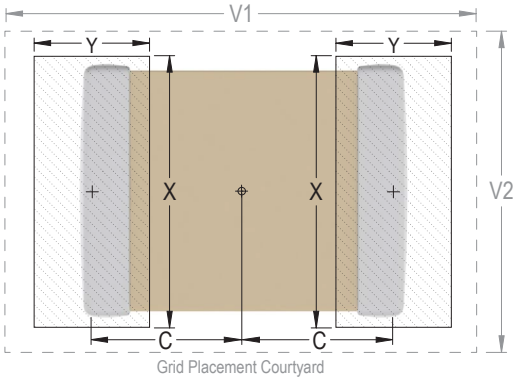
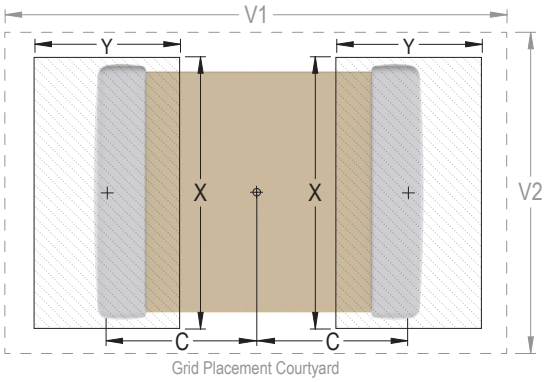


Table 3B – Land Pattern Design Recommendations per IPC–7351 – Flexible Termination

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

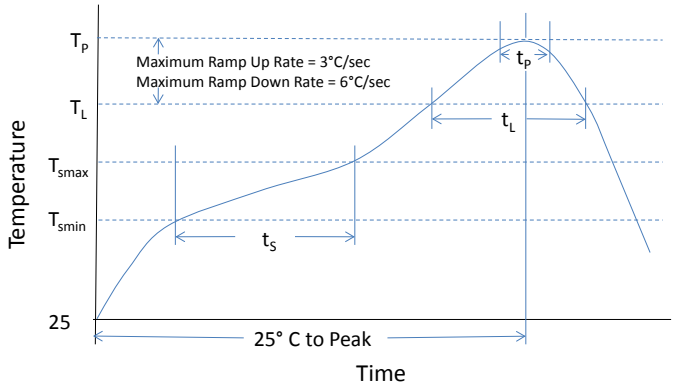


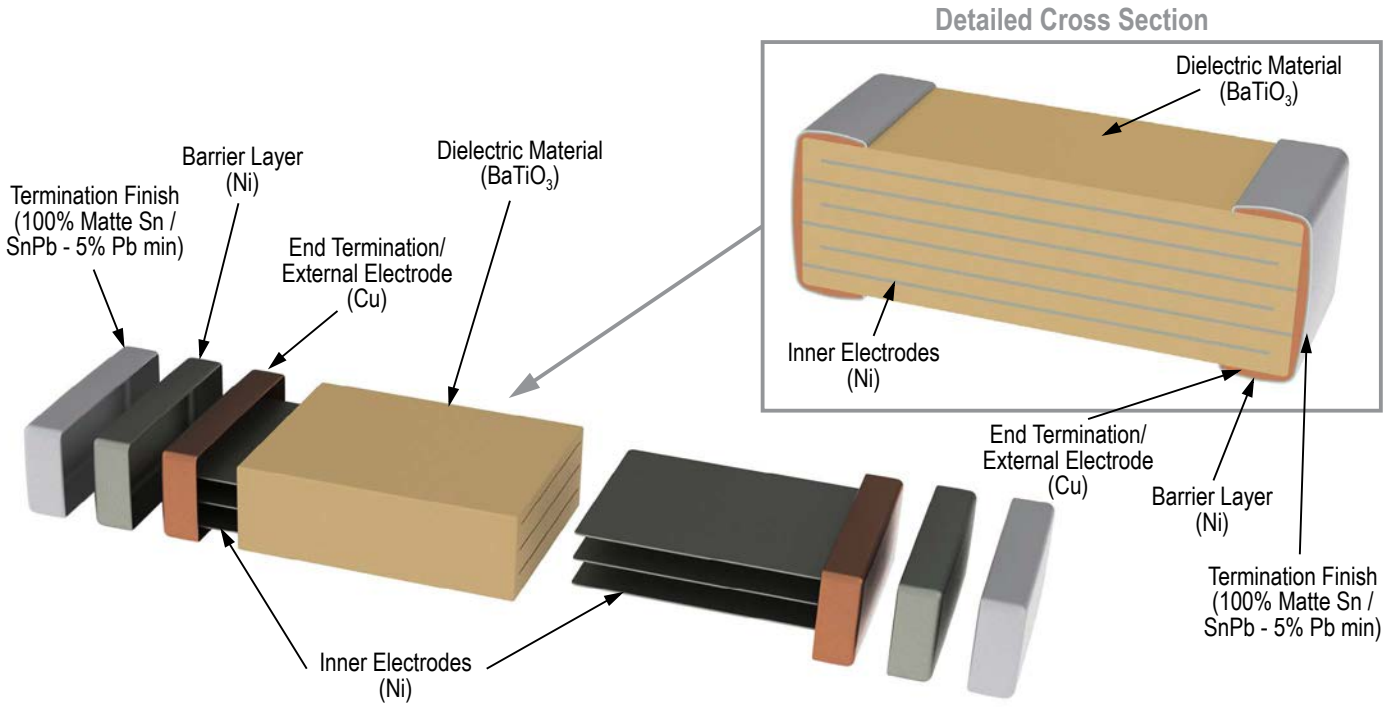
Table 4 – Performance & Reliability: Test Methods and Conditions

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 +/- 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.

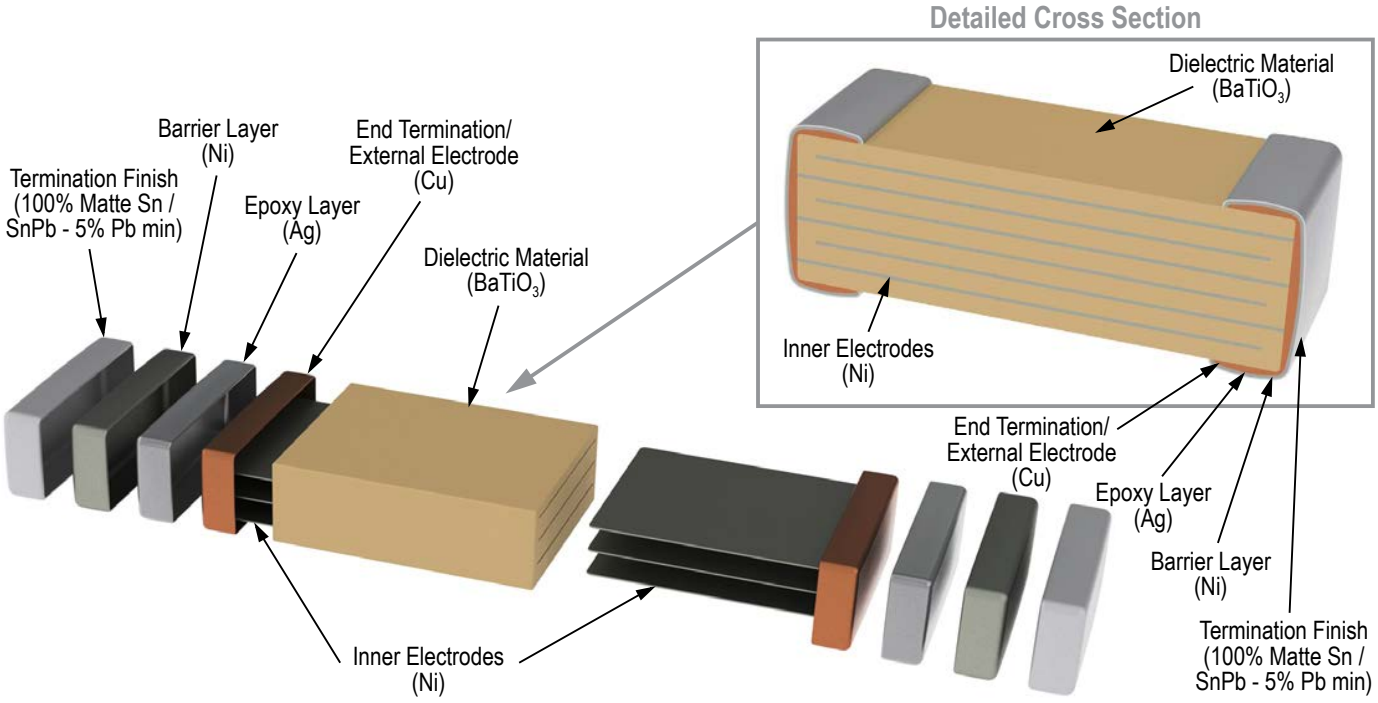
Storage and Handling

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



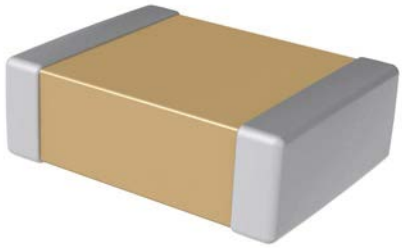
Open Mode Design (FO-CAP), X7R Dielectric, 16 – 200 VDC (Commercial & Automotive Grade)

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 + 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" below

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

[1] *SnPb termination finish option is not available on automotive grade product.*

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Packaging C-Spec Ordering Options Table

Packaging Type	Packaging/Grade Ordering Code (C-Spec)
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 and smaller case sizes) 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's 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:

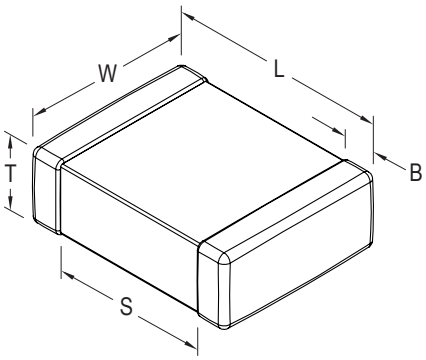
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design record and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that 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 (.079) ± 0.20 (.008)	1.25 (.049) ± 0.20 (.008)	See Table 2 for Thickness	0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	Solder Wave or Solder Reflow
1206	3216	3.20 (.126) ± 0.20 (.008)	1.60 (.063) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)	N/A	
1210	3225	3.20 (.126) ± 0.20 (.008)	2.50 (.098) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)		Solder Reflow Only
1812	4532	4.50 (.177) ± 0.30 (.012)	3.20 (.126) ± 0.30 (.012)		0.60 (.024) ± 0.35 (.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 (.079) ± 0.30 (.012)	1.25 (.049) ± 0.30 (.012)	See Table 2 for Thickness	0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	Solder Wave or Solder Reflow
1206	3216	3.30 (.130) ± 0.40 (.016)	1.60 (.063) ± 0.35 (.013)		0.60 (.024) ± 0.25 (.010)	N/A	
1210	3225	3.30 (.130) ± 0.40 (.016)	2.60 (.102) ± 0.30 (.012)		0.60 (.024) ± 0.25 (.010)		Solder Reflow Only
1812	4532	4.50 (.178) ± 0.40 (.016)	3.20 (.126) ± 0.30 (.012)		0.70 (.028) ± 0.35 (.014)		

Qualification/Certification

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

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.

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 @ 25°C	5%(6.3V & 10V), 3.5%(16V & 25V) and 2.5%(50V to 250V)
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (Rated voltage applied for 120 ± 5 secs @ 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 1 – Capacitance Range/Selection Waterfall (0805 – 1812 Case Sizes)

Capacitance	Capacitance Code	Case Size/ Series		C0805F					C1206F					C1210F					C1812F			
		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		EC	EC	EC	EC	EC									
22,000 pF	223	K	M	DP	DP	DP	DG		EC	EC	EC	EC	EC									
27,000 pF	273	K	M	DP	DP	DP	DG		EC	EC	EC	EC	EC									
33,000 pF	333	K	M	DP	DP	DP	DG		EC	EC	EC	EC	EC									
39,000 pF	393	K	M	DP	DP	DP	DG		EC	EC	EC	EC	EC									
47,000 pF	473	K	M	DP	DP	DP	DE		EC	EC	EC	EC	EG						GB	GB	GB	GB
56,000 pF	563	K	M	DP	DP	DP			EC	EC	EC	EC	EG						GB	GB	GB	GB
68,000 pF	683	K	M	DP	DP	DG	DG		EC	EC	EC	EC	EG	FD	FD	FD	FD	FD	GB	GB	GB	GB
82,000 pF	823	K	M	DP	DP	DG			EC	EC	EC	EC	EG	FD	FD	FD	FD	FD	GB	GB	GB	GB
0.10 µF	104	K	M	DG	DG	DG			EC	EC	EC	EC	EG	FD	FD	FD	FD	FG	GB	GB	GB	GB
0.12 µF	124	K	M	DG	DG				EC	EC	EC	EC		FD	FD	FD	FD	FG	GB	GB	GB	GB
0.15 µF	154	K	M	DG	DG				EC	EC	EC	EG		FD	FD	FD	FD	FH	GB	GB	GB	GB
0.18 µF	184	K	M	DG	DG				EC	EC	EC	EG		FD	FD	FD	FD	FH	GB	GB	GB	GB
0.22 µF	224	K	M	DG	DP	DG			EC	EC	EC	ED		FD	FD	FD	FG	FS	GB	GB	GB	GC
0.27 µF	274	K	M	DP	DP				EC	EC	EC			FD	FD	FD	FG		GB	GB	GB	GF
0.33 µF	334	K	M	DP	DG				EG	EG	EG	EG		FD	FD	FD	FH		GB	GB	GB	GK
0.39 µF	394	K	M	DP	DG				EG	EG				FD	FD	FG	FH		GB	GB	GB	GL
0.47 µF	474	K	M	DE	DG				EG	EG	EC			FD	FD	FG	FJ		GB	GB	GC	
0.56 µF	564	K	M						EG					FD	FD	FG	FR		GB	GB	GD	
0.68 µF	684	K	M	DG					EG					FD	FG	FH	FR		GD	GD	GF	
0.82 µF	824	K	M						EG					FD	FG	FH	FR		GD	GD	GK	
1.0 µF	105	K	M						EG	EC	EH			FD	FH	FJ	FS		GN	GN	GM	
1.2 µF	125	K	M											FG								
1.5 µF	155	K	M											FH								
1.8 µF	185	K	M											FH								
2.2 µF	225	K	M						EC	EH				FJ	FM	FM						
2.7 µF	275	K	M																			
3.3 µF	335	K	M											FM								
3.9 µF	395	K	M																			
4.7 µF	475	K	M						EH					FG	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					C1206F					C1210F					C1812F			

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
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
EC	1206	0.90 ± 0.10	0	0	4,000	10,000
ED	1206	1.00 ± 0.10	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
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
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 – 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 out 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.

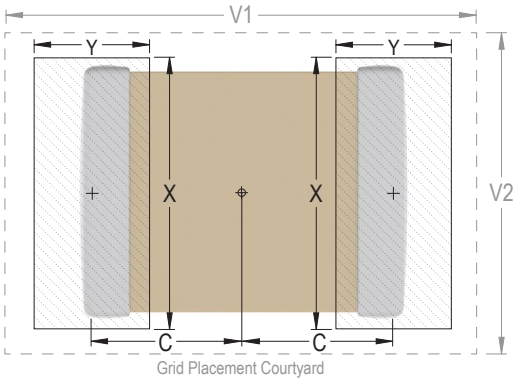
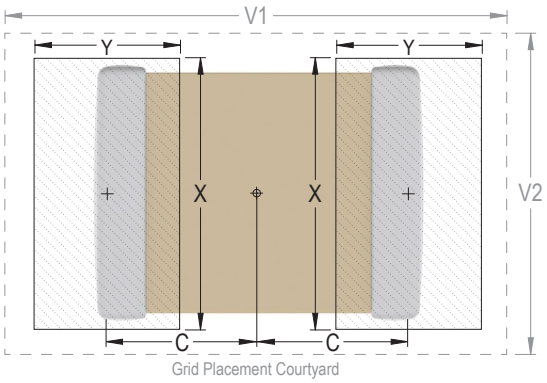


Table 3B – Land Pattern Design Recommendations per IPC–7351 – Flexible Termination

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.

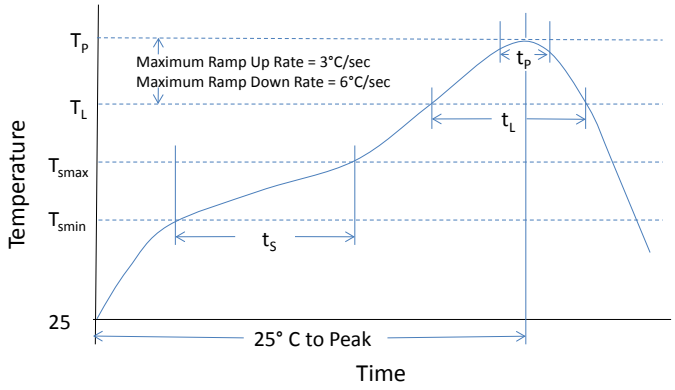


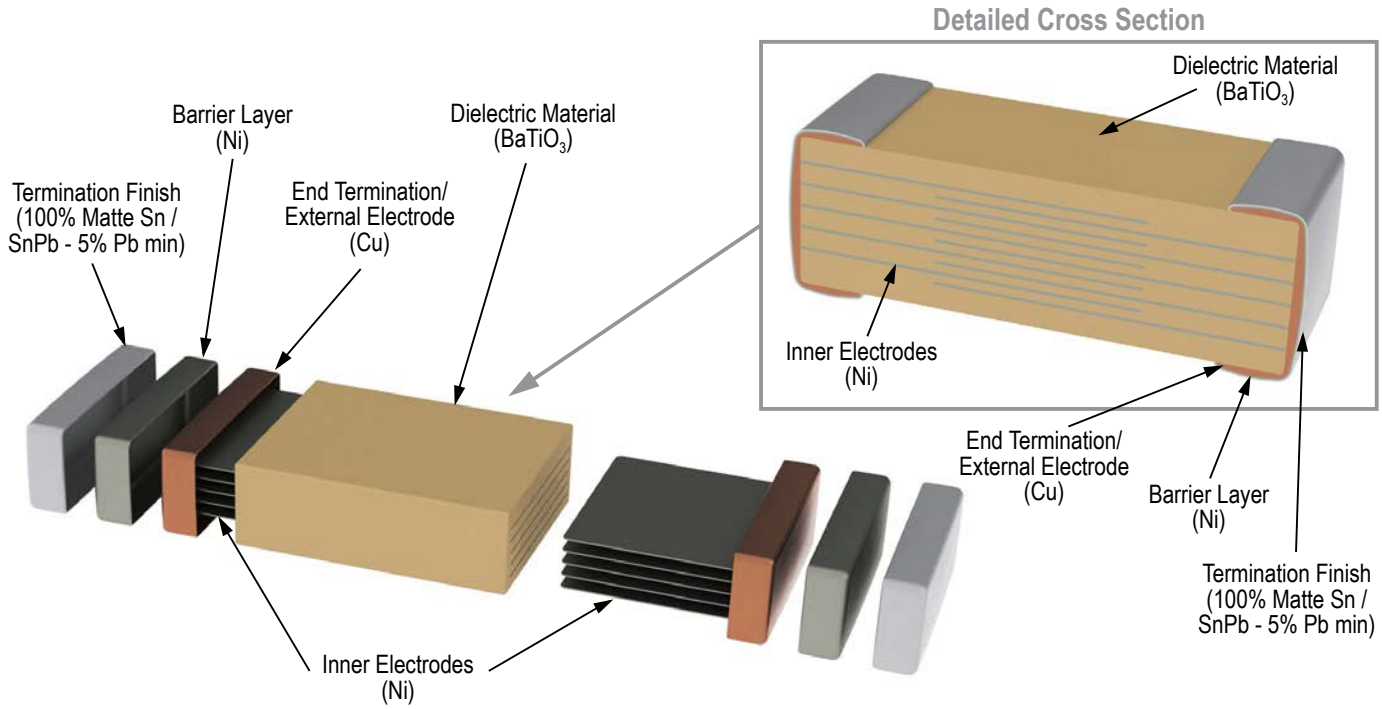
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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 +/- 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.

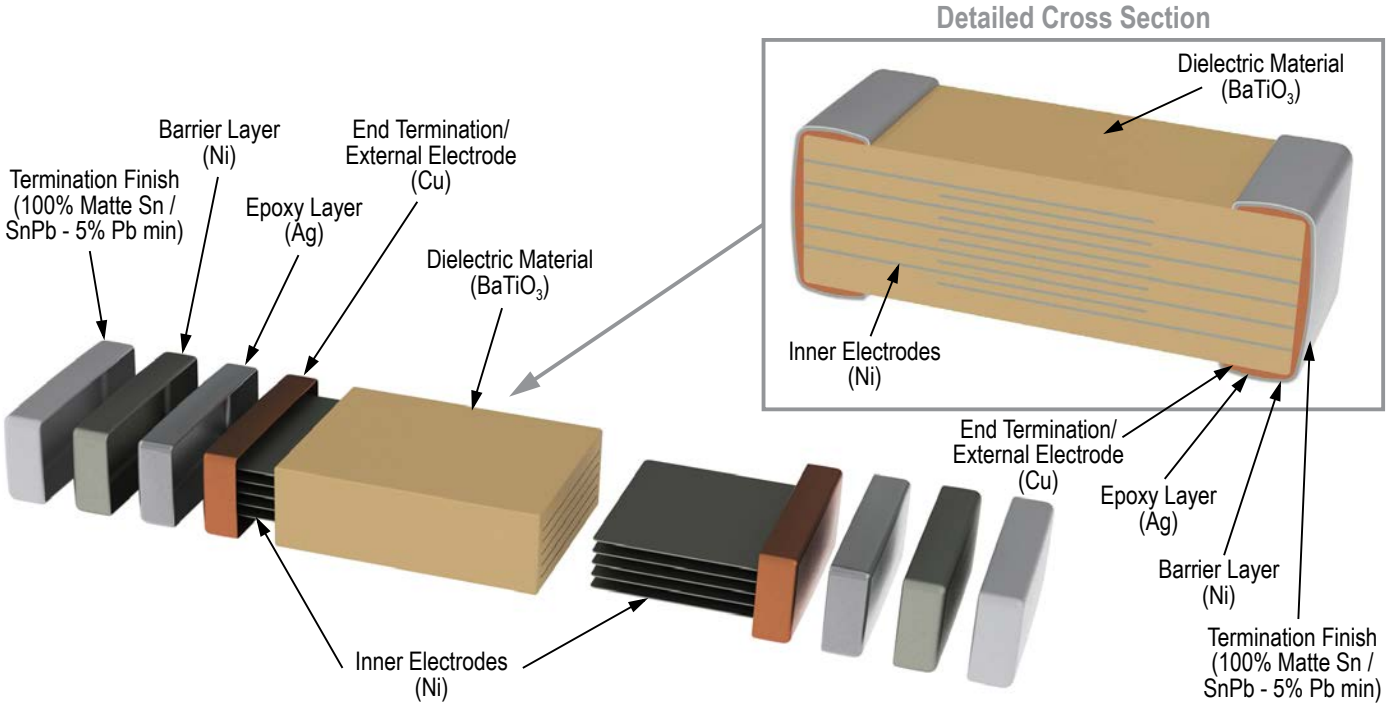
Storage and Handling

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



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

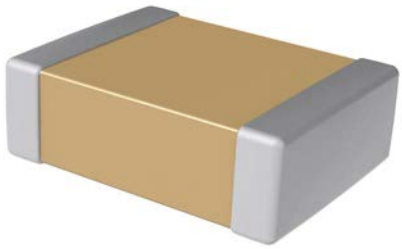
Overview

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 + 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" below

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

[1] *SnPb termination finish option is not available on automotive grade product.*

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Packaging C-Spec Ordering Options Table

Packaging Type	Packaging/Grade Ordering Code (C-Spec)
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 and smaller case sizes) 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's 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:

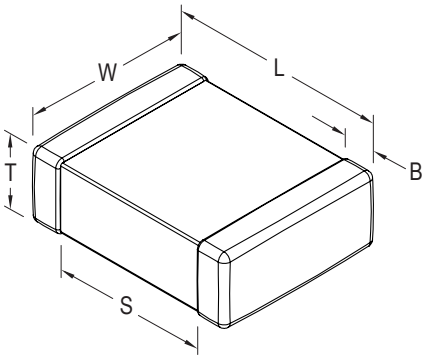
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design record and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that 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 (.126) ±0.20 (.008)	1.60 (0.063) ± 0.20 (0.008)		0.50 (0.02) ±0.25 (0.010)	N/A	
1210	3225	3.20 (.126) ±0.20 (.008)	2.50 (0.098) ± 0.20 (0.008)		0.50 (0.02) ±0.25 (0.010)		Solder Reflow Only
1812	4532	4.50 (.177) ±0.30 (.012)	3.20 (0.126) ± 0.30 (0.012)		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 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.

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 @ 25°C	5%(6.3V & 10V), 3.5%(16V & 25V) and 2.5%(50V to 250V)
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (Rated voltage applied for 120 ± 5 secs @ 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	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
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 out 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

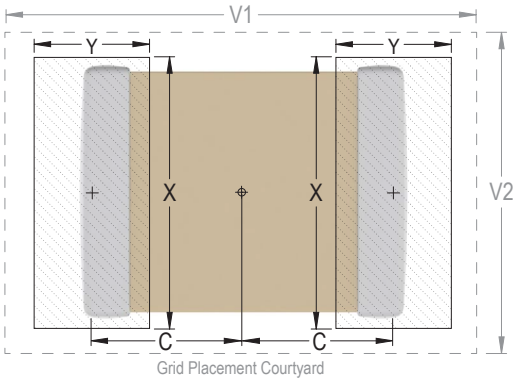
[1] *Only for capacitance values ≥ 22 µF*

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.

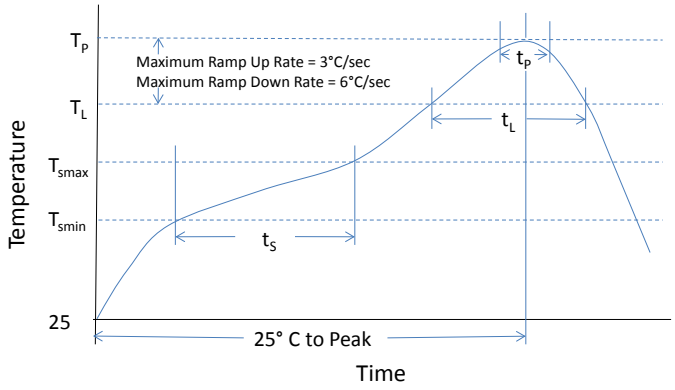


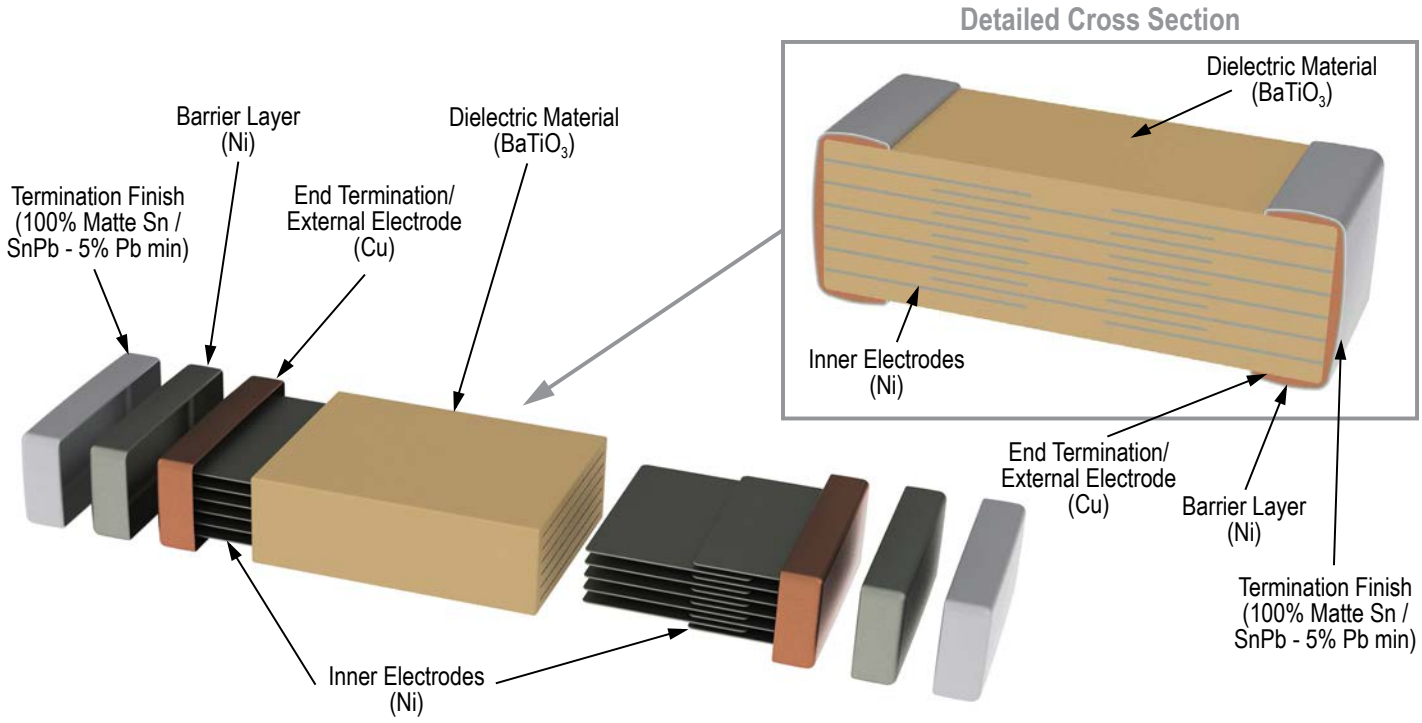
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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 +/- 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



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

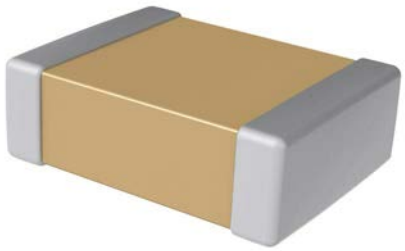
Overview

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 + 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" 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.

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Packaging C-Spec Ordering Options Table

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

- −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's 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:

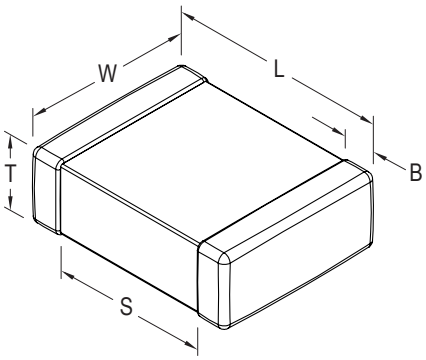
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design record and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that 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 (.064) ± 0.17 (.007)	0.80 (.032) ±0.15 (.006)	See Table 2 for Thickness	0.45 (.018) ± 0.15 (.006)	0.58 (.023)	Solder Wave or Solder Reflow
0805	2012	2.00 (.079) ± 0.30 (.012)	1.25 (.049) ± 0.30 (.012)		0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	
1206	3216	3.30 (.130) ± 0.40 (.016)	1.60 (.063) ± 0.35 (.013)		0.60 (.024) ± 0.25 (.010)	N/A	
1210	3225	3.30 (.130) ± 0.40 (.016)	2.60 (.102) ± 0.30 (.012)		0.60 (.024) ± 0.25 (.010)		Solder Reflow Only
1812	4532	4.50 (.178) ± 0.40 (.016)	3.20 (.126) ± 0.30 (.012)		0.70 (.028) ± 0.35 (.014)		
1825	4564	4.60 (.181) ± 0.40 (.016)	6.40 (.252) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		
2220	5650	5.90 (.232) ± 0.75 (.030)	5.00 (.197) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		
2225	5664	5.90 (.232) ± 0.75 (.030)	6.40 (.248) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		

Qualification/Certification

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

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	4,000	10,000	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.*

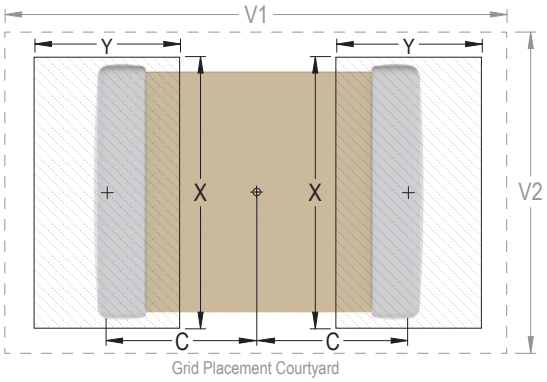
[2] *A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to out standard "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	2.30	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 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.

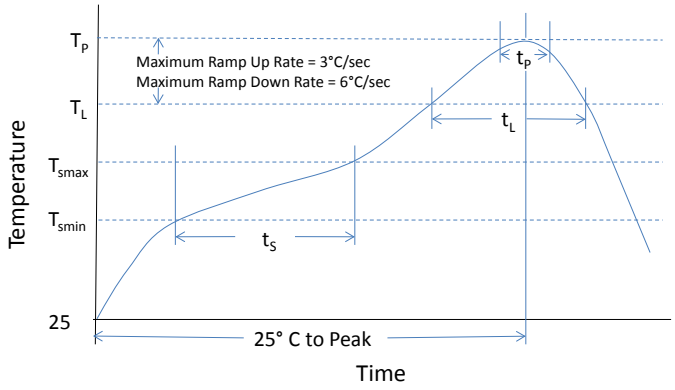


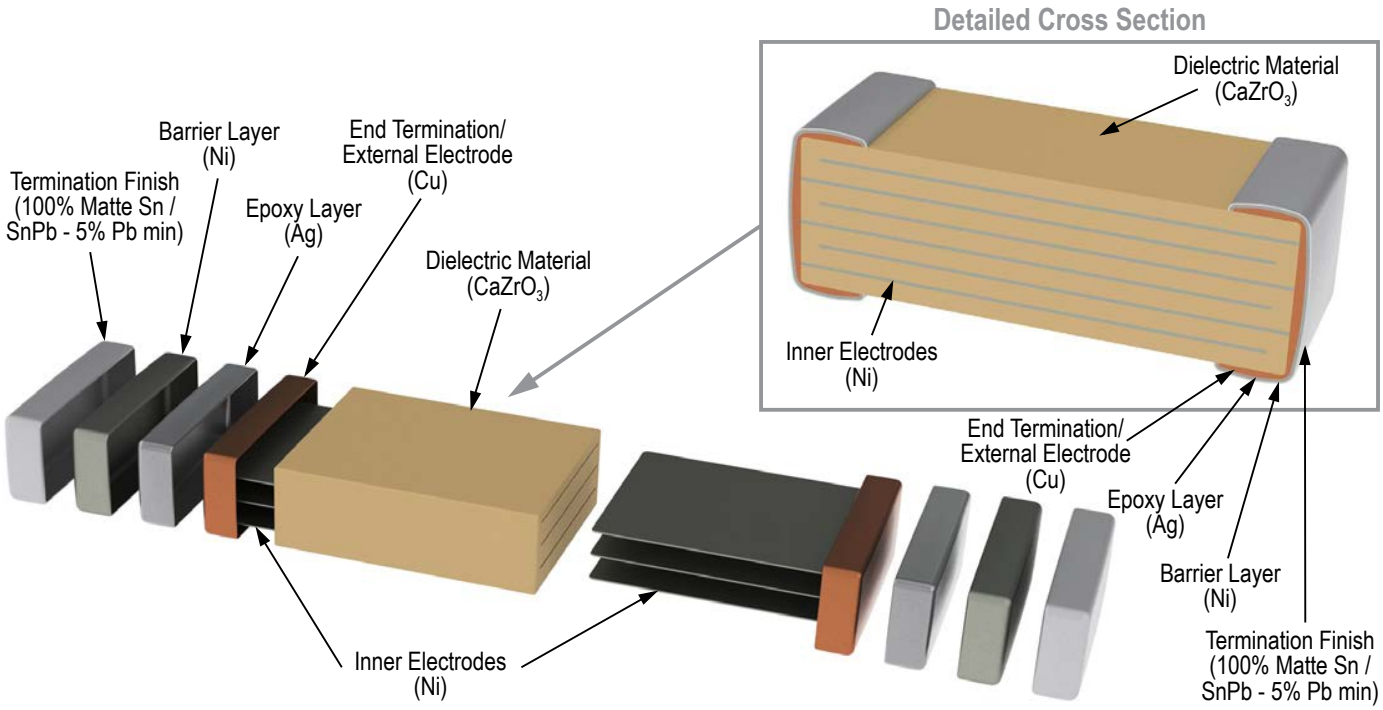
Table 4 – Performance & Reliability: Test Methods and Conditions

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 +/- 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.

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

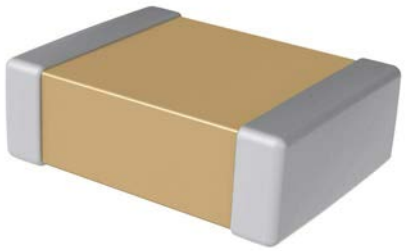
Overview

KEMET's 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.

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 + 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" below

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

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Packaging C-Spec Ordering Options Table

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

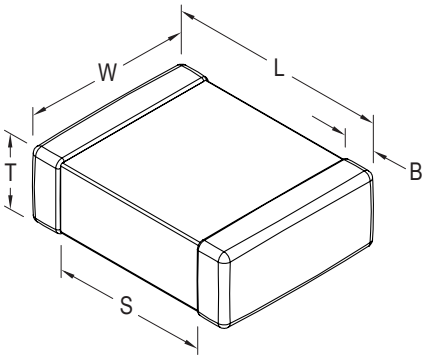
Benefits

- −55°C to +125°C operating temperature range
- 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	1608	1.60 (.063) ± 0.17 (.007)	0.80 (.032) ± 0.15 (.006)	See Table 2 for Thickness	0.45 (.018) ± 0.15 (.006)	0.58 (.023)	Solder Wave or Solder Reflow
0805	2012	2.00 (.079) ± 0.30 (.012)	1.25 (.049) ± 0.30 (.012)		0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	
1206	3216	3.30 (.130) ± 0.40 (.016)	1.60 (.063) ± 0.35 (.013)		0.60 (.024) ± 0.25 (.010)	N/A	
1210	3225	3.30 (.130) ± 0.40 (.016)	2.60 (.102) ± 0.30 (.012)		0.60 (.024) ± 0.25 (.010)		Solder Reflow Only
1808	4520	4.70 (.185) ± 0.50 (.020)	2.00 (.079) ± 0.20 (.008)		0.70 (.028) ± 0.35 (.014)		
1812	4532	4.50 (.178) ± 0.40 (.016)	3.20 (.126) ± 0.30 (.012)		0.70 (.028) ± 0.35 (.014)		
1825	4564	4.60 (.181) ± 0.40 (.016)	6.40 (.252) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		
2220	5650	5.90 (.232) ± 0.75 (.030)	5.00 (.197) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		
2225	5664	5.90 (.232) ± 0.75 (.030)	6.40 (.248) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.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)	±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 @ 25°C	5%(6.3V & 10V), 3.5%(16V & 25V) and 2.5%(50V to 250V)
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (Rated voltage applied for 120 ± 5 secs @ 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 – 1210 Case Sizes)

Cap	Cap Code	Case Size/ Series	C0603X							C0805X								C1206X								C1210X							
		Voltage Code	9	8	4	3	5	1	2	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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		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		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		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		EQ	EQ	EQ	EQ	EQ	ER	ES	ES	FN	FN	FN	FN	FN	FN	FQ	FQ
56,000 pF	563	J K M	CJ	CJ	CJ	CJ	CJ			DD	DD	DD	DD	DD	DS	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			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		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		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			FQ	FQ	FQ	FQ	FQ	FX	FK	FK
0.22 µF	224	J K M	CJ	CJ	CJ	CJ				DR	DR	DR	DR	DG	DG			ER	ER	ER	ER	ER	ER			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		
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		
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		
0.47 µF	474	J K M	CJ	CJ	CJ					DG	DG	DG	DG	DS				ER	ER	ER	ER	ER	EU			FX	FX	FX	FX	FX	FX		
0.56 µF	564	J K M								DD	DD	DD	DG	DH				ES	ES	ES	ES	ER				FX	FX	FX	FX	FX	FA		
0.68 µF	684	J K M								DD	DD	DD	DG	DH				ET	ET	ET	ET	ES				FX	FX	FX	FX	FX	FZ		
0.82 µF	824	J K M								DD	DD	DD	DG					EF	EF	EF	EF	ES				FA	FA	FA	FA	FA	FL		
1.0 µF	105	J K M								DD	DD	DD	DG					EF	EF	EF	EU	ES				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			
1.5 µF	155	J K M								DG	DG	DG						EF	EF	EF	EU	EH				FU	FU	FU	FU	FZ			
1.8 µF	185	J K M								DG	DG	DG						ES	ES	ES	EF	EH				FU	FU	FU	FU	FZ			
2.2 µF	225	J K M								DG	DG	DG						ES	ES	ES	EF	EH				FJ	FJ	FJ	FJ	FZ			
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																EF	EF	EF	EH					FQ	FQ	FQ	FZ	FS			
5.6 µF	565	J K M																EH	EH	EH						FA	FA	FA	FU				
Cap	Cap Code	Rated Voltage (VDC)	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	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	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'd

Cap	Cap Code	Case Size/ Series	C0603X							C0805X								C1206X								C1210X							
		Voltage Code	9	8	4	3	5	1	2	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	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																															
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																EH	EH	EH						FU	FU	FU	FS				
12 µF	126	J K M																															
15 µF	156	J K M																															
18 µF	186	J K M																								FS	FS						
22 µF	226	J K M																															
Cap	Cap Code	Rated Voltage (VDC)	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	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	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						KC	KC	KC	KC
56,000 pF	563	J K M	LD	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB						KC	KC	KC	KC
68,000 pF	683	J K M	LD				GB	GB	GB	GB	GB	HB	HB	HB	HB						KC	KC	KC	KC
82,000 pF	823	J K M	LD				GB	GB	GB	GB	GB	HB	HB	HB	HB	JC	JC	JC	JC	JC	KC	KC	KC	KC
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										HB				JC	JC				KB	KE	KE	KE
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 1B – Capacitance Range/Selection Waterfall (1808 – 2225 Case Sizes) cont'd

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																					
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			
2.7 µF	275	J K M																						
3.3 µF	335	J K M																						
3.9 µF	395	J K M																						
4.7 µF	475	J K M					GK	GK																
5.6 µF	565	J K M																						
6.8 µF	685	J K M																						
8.2 µF	825	J K M																						
10 µF	106	J K M					GK									JF	JO							
12 µF	126	J K M																						
15 µF	156	J K M														JO	JO							
18 µF	186	J K M																						
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
EQ	1206	0.78 ± 0.20	4,000	10,000	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
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
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
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
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 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		

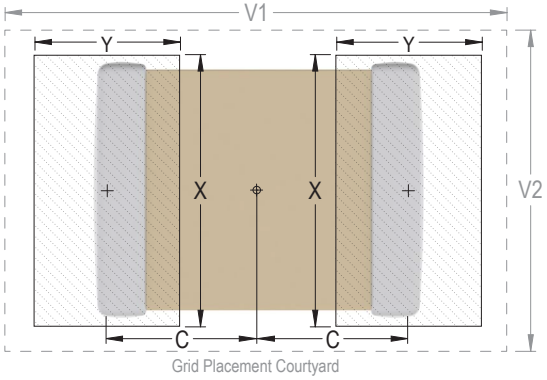
[1] The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial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

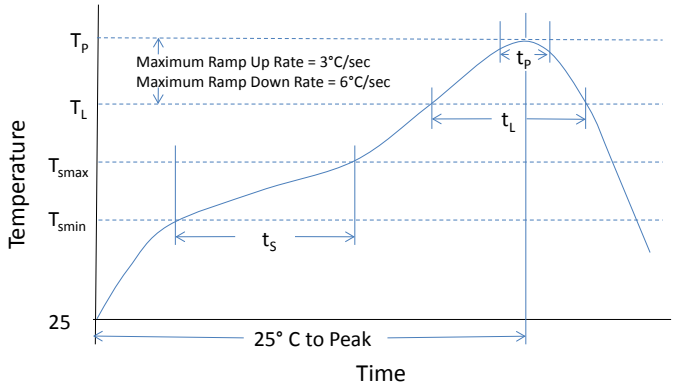


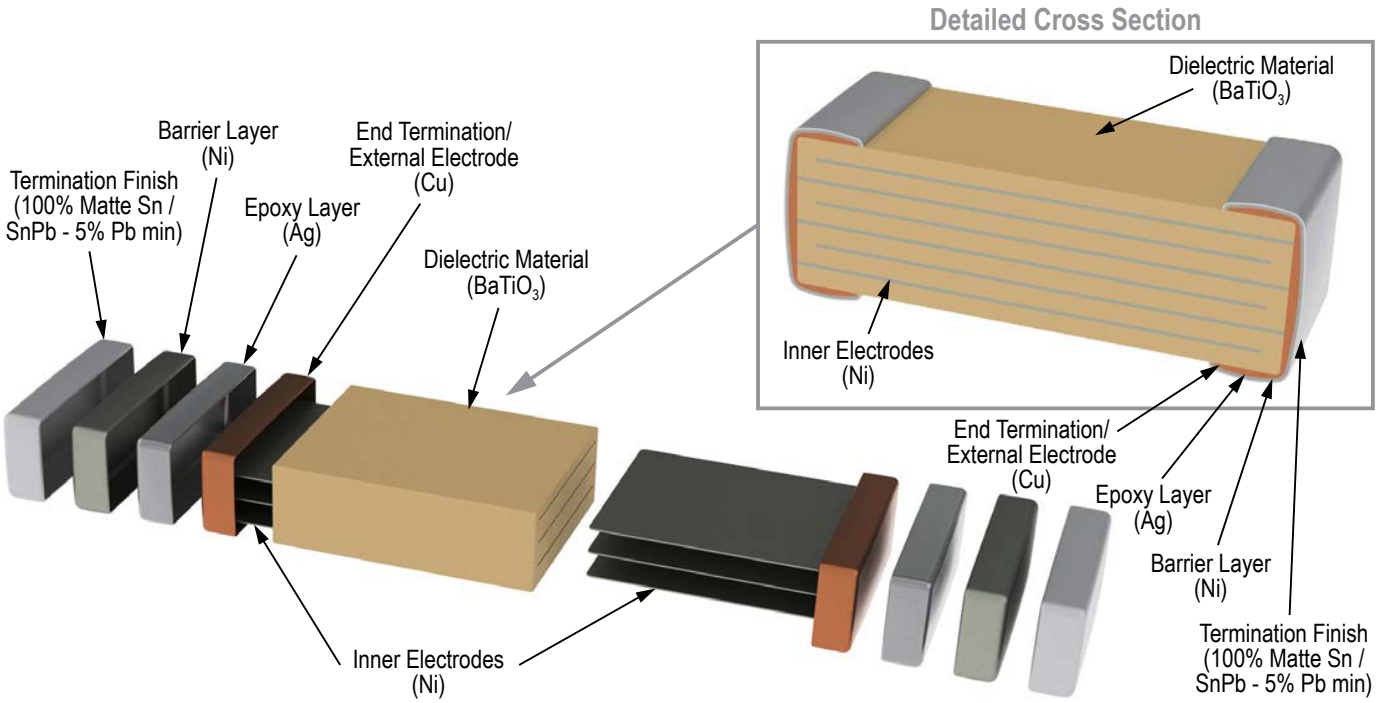
Table 4 – Performance & Reliability: Test Methods and Conditions

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 +/- 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



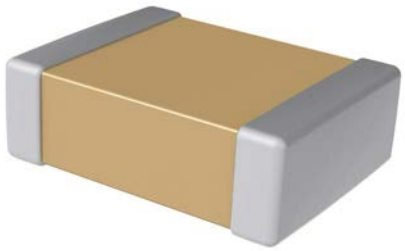
Floating Electrode Design with Flexible Termination System (FF-CAP), X7R Dielectric, 6.3 – 250 VDC (Commercial & Automotive Grade)

Overview

KEMET's Floating Electrode with Flexible Termination capacitor (FF-CAP) combines two existing KEMET technologies– Floating Electrode and Flexible Termination. The floating electrode component utilizes a cascading internal electrode design configured to form multiple capacitors in series within a single monolithic structure. This unique configuration results in enhanced voltage and ESD performance over standard capacitor designs while allowing for a fail-open condition if mechanically damaged (cracked). The flexible termination component utilizes a conductive silver epoxy between the base metal and nickel barrier layers of KEMET's standard termination system in order to establish pliability while maintaining terminal strength, solderability and electrical performance. Both technologies address the primary failure mode of 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 + 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" below

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

[1] *SnPb termination finish option is not available on automotive grade product.*

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Packaging C-Spec Ordering Options Table

Packaging Type	Packaging/Grade Ordering Code (C-Spec)
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 and smaller case sizes) 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 & 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's 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:

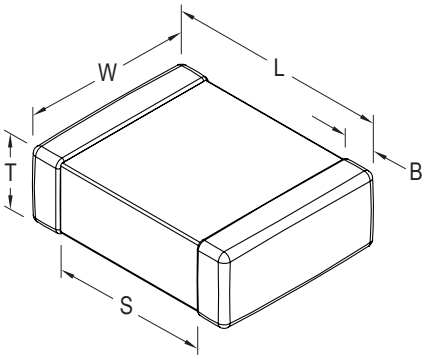
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design record and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that 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 (.063) ± 0.17 (.007)	0.80 (.032) ± 0.15 (.006)	See Table 2 for Thickness	0.45 (.018) ± 0.15 (.006)	0.58 (.023)	Solder Wave or Solder Reflow
0805	2012	2.00 (.079) ± 0.30 (.012)	1.25 (.049) ± 0.30 (.012)		0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	
1206	3216	3.30 (.130) ± 0.40 (.016)	1.60 (.063) ± 0.35 (.013)		0.60 (.024) ± 0.25 (.010)	N/A	
1210	3225	3.30 (.130) ± 0.40 (.016)	2.60 (.102) ± 0.30 (.012)		0.60 (.024) ± 0.25 (.010)		Solder Reflow Only
1812	4532	4.50 (.178) ± 0.40 (.016)	3.20 (.126) ± 0.30 (.012)		0.70 (.028) ± 0.35 (.014)		

Qualification/Certification

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

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 @ 25°C	5%(6.3V & 10V), 3.5%(16V & 25V) and 2.5%(50V to 250V)
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (Rated voltage applied for 120 ± 5 secs @ 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	4,000	10,000	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		

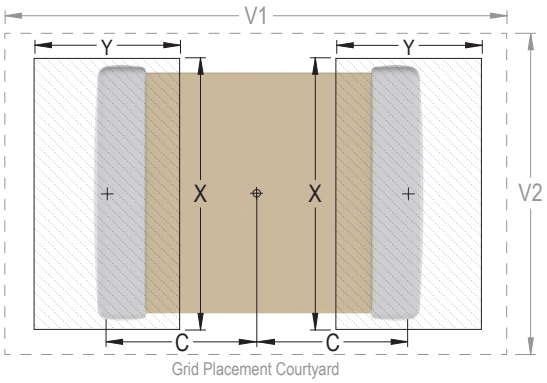
[1] The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial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



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.

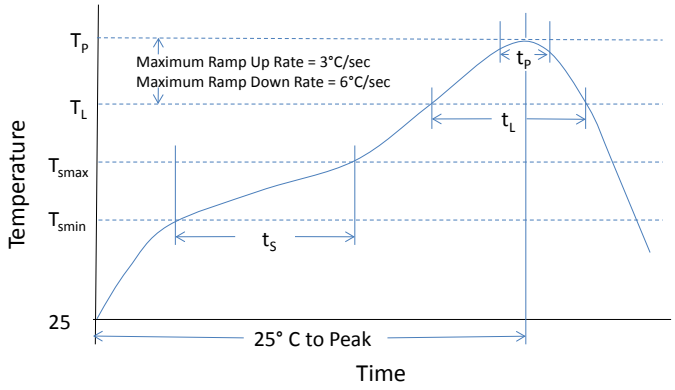


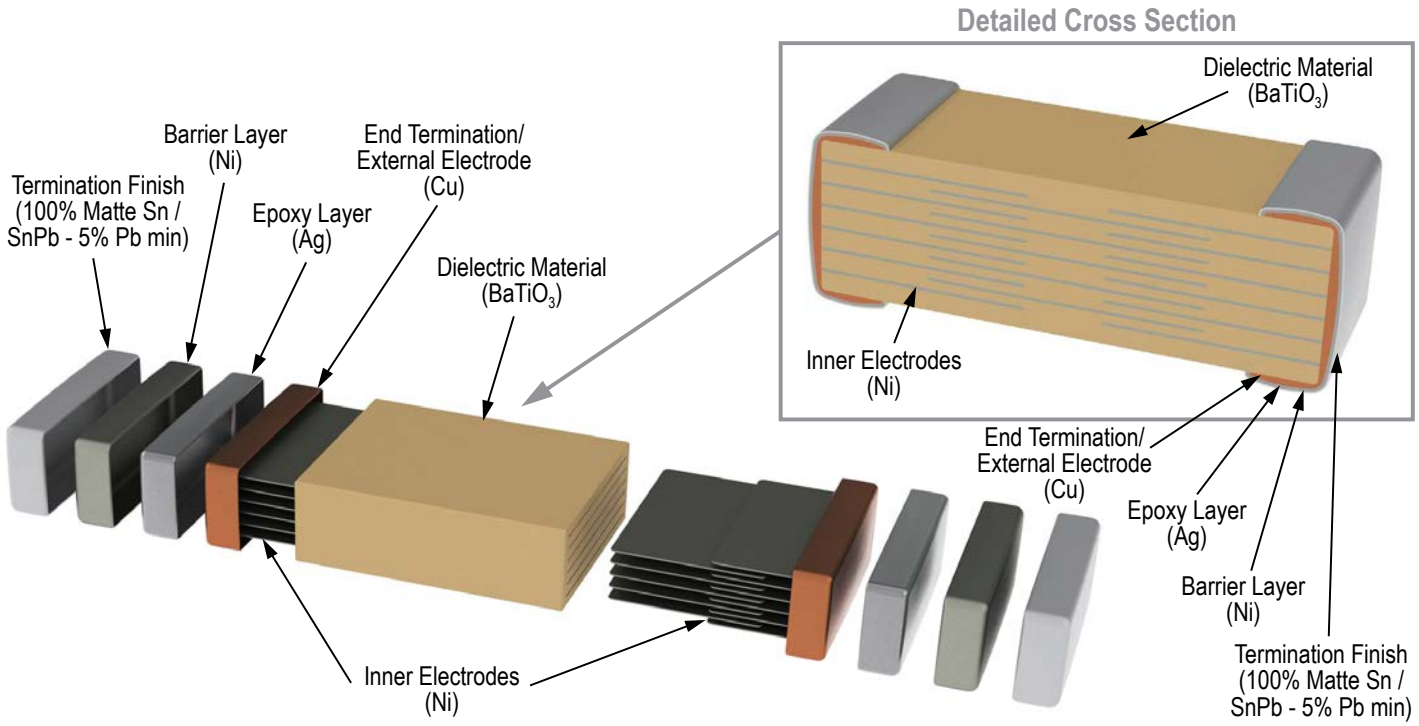
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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 +/- 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



Flexible Termination System (FT-CAP), Ultra-Stable X8R Dielectric, 25 – 100 VDC (Commercial & Automotive Grade)

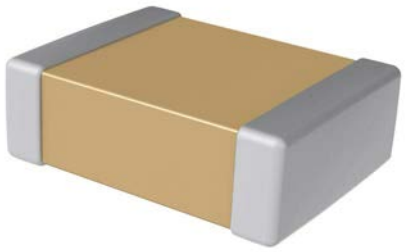
Overview

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 + number of zeros.	F = ±1% G = ±2% J = ±5% K = ±10% M = ±20%	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" below

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

[1] SnPb termination finish option is not available on Automotive Grade product.

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Packaging C-Spec Ordering Options Table

Packaging Type	Packaging/Grade Ordering Code (C-Spec)
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 25 V, 50 V, and 100 V
- Capacitance offerings ranging from 430 pF to 0.22 µF
- Available capacitance tolerances of ±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 & 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's 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:

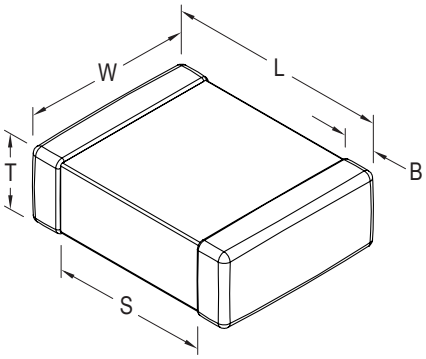
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design record and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

Qualification/Certification

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

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%
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 @ 25°C	2.5%
[3]Insulation Resistance (IR) Minimum Limit @ 25°C	1,000 megohm microfarads or 100 GΩ (Rated voltage applied for 120 ±5 seconds @ 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
Ultra-Stable X8R	All	All	3.0	0.3% or ±0.25 pF	10% of Initial Limit

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

Capacitance	Capacitance Code	Case Size/Series					C0603X			C0805X			C1206X			C1210X			C1812X	
		Voltage Code					3	5	1	3	5	1	3	5	1	3	5	1	5	1
		Rated Voltage (VDC)					25	50	100	25	50	100	25	50	100	25	50	100	50	100
		Capacitance Tolerance					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions													
430 pF	431	F	G	J	K	M	CJ	CJ	CJ											
470 pF	471	F	G	J	K	M	CJ	CJ	CJ											
510 pF	511	F	G	J	K	M	CJ	CJ	CJ											
560 pF	561	F	G	J	K	M	CJ	CJ	CJ											
620 pF	621	F	G	J	K	M	CJ	CJ	CJ											
680 pF	681	F	G	J	K	M	CJ	CJ	CJ											
750 pF	751	F	G	J	K	M	CJ	CJ	CJ											
820 pF	821	F	G	J	K	M	CJ	CJ	CJ											
910 pF	911	F	G	J	K	M	CJ	CJ	CJ											
1,000 pF	102	F	G	J	K	M	CJ	CJ	CJ											
1,100 pF	112	F	G	J	K	M	CJ	CJ	CJ											
1,200 pF	122	F	G	J	K	M	CJ	CJ	CJ											
1,300 pF	132	F	G	J	K	M	CJ	CJ	CJ											
1,500 pF	152	F	G	J	K	M	CJ	CJ	CJ											
1,600 pF	162	F	G	J	K	M	CJ	CJ	CJ											
1,800 pF	182	F	G	J	K	M	CJ	CJ	CJ											
2,000 pF	202	F	G	J	K	M	CJ	CJ	CJ	DR	DR	DR								
2,200 pF	222	F	G	J	K	M	CJ	CJ	CJ	DR	DR	DR								
2,400 pF	242	F	G	J	K	M	CJ	CJ	CJ	DR	DR	DR								
2,700 pF	272	F	G	J	K	M	CJ	CJ	CJ	DR	DR	DR								
3,000 pF	302	F	G	J	K	M	CJ	CJ	CJ	DR	DR	DR								
3,300 pF	332	F	G	J	K	M	CJ	CJ	CJ	DR	DR	DR								
3,600 pF	362	F	G	J	K	M	CJ	CJ	CJ	DR	DR	DR								
3,900 pF	392	F	G	J	K	M	CJ	CJ	CJ	DR	DR	DR								
4,300 pF	432	F	G	J	K	M	CJ	CJ	CJ	DR	DR	DR								
4,700 pF	472	F	G	J	K	M	CJ	CJ	CJ	DR	DR	DR								
5,100 pF	512	F	G	J	K	M	CJ	CJ		DR	DR	DR								
5,600 pF	562	F	G	J	K	M	CJ	CJ		DR	DR	DR								
6,200 pF	622	F	G	J	K	M	CJ	CJ		DR	DR	DR								
6,800 pF	682	F	G	J	K	M	CJ	CJ		DR	DR	DR	EQ	EQ	EQ					
7,500 pF	752	F	G	J	K	M	CJ			DR	DR	DR	EQ	EQ	EQ					
8,200 pF	822	F	G	J	K	M	CJ			DR	DR	DR	EQ	EQ	EQ					
9,100 pF	912	F	G	J	K	M	CJ			DR	DR	DR	EQ	EQ	EQ					
10,000 pF	103	F	G	J	K	M	CJ			DR	DR	DD	EQ	EQ	EQ					
12,000 pF	123	F	G	J	K	M				DR	DR	DS	EQ	EQ	EQ	FN	FN	FN		
15,000 pF	153	F	G	J	K	M				DR	DD	DG	EQ	EQ	EQ	FN	FN	FN	GB	GB
18,000 pF	183	F	G	J	K	M				DR	DD		EQ	EQ	EQ	FN	FN	FN	GB	GB
22,000 pF	223	F	G	J	K	M				DD	DF		EQ	EQ	ER	FN	FN	FN	GB	GB
27,000 pF	273	F	G	J	K	M				DF			EQ	EQ	ET	FN	FN	FN	GB	GB
33,000 pF	333	F	G	J	K	M				DG			EQ	EQ	ET	FN	FN	FN	GB	GB
47,000 pF	473	F	G	J	K	M							ER	ET	EH	FN	FN	FE	GB	GB
56,000 pF	563	F	G	J	K	M							ES	EF	EH	FN	FN	FA	GB	GB
68,000 pF	683	F	G	J	K	M							EF	EH		FN	FQ	FZ	GB	GB
82,000 pF	823	F	G	J	K	M							EH	EH		FQ	FA	FU	GB	GB
100,000 pF	104	F	G	J	K	M							EH			FE	FZ	FM	GB	GD
120,000 pF	124	F	G	J	K	M										FZ	FU		GB	GH
150,000 pF	154	F	G	J	K	M										FU	FM		GD	GN
180,000 pF	184	F	G	J	K	M										FJ			GH	
220,000 pF	224	F	G	J	K	M													GK	
Capacitance	Capacitance Code	Rated Voltage (VDC)					25	50	100	25	50	100	25	50	100	25	50	100	50	100
		Voltage Code					3	5	1	3	5	1	3	5	1	3	5	1	5	1
		Case Size/Series					C0603X			C0805X			C1206X			C1210X			C1812X	

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	4,000	10,000	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
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		

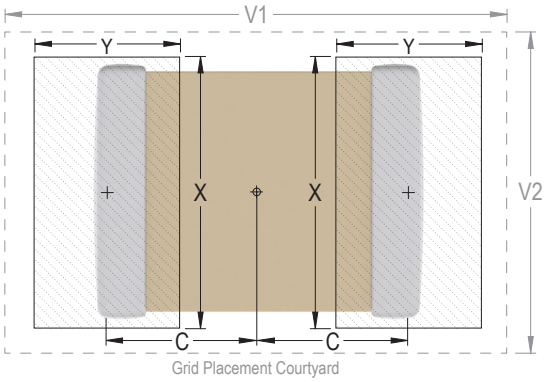
[1] The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial 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 out 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 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.

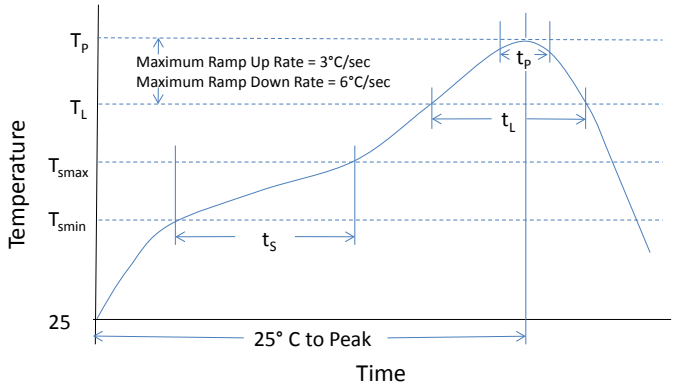


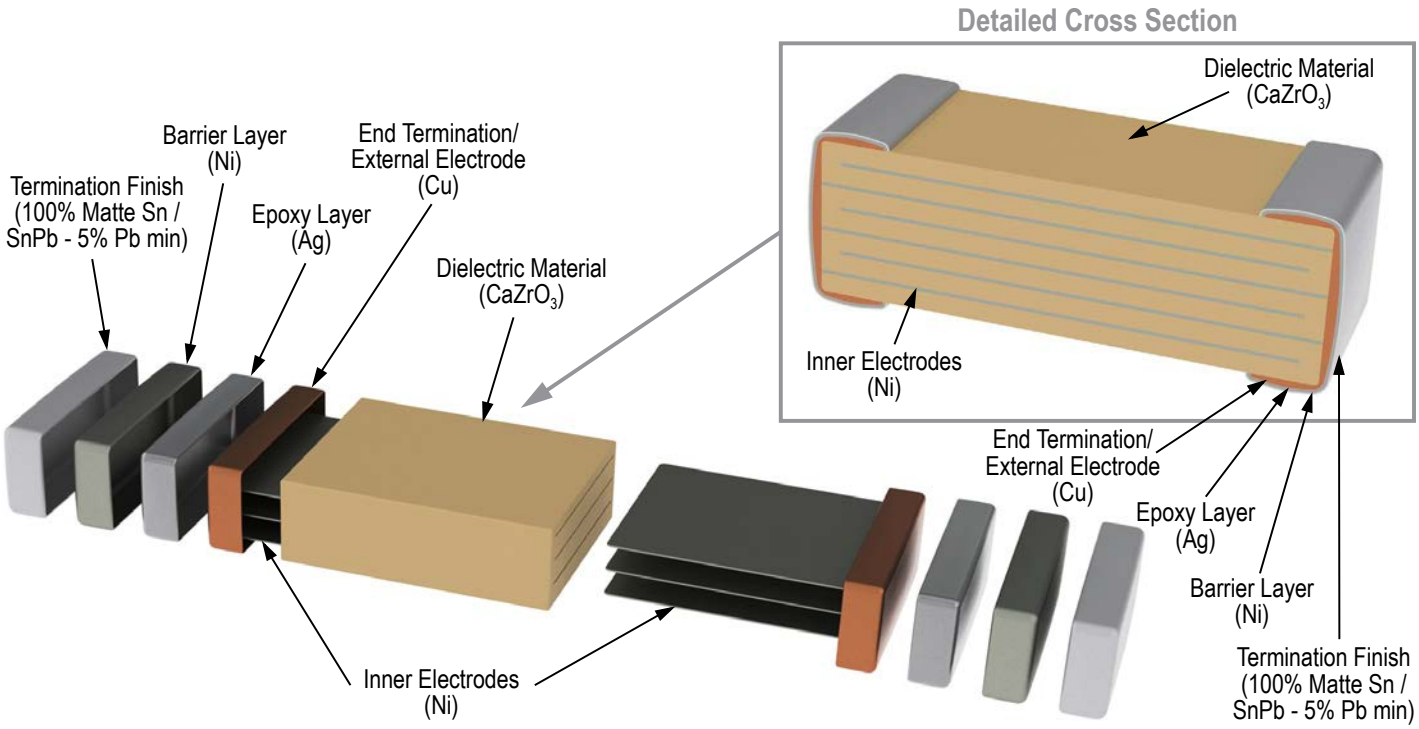
Table 4 – Performance & Reliability: Test Methods and Conditions

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 +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



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.

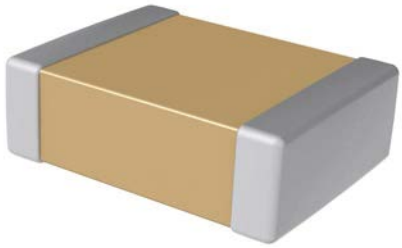
High Temperature 150°C, X8L Dielectric, 10 – 50 VDC (Commercial & Automotive Grade)

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 + number of zeros	J = ±5% K = ±10% M = ±20%	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" below

[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.*

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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 and smaller case sizes) 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 & 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's 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:

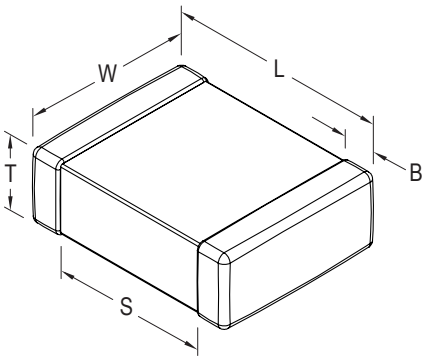
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design record and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

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)	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 (0.020) ±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

Qualification/Certification

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

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 @ 25°C	3.5% (≤ 16V) and 2.5% (≥ 25V)
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	500 megohm microfarads or 10 GΩ (Rated voltage applied for 120 ±5 seconds @ 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		

Insulation Resistance Limit Table (X8L Dielectric)

EIA Case Size	1,000 Megohm Microfarads or 100 GΩ	500 Megohm Microfarads or 10 GΩ
0201	N/A	ALL
0402	< .012 µF	≥ .012 µF
0603	< .047 µF	≥ .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 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																						
33,000 pF	333	J	K	M	BB	BB																						
39,000 pF	393	J	K	M	BB	BB																						
47,000 pF	473	J	K	M	BB	BB			CF	CF	CF	CF	CF															
56,000 pF	563	J	K	M																								
68,000 pF	683	J	K	M																								
82,000 pF	823	J	K	M																								
0.10 µF	104	J	K	M					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				DG	DG	DG	DG	DG										
0.22 µF	224	J	K	M					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 out 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.

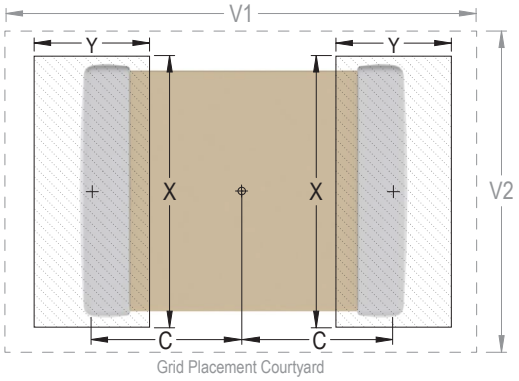
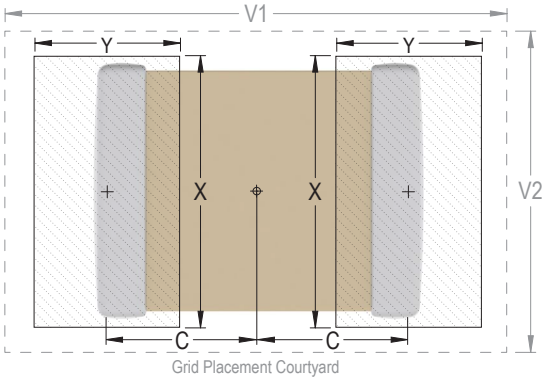


Table 3B – Land Pattern Design Recommendations per IPC–7351 – Flexible Termination

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.

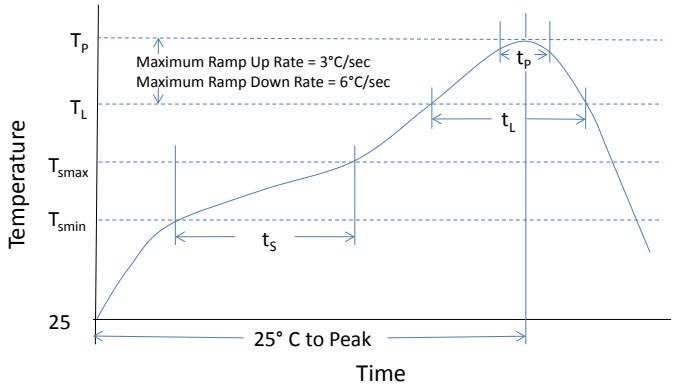


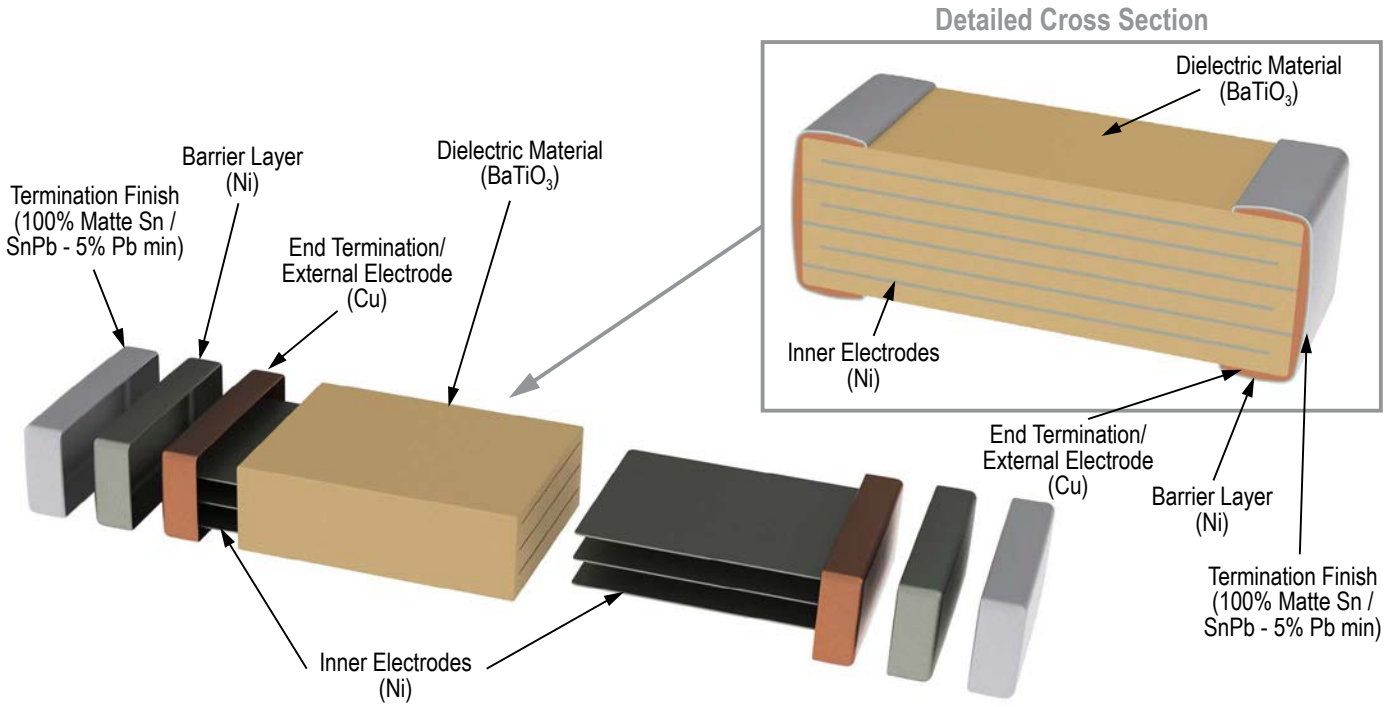
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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 +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.

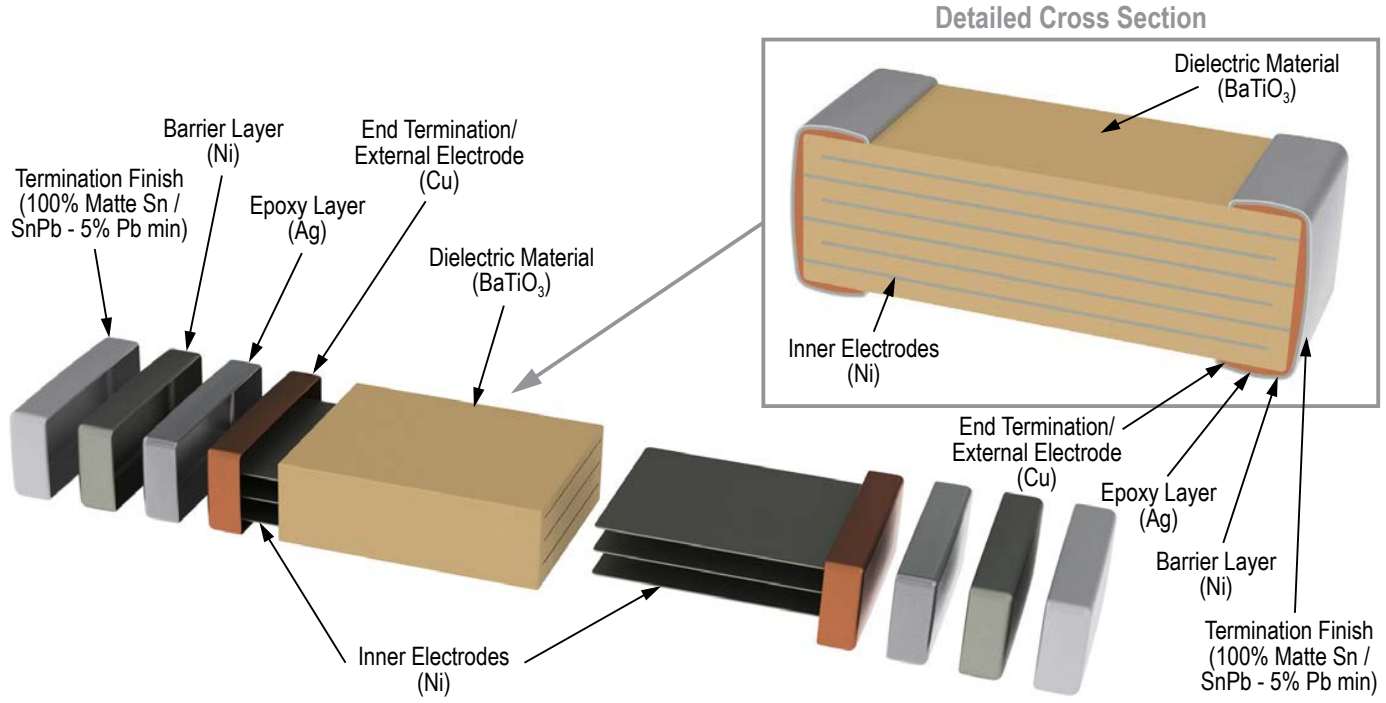
Storage and Handling

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



High Voltage with Flexible Termination System (HV FT-CAP), C0G Dielectric, 500 – 3,000 VDC (Commercial Grade)

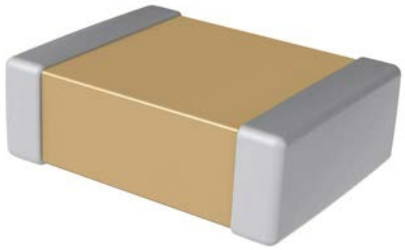
Overview

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, 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.

KEMET's high voltage surface mount MLCCs in C0G dielectric feature a 125°C maximum operating temperature and offer the most stable voltage and temperature performance of all ceramic dielectric materials. 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/ºC 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 high voltage MLCC's 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.

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	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)
	0805 1206 1210 1808 1812 1825 2220 2225	X= Flexible Termination	Two significant digits + 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" 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.

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Packaging C-Spec Ordering Options Table

Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)
Bulk Bag/Unmarked	Not required (Blank)
7" Reel/Unmarked	TU
13" Reel/Unmarked	7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes)
7" Reel/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".

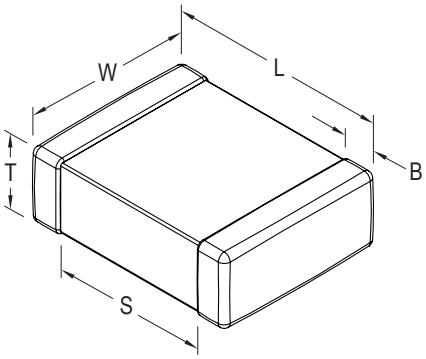
Benefits

- −55°C to +125°C operating temperature range
- Superior flex performance (up to 5 mm)
- 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 1 pF to 39 nF
- 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 & ESL
- High thermal stability
- High ripple current capability
- Preferred capacitance solution at line frequencies & 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
- 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, snubbed 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.

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 (.079) ± 0.30 (.012)	1.25 (.049) ± 0.30 (.012)	See Table 2 for Thickness	0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	Solder Wave or Solder Reflow
1206	3216	3.30 (.130) ± 0.40 (.016)	1.60 (.063) ± 0.35 (.013)		0.60 (.024) ± 0.25 (.010)	N/A	
1210	3225	3.30 (.130) ± 0.40 (.016)	2.60 (.102) ± 0.30 (.012)		0.60 (.024) ± 0.25 (.010)		Solder Reflow Only
1808	4520	4.70 (.185) ± 0.50 (.020)	2.00 (.079) ± 0.20 (.008)		0.70 (.028) ± 0.35 (.014)		
1812	4532	4.50 (.178) ± 0.40 (.016)	3.20 (.126) ± 0.30 (.012)		0.70 (.028) ± 0.35 (.014)		
1825	4564	4.60 (.181) ± 0.40 (.016)	6.40 (.252) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		
2220	5650	5.90 (.232) ± 0.75 (.030)	5.00 (.197) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		
2225	5664	5.90 (.232) ± 0.75 (.030)	6.40 (.248) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		

Qualification/Certification

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

Environmental Compliance

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

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)	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)
[2]Dissipation Factor (DF) Maximum Limit at 25ºC	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 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

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

Capacitance	Cap Code	Case Size/Series	C0805X			C1206X					C1210X					C1808X						
		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	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	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	EF	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	FM	FM	LA	LA	LA	LB	LC	LC	
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	DG	DG		ES	ES	EF	EU		FZ	FZ	FZ	FK	FK	LA	LA	LA	LB	LC	LC	
330 pF	331	F G J K M	DG	DG		ES	ES	EF	EU		FZ	FZ	FZ	FK	FK	LA	LA	LA	LB	LC	LC	
360 pF	361	F G J K M	DG	DG		ES	ES	EF	EU		FZ	FZ	FZ	FK	FS	LA	LA	LA	LB	LA	LC	
390 pF	391	F G J K M	DG	DG		ES	ES	EF	EU		FZ	FZ	FZ	FK	FS	LA	LA	LA	LB	LA	LC	
430 pF	431	F G J K M	DG	DG		ES	ES	EF	EU		FZ	FM	FM	FS	FS	LA	LB	LB	LC	LA		
470 pF	471	F G J K M	DG	DG		ES	ES	EU	EU		FZ	FM	FM	FS	FS	LA	LB	LB	LC	LA		
510 pF	511	F G J K M	DG	DG		ES	ES	EU	EU		FZ	FM	FM	FS	FS	LA	LB	LB	LC	LB		
560 pF	561	F G J K M	DG	DG		ES	ES	EU	EU		FZ	FM	FM	FS	FS	LA	LB	LB	LC	LB		
620 pF	621	F G J K M	DG			ES	ES	EU			FZ	FM	FM	FS	FS	LA	LB	LB	LA	LC		
680 pF	681	F G J K M	DG			ES	ES	EU			FZ	FM	FM	FS	FS	LB	LB	LB	LA	LC		
750 pF	751	F G J K M	DG			ES	EF	EU			FZ	FM	FM	FM		LB	LB	LB	LA			
820 pF	821	F G J K M	DG			ES	EF	EU			FZ	FM	FM	FM		LB	LB	LB	LA			
910 pF	911	F G J K M				ES	EF	EU			FM	FM	FM	FY		LB	LB	LB	LA			
1,000 pF	102	F G J K M				ES	EF	EU			FM	FM	FM	FY		LB	LB	LB	LB			
Capacitance	Cap Code	Rated Voltage (VDC)	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	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		Case Size/Series	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 (0805 – 1808 Case Sizes) cont'd

Capacitance	Cap Code	Case Size/Series	C0805X			C1206X					C1210X					C1808X						
		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	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				EF	EU				FM	FK	FK	FS		LC	LC	LC	LB			
1,200 pF	122	F G J K M				EF	EU				FM	FK	FK	FS		LC	LC	LC	LC			
1,300 pF	132	F G J K M				EF	EU				FM	FS	FS			LC	LC	LC	LC			
1,500 pF	152	F G J K M				EF	EU				FK	FS	FS			LC	LC	LC	LC			
1,600 pF	162	F G J K M				EF	EU				FK	FS	FS			LC	LC	LC				
1,800 pF	182	F G J K M				EF	EU				FK	FS	FS			LC	LC	LC				
2,000 pF	202	F G J K M				EU	EQ				FK	FL	FS			LC	LA	LB				
2,200 pF	222	F G J K M				EU	EQ				FK	FL	FS			LC	LA	LB				
2,400 pF	242	F G J K M				EU	EQ				FS	FL	FS			LC	LA	LB				
2,700 pF	272	F G J K M				EU	EQ				FS	FL	FS			LC	LA	LC				
3,000 pF	302	F G J K M				EQ	EQ				FS	FL				LA	LA					
3,300 pF	332	F G J K M				EQ	EQ				FS	FM				LA	LA					
3,600 pF	362	F G J K M				ER	ER				FL	FM				LA	LB					
3,900 pF	392	F G J K M				ER	ER				FL	FY				LA	LB					
4,300 pF	432	F G J K M				ES	ES				FM	FY				LA	LC					
4,700 pF	472	F G J K M				ES	ES				FM	FY				LA	LC					
5,100 pF	512	F G J K M									FY	FS				LA						
5,200 pF	562	F G J K M									FY	FS				LB						
6,200pF	622	F G J K M									FY	FE				LC						
6,800pF	682	F G J K M									FY	FE				LC						
7,500pF	752	F G J K M									FS											
8,200pF	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	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	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).
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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	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
11 pF	110	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
12 pF	120	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
13 pF	130	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
15 pF	150	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
16 pF	160	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
18 pF	180	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
20 pF	200	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
22 pF	220	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
24 pF	240	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
27 pF	270	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
30 pF	300	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
33 pF	330	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
36 pF	360	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
39 pF	390	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
43 pF	430	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
47 pF	470	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
51 pF	510	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
56 pF	560	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
62 pF	620	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
68 pF	680	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
75 pF	750	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
82 pF	820	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
91 pF	910	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
100 pF	101	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
110 pF	111	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
120 pF	121	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
130 pF	131	F G J K M	GK	GK	GK	GK	GK	GK	GK								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								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								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								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
200 pF	201	F G J K M	GH	GH	GH	GH	GH	GK	GM								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
220 pF	221	F G J K M	GH	GH	GH	GH	GH	GK	GM								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
240 pF	241	F G J K M	GH	GH	GH	GH	GH	GK	GM								JK	JK	JK	JK	JK	JK	JK	KE	KE	KE	KE	KE	KE	KF
270 pF	271	F G J K M	GH	GH	GH	GH	GH	GK	GM								JK	JK	JK	JK	JK	JK	JK	KE	KE	KE	KE	KE	KE	KF
300 pF	301	F G J K M	GH	GH	GH	GH	GH	GK	GM								JK	JK	JK	JK	JK	JK	JK	KE	KE	KE	KE	KE	KE	KF
330 pF	331	F G J K M	GH	GH	GH	GH	GH	GK	GO								JE	JE	JE	JE	JE	JK	JK	KE	KE	KE	KE	KE	KE	KF
360 pF	361	F G J K M	GK	GK	GK	GK	GH	GK	GO								JE	JE	JE	JE	JE	JK	JK	KE	KE	KE	KE	KE	KE	KF
390 pF	391	F G J K M	GK	GK	GK	GK	GK	GK	GO								JE	JE	JE	JE	JE	JK	JK	KE	KE	KE	KE	KE	KE	KF
430 pF	431	F G J K M	GK	GK	GK	GK	GK	GK								HJ	JE	JE	JE	JE	JE	JK	JE	KE	KE	KE	KE	KE	KE	KF
470 pF	471	F G J K M	GK	GK	GK	GK	GK	GK								HJ	JE	JE	JE	JE	JE	JK	JK	KF	KF	KF	KF	KE	KE	KF
510 pF	511	F G J K M	GH	GH	GH	GK	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	GH	GH	GH	GK	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	GH	GH	GH	GH	GK	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	GH	GH	GH	GK	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	GH	GH	GH	GK	GK										JE	JE	JE	JK	JK	JK	JL	KE	KE	KE	KF	KE	KF	KH
820 pF	821	F G J K M	GH	GH	GH	GK	GK										JE	JE	JE	JK	JK	JK	JN	KE	KE	KE	KF	KE	KF	KJ
910 pF	911	F G J K M	GH	GH	GH	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	GH	GH	GH	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	GH	GK	GK	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
		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)*
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Table 1B – Capacitance Range/Selection Waterfall (1812 – 2225 Case Sizes) cont'd

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	GH	GK	GK	GH	GO								HJ		JE	JK	JK	JK	JK	JL		KE	KE	KE	KF	KF	KF	
1,300 pF	132	F G J K M	GH	GK	GK	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	GK	GK	GK	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	GK	GK	GK	GK								HG	HK		JE	JK	JK	JK	JE	JL		KE	KE	KE	KF	KE	KH	
1,800 pF	182	F G J K M	GK	GK	GK	GM								HG			JE	JK	JK	JK	JE	JN		KE	KE	KE	KF	KE	KH	
2,000 pF	202	F G J K M	GK	GK	GK	GM							HE	HJ			JE	JK	JK	JE	JK			KE	KE	KE	KF	KE	KJ	
2,200 pF	222	F G J K M	GK	GK	GK	GO							HE	HJ			JE	JK	JK	JE	JK			KE	KE	KE	KF	KF	KJ	
2,400 pF	242	F G J K M	GK	GH	GK	GO							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	HK			JK	JK	JK	JE	JL			KE	KE	KE	KE	KH		
3,000 pF	302	F G J K M	GK	GH	GK								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				JK	JK	JK	JK	JN			KE	KE	KE	KE	KJ		
3,600 pF	362	F G J K M	GK	GH	GM								HG				JK	JK	JK	JK	JN			KE	KF	KF	KF	KJ		
3,900 pF	392	F G J K M	GK	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							HE	HG					JK	JE	JE	JN				KE	KF	KF	KJ			
6,800 pF	682	F G J K M	GH	GM							HE	HJ					JK	JE	JK	JN				KE	KF	KF	KJ			
7,500 pF	752	F G J K M	GH	GM							HE	HJ					JK	JE	JK					KF	KE	KF				
8,200 pF	822	F G J K M	GK	GO							HE	HJ					JK	JE	JL					KF	KE	KF				
9,100 pF	912	F G J K M	GM	GO						HE	HG	HK					JE	JE	JL					KF	KE	KH				
10,000 pF	103	F G J K M	GM	GO						HE	HG	HK					JE	JE	JL					KF	KE	KH				
12,000 pF	123	F G J K M	GO							HE	HG						JE	JK	JN					KE	KE	KH				
15,000 pF	153	F G J K M	GO							HE	HJ						JE	JL						KE	KF	KJ				
18,000 pF	183	F G J K M								HG	HK						JE	JL						KE	KH					
22,000 pF	223	F G J K M								HJ							JK	JN						KF	KJ					
27,000 pF	273	F G J K M								HJ							JL	JN						KF	KJ					
33,000 pF	333	F G J K M								HK							JN							KH						
39,000 pF	393	F G J K M																						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).
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	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
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
EQ	1206	0.78 ± 0.20	4000	10000	4,000	10,000
ER	1206	0.90 ± 0.20	0	0	4,000	10,000
FE	1210	1.00 ± 0.10	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
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
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.*

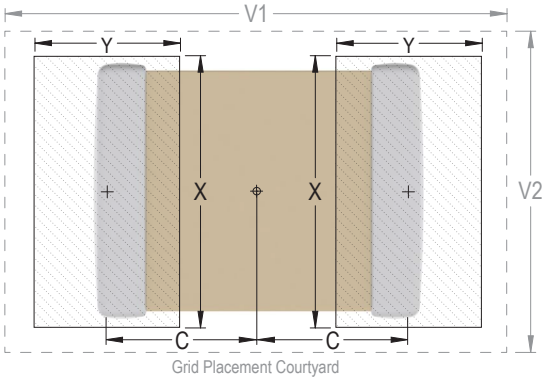
[2] *A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to out standard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

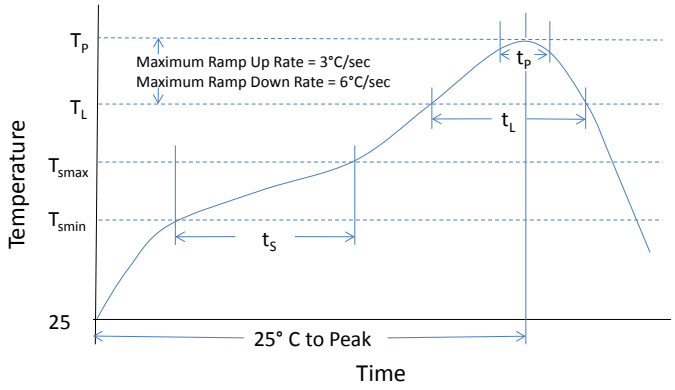


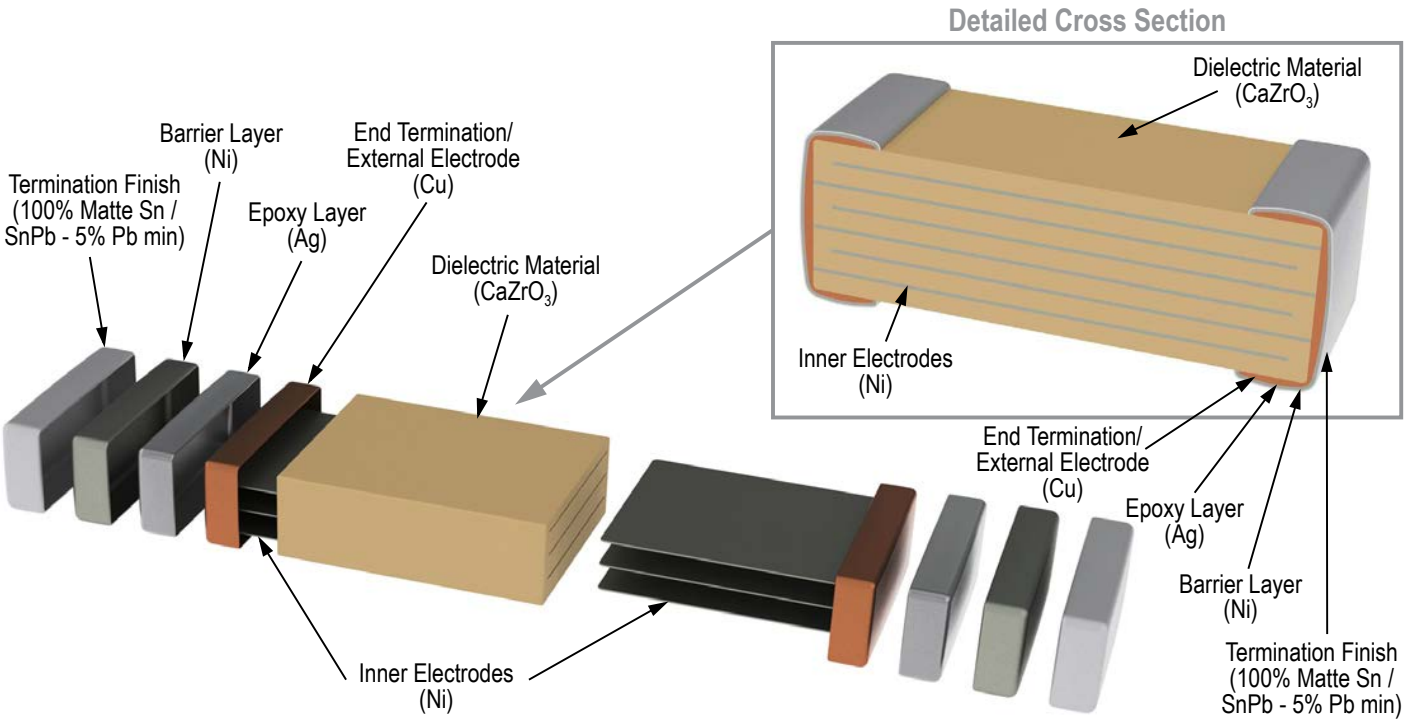
Table 4 – Performance & Reliability: Test Methods and Conditions

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 +/- 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 (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 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.

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

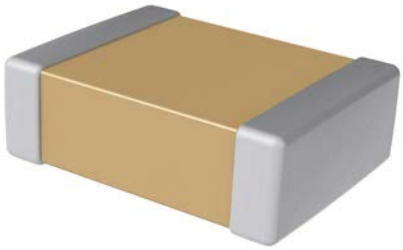
Overview

KEMET's High Voltage with Flexible Termination (HV FT-CAP) surface mount MLCCs in X7R dielectric address the primary failure mode of MLCCs– flex cracks, which are typically the result of excessive tensile and shear stresses produced during board flexure and thermal cycling. Featuring several of the highest CV (capacitance/voltage) values available in the industry, these devices utilize a pliable and conductive silver epoxy between the base metal and nickel barrier layers of the termination system. The addition of this epoxy layer inhibits the transfer of board stress to the rigid ceramic body, therefore mitigating flex cracks which can result in low IR or short circuit failures. Although flexible termination technology does not eliminate the potential for mechanical damage that may propagate during extreme environmental and handling conditions, it does provide superior flex performance over standard termination systems.

The HV FT-CAP offers low leakage current, exhibits low ESR at high frequencies and finds conventional use as snubbers or filters in applications such as switching power supplies and lighting ballasts. Their exceptional performance at high frequencies has made them a preferred 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.

Combined with the stability of an X7R dielectric and designed to accommodate all capacitance requirements, these flex-robust devices are RoHS-compliant, offer up to 5 mm of flex-bend capability and exhibits a predictable change in capacitance with respect to time and voltage. Capacitance change with reference to ambient temperature is limited to ±15% from −55°C to +125°C.

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



Ordering Information

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 + 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" below

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

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Packaging C-Spec Ordering Options Table

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

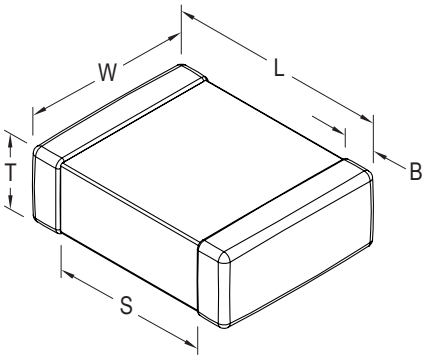
Applications

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
0603	1608	1.60 (.063) ± 0.17 (.007)	0.80 (.032) ± 0.15 (.006)	See Table 2 for Thickness	0.45 (.018) ± 0.15 (.006)	0.58 (.023)	Solder Wave or Solder Reflow
0805	2012	2.00 (.079) ± 0.30 (.012)	1.25 (.049) ± 0.30 (.012)		0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	
1206	3216	3.30 (.130) ± 0.40 (.016)	1.60 (.063) ± 0.35 (.013)		0.60 (.024) ± 0.25 (.010)	N/A	
1210	3225	3.30 (.130) ± 0.40 (.016)	2.60 (.102) ± 0.30 (.012)		0.60 (.024) ± 0.25 (.010)		Solder Reflow Only
1808	4520	4.70 (.185) ± 0.50 (.020)	2.00 (.079) ± 0.20 (.008)		0.70 (.028) ± 0.35 (.014)		
1812	4532	4.50 (.178) ± 0.40 (.016)	3.20 (.126) ± 0.30 (.012)		0.70 (.028) ± 0.35 (.014)		
1825	4564	4.60 (.181) ± 0.40 (.016)	6.40 (.252) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		
2220	5650	5.90 (.232) ± 0.75 (.030)	5.00 (.197) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		
2225	5664	5.90 (.232) ± 0.75 (.030)	6.40 (.248) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.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)	±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 @ 25°C	2.5%
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (500VDC applied for 120 ± 5 secs @ 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 (%)	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
0603	N/A	All
0805	< 0.0039 µF	≥ 0.0039 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	All	N/A

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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GG	GG	GG	GG	GG	GG	GK
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	GK	GK	GK	GK	GK	GK	GK
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	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	LB	LB	LB	LB	LB	LB	LB	GK	GK	GK	GK	GK	GK	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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GH	GH	GH	GH	GH	GK	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	GH	GH	GH	GH	GH	GK	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	GH	GH	GH	GH	GH	GK	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	GH	GH	GH	GH	GH	GK	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		GH	GH	GH	GH	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		GH	GH	GH	GH	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		GH	GH	GH	GH	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		GH	GH	GH	GH	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			GH	GH	GH	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			GH	GH	GH	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			GH	GH	GH	GH	GK	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	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				GH	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'd

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				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	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				
62,000 pF	623	J K M							EJ					FZ	FK	FS			LA	LA	LC					GK	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		

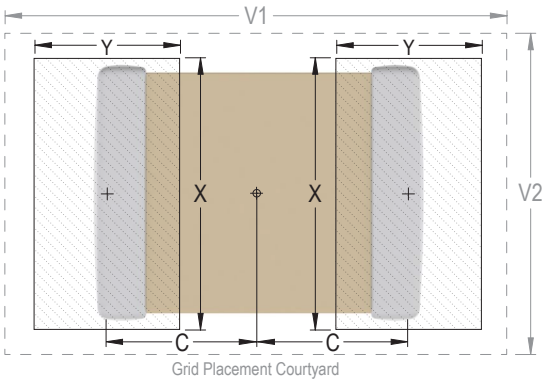
[1] The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial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

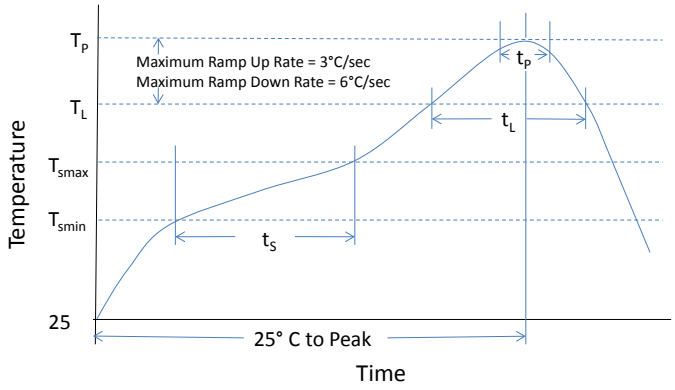


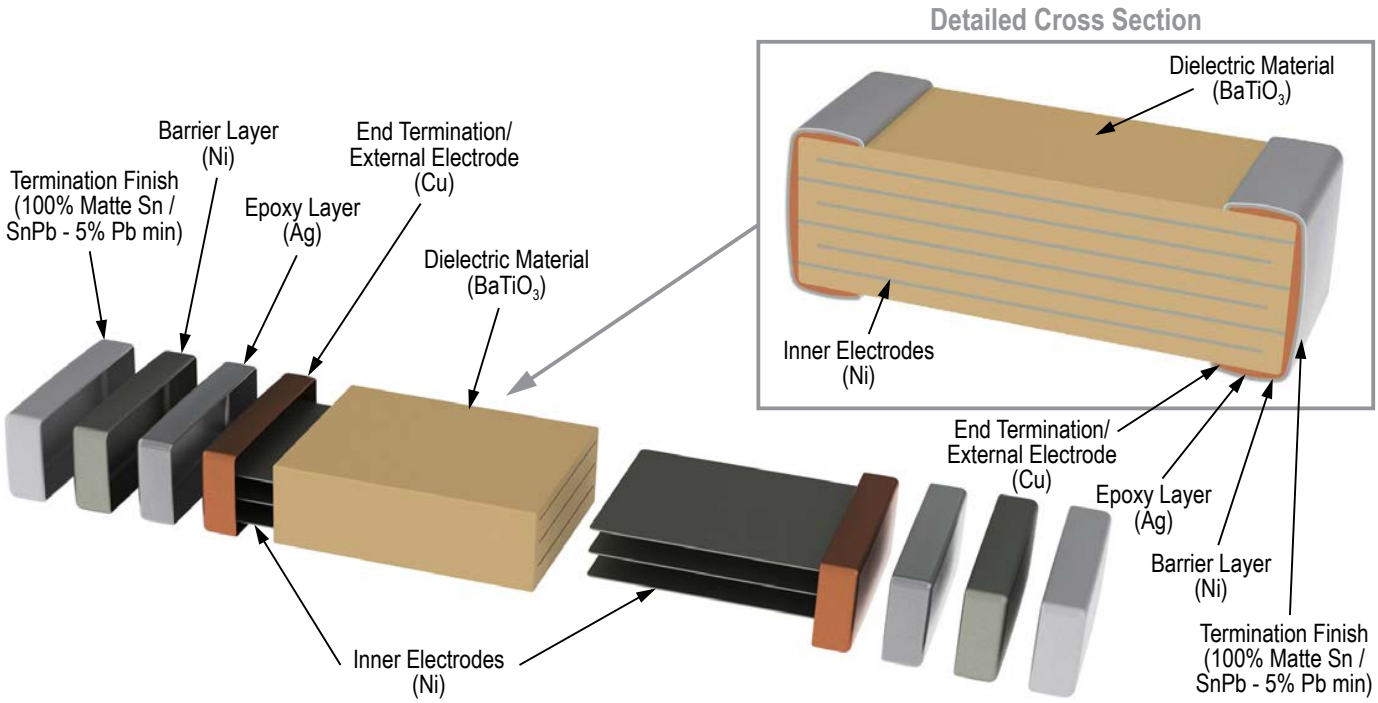
Table 4 – Performance & Reliability: Test Methods and Conditions

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 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 (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 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



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

Overview

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.

KEMET's ArcShield high voltage surface mount MLCCs are available in Automotive Grade, which undergo stricter testing protocol and inspection criteria. Whether under-hood 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 + 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" below

[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.

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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 and smaller case sizes) 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 & ESL
- Non-polar device, minimizing installation concerns
- Commercial & 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's 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 record 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.

Qualification/Certification

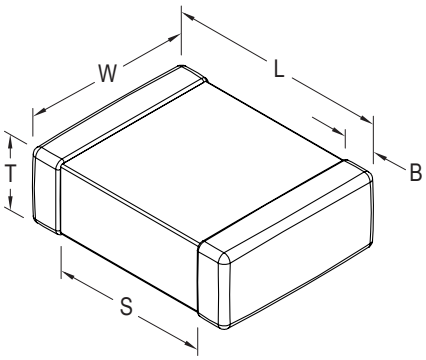
Commercial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance & Reliability.

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.

Environmental Compliance

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

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 (.063) ± 0.15 (.006)	0.80 (.032) ± 0.15 (.006)	See Table 2 for Thickness	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	
1210	3225	3.20 (.126) ± 0.20 (.008)	2.50 (.098) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)		Solder Reflow Only
1808	4520	4.70 (.185) ± 0.50 (.020)	2.00 (.079) ± 0.20 (.008)		0.60 (.024) ± 0.35 (.014)		
1812	4532	4.50 (.177) ± 0.30 (.012)	3.20 (.126) ± 0.30 (.012)		0.60 (.024) ± 0.35 (.014)		
1825	4564	4.50 (.177) ± 0.30 (.012)	6.40 (.252) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2220	5650	5.70 (.224) ± 0.40 (.016)	5.00 (.197) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2225	5664	5.60 (.220) ± 0.40 (.016)	6.40 (.248) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.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 (.064) ± 0.17 (.007)	0.80 (.032) ± 0.15 (.006)	See Table 2 for Thickness	0.45 (.018) ± 0.15 (.006)	0.58 (.023)	Solder Wave or Solder Reflow
0805	2012	2.00 (.079) ± 0.30 (.012)	1.25 (.049) ± 0.30 (.012)		0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	
1206	3216	3.30 (.130) ± 0.40 (.016)	1.60 (.063) ± 0.35 (.013)		0.60 (.024) ± 0.25 (.010)	N/A	
1210	3225	3.30 (.130) ± 0.40 (.016)	2.60 (.102) ± 0.30 (.012)		0.60 (.024) ± 0.25 (.010)		Solder Reflow Only
1808	4520	4.70 (.185) ± 0.50 (.020)	2.00 (.079) ± 0.20 (.008)		0.70 (.028) ± 0.35 (.014)		
1812	4532	4.50 (.178) ± 0.40 (.016)	3.20 (.126) ± 0.30 (.012)		0.70 (.028) ± 0.35 (.014)		
1825	4564	4.60 (.181) ± 0.40 (.016)	6.40 (.252) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		
2220	5650	5.90 (.232) ± 0.75 (.030)	5.00 (.197) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		
2225	5664	5.90 (.232) ± 0.75 (.030)	6.40 (.248) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.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 @ 25°C	2.5%
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	100 megohm microfarads or 10GΩ (500VDC applied for 120 ± 5 secs @ 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	KF	KE
0.22 µF	224	J K M																GJ			HE	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 Patent 8,885,319 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	0603	0.80 ± 0.10	4,000	15,000	0	0
DG	0805	1.25 ± 0.15	0	0	2,500	10,000
EJ	1206	1.70 ± 0.20	0	0	2,000	8,000
FZ	1210	1.25 ± 0.20	0	0	2,500	10,000
FU	1210	1.55 ± 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
GE	1812	1.30 ± 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
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
GS	1812	2.10 ± 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 out 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.

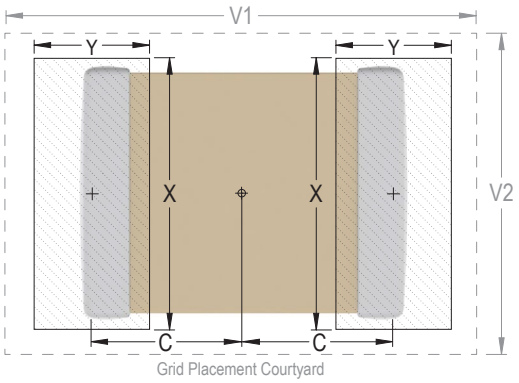
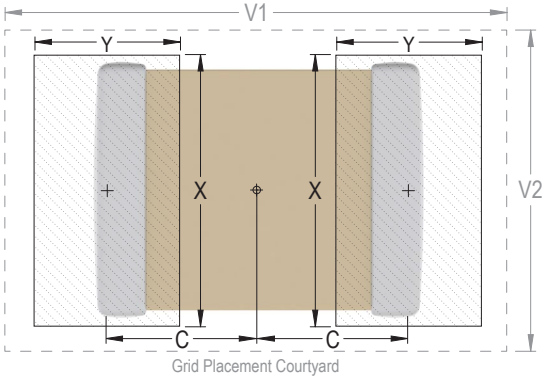


Table 3B – Land Pattern Design Recommendations per IPC–7351 – Flexible Termination

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:

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.

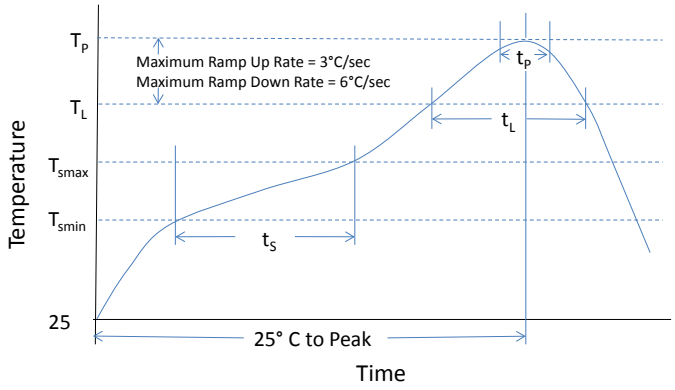


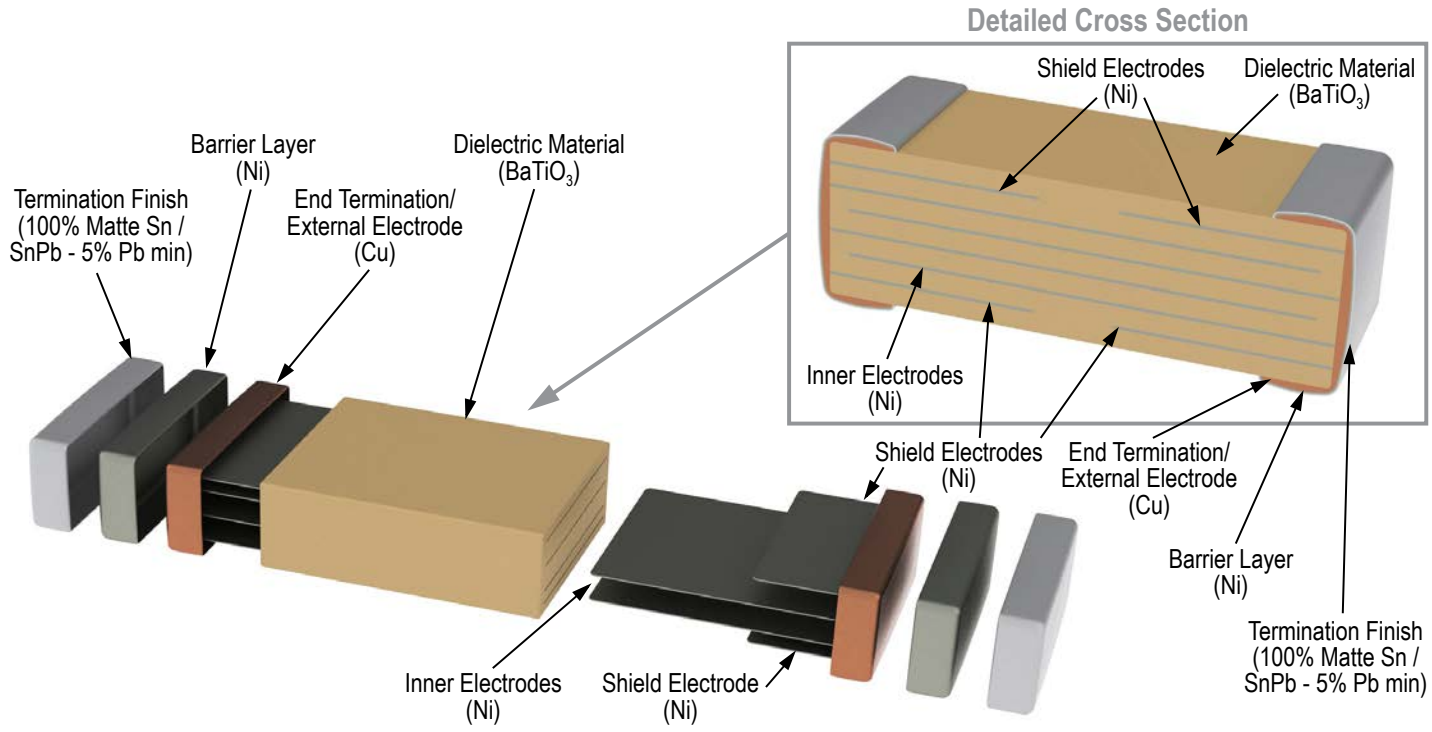
Table 4 – Performance & Reliability: Test Methods and Conditions

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 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 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.

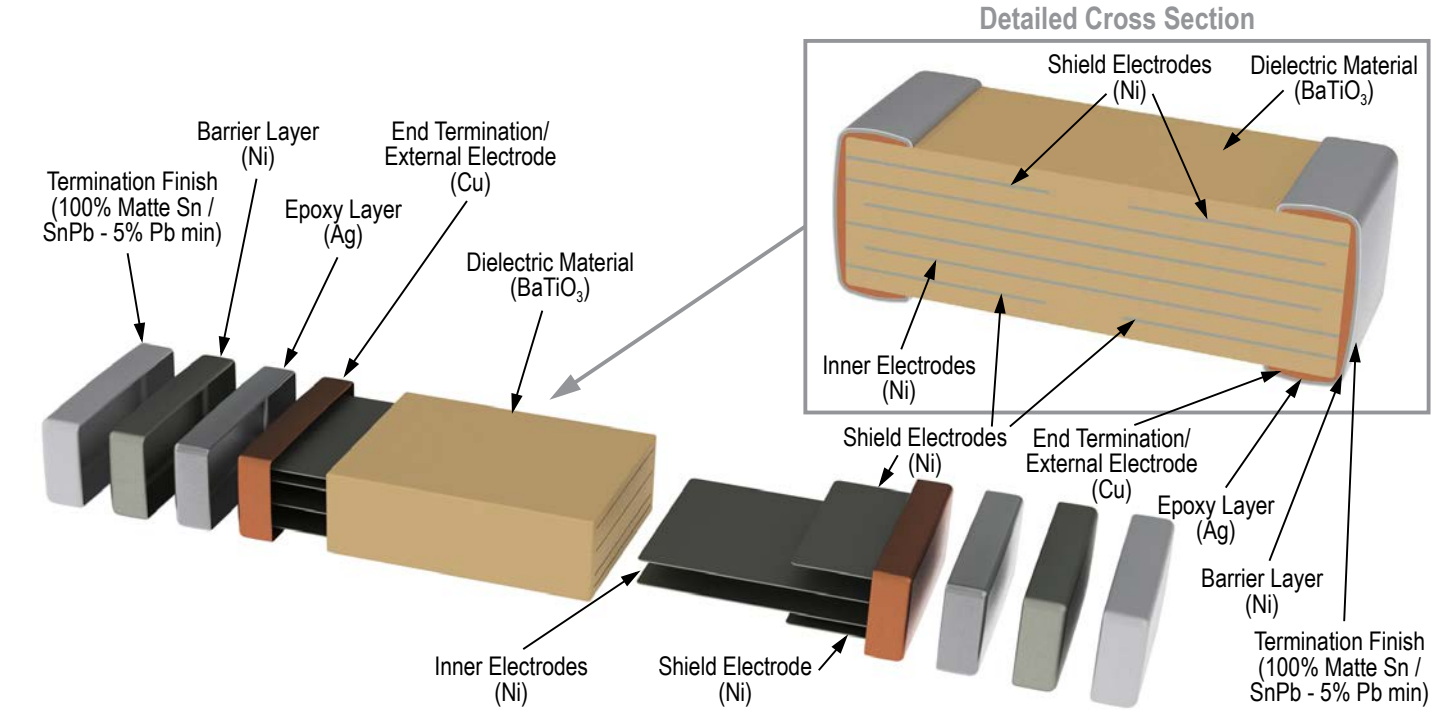
Storage & Handling

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 – Standard Termination



Construction – Flexible Termination



KPS Series, 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
- 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

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 + 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" below

[1] Double chip stacks ("2" in the 13th character position of the ordering code) are only available in M (±20%) capacitance tolerance. Single chip stacks ("1" in the 13th character position of the ordering code) are available in K (±10%) or M (±20%) tolerances.

[2] Additional leadframe finish options may be available. Contact KEMET for details.

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Packaging C-Spec Ordering Options Table

Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)[2]
7" Reel (Embossed Plastic Tape) / Unmarked	7186
13" Reel (Embossed Plastic Tape) / Unmarked	7289

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

Benefits cont'd

- 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

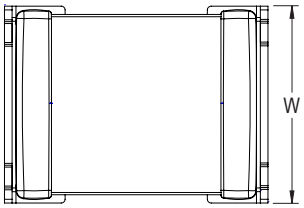
Commercial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance & Reliability.

Environmental Compliance

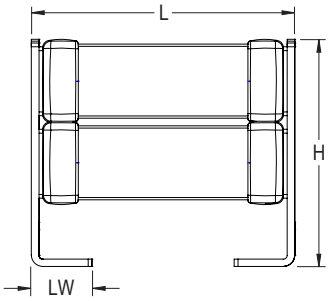
Lead (Pb)-Free, RoHS, and REACH compliant without exemptions.

Dimensions – Millimeters (Inches)

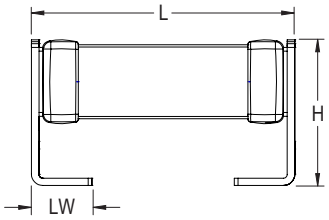
Single or Double Chip Stack



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 (.138) ±0.30 (.012)	2.60 (.102) ±0.30 (.012)	3.35 (.132) ±0.10 (.004)	0.80 (.032) ±0.15 (.006)	Solder Reflow Only
	1812	4532	5.00 (.197) ±0.50 (.020)	3.50 (.138) ±0.50 (.020)	2.65 (.104) ±0.35 (.014)	1.10 (.043) ±0.30 (.012)	
	2220	5650	6.00 (.236) ±0.50 (.020)	5.00 (.197) ±0.50 (.020)	3.50 (.138) ±0.30 (.012)	1.60 (.063) ±0.30 (.012)	
Double	1210	3225	3.50 (.138) ±0.30 (.012)	2.60 (.102) ±0.30 (.012)	6.15 (.242) ±0.15 (.006)	0.80 (.031) ±0.15 (.006)	
	1812	4532	5.00 (.197) ±0.50 (.020)	3.50 (.138) ±0.50 (.020)	5.00 (.197) ±0.50 (.020)	1.10 (.043) ±0.30 (.012)	
	2220	5650	6.00 (.236) ±0.50 (.020)	5.00 (.197) ±0.50 (.020)	5.00 (.197) ±0.50 (.020)	1.60 (.063) ±0.30 (.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 @ 25°C	5%(10V), 3.5%(16V & 25V) and 2.5%(50V to 250V)
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (Rated voltage applied for 120 ± 5 secs @ 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

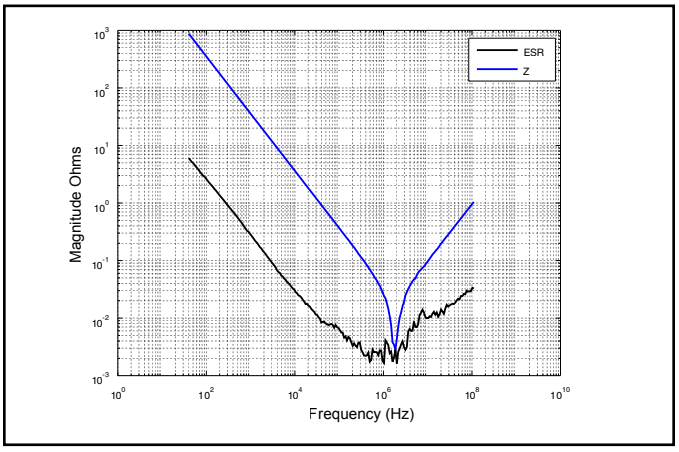
High Temperature Life, Biased Humidity, Moisture Resistance					
Dielectric	Rated DC Voltage	Capacitance Value	Dissipation Factor (Maximum %)	Capacitance Shift	Insulation Resistance
X7R	> 25	All	3.0	±20%	10% of Initial Limit
	16/25		5.0		
	< 16		7.5		

Insulation Resistance Limit Table

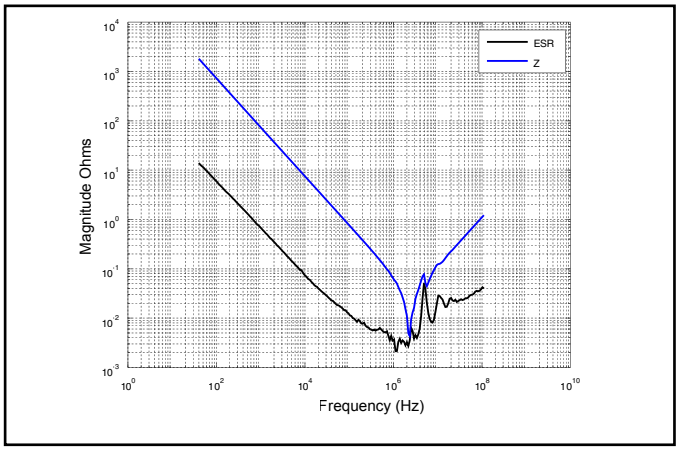
EIA Case Size	1,000 Megohm Microfarads or 100 GΩ	500 Megohm Microfarads or 10 GΩ
1210	< 0.39 µF	≥ 0.39 µF
1812	< 2.2 µF	≥ 2.2 µF
2220	< 10 µF	≥ 10 µF

Electrical Characteristics

Z and ESR C1210C475M5R1C

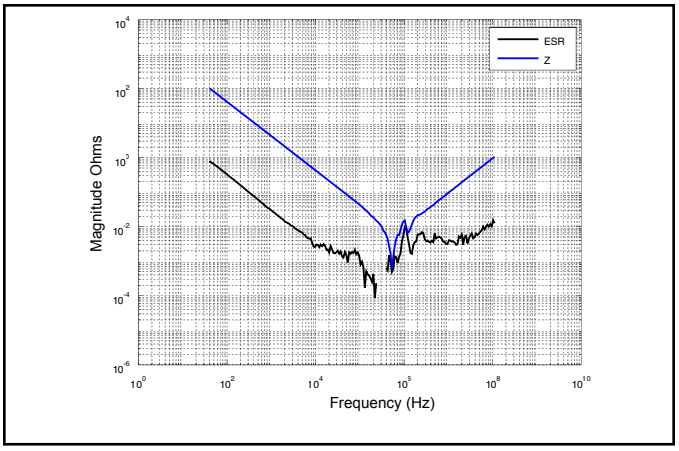


Z and ESR C2220C225MAR2C

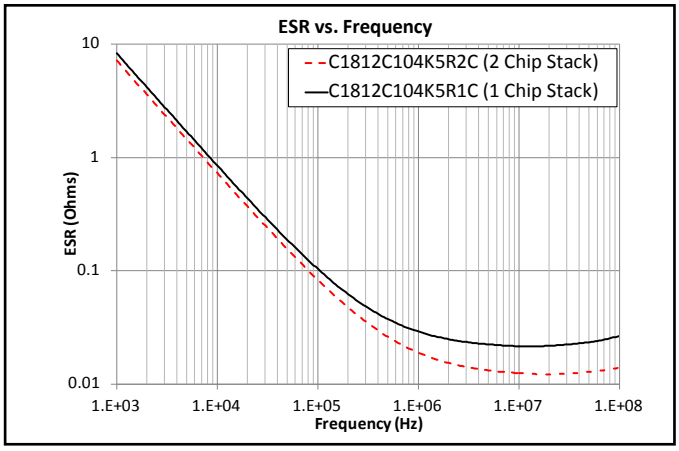


Electrical Characteristics

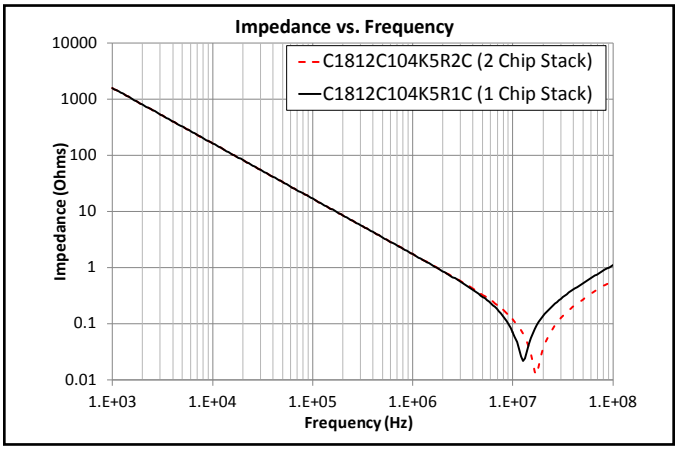
Z and ESR C2220C476M3R2C



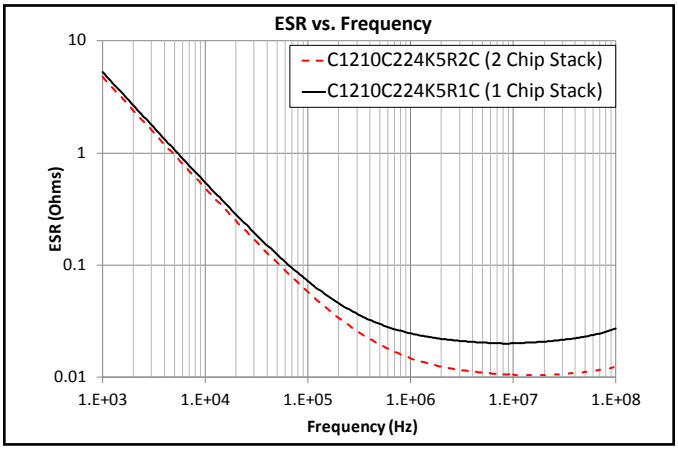
ESR – 1812, .10 µF, 50 V X7R



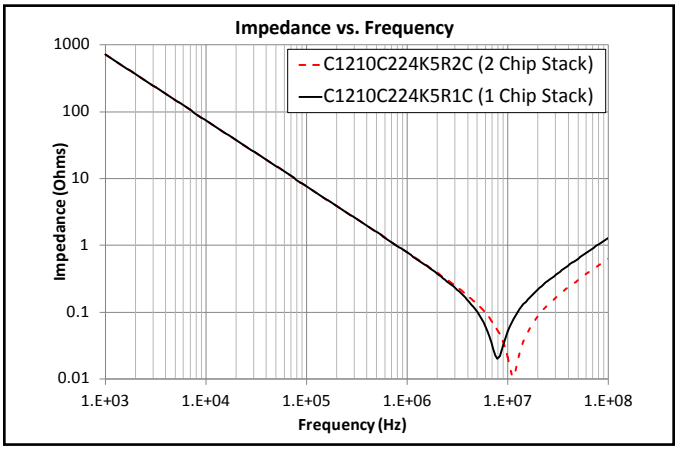
Impedance – 1812, .10 µF, 50 V X7R



ESR – 1210, .22 µF, 50 V X7R

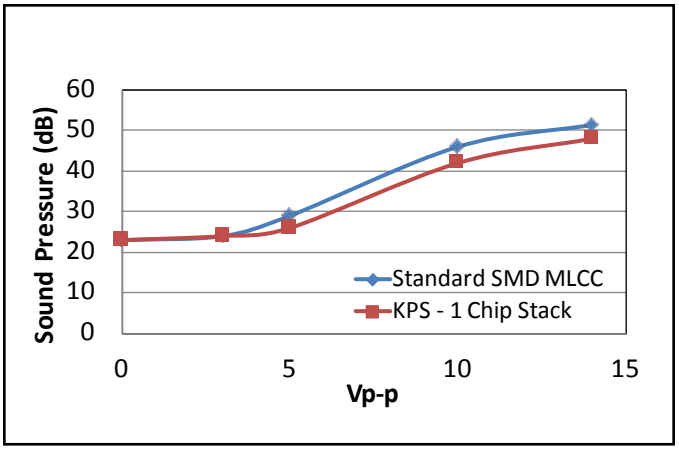


Impedance – 1210, .22 µF, 50 V X7R

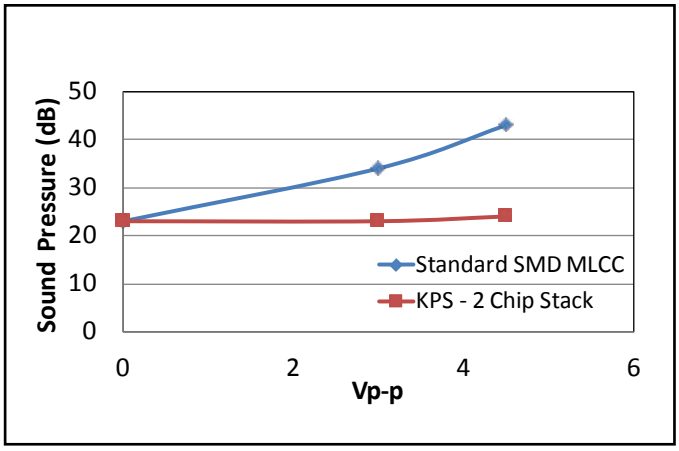


Electrical Characteristics cont'd

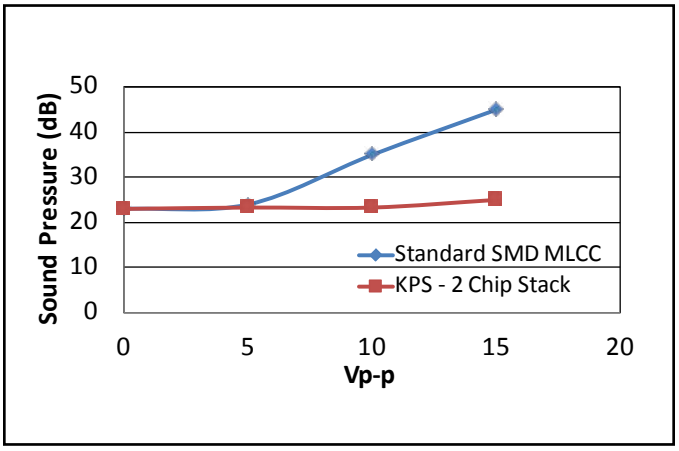
Microphonics – 1210, 4.7 µF, 50 V, X7R



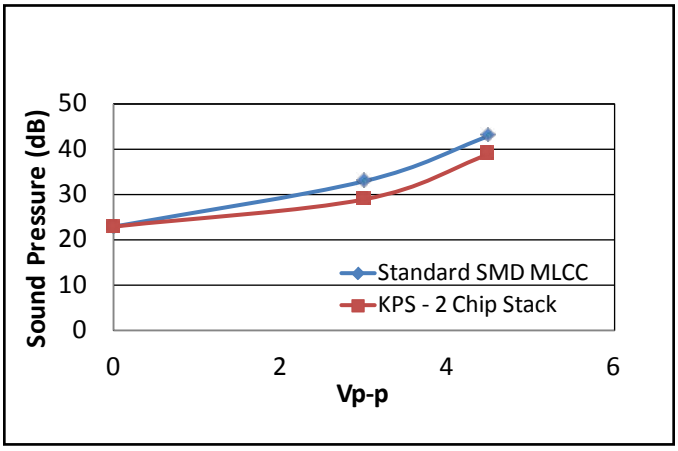
Microphonics – 2220, 22 µF, 50 V, X7R



Microphonics – 2220, 47 µF, 25 V, X7R

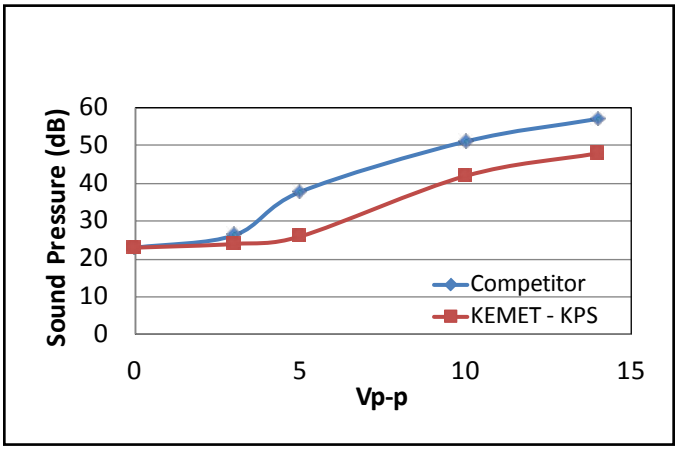


Microphonics – 1210, 22 µF, 25 V, X7R

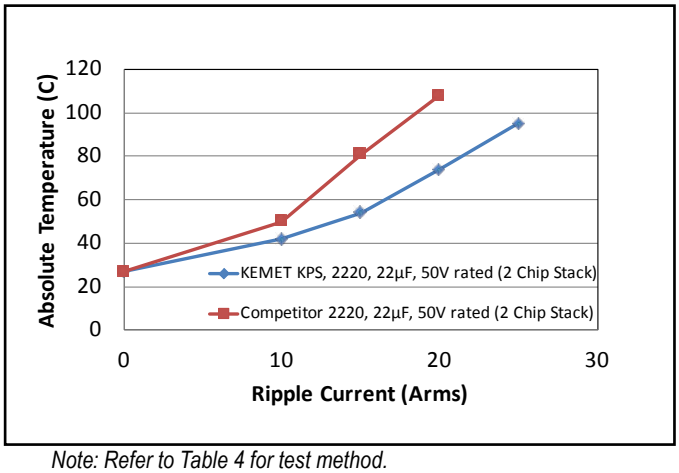


Competitive Comparision

Microphonics – 1210, 4.7 µF, 50 V, X7R



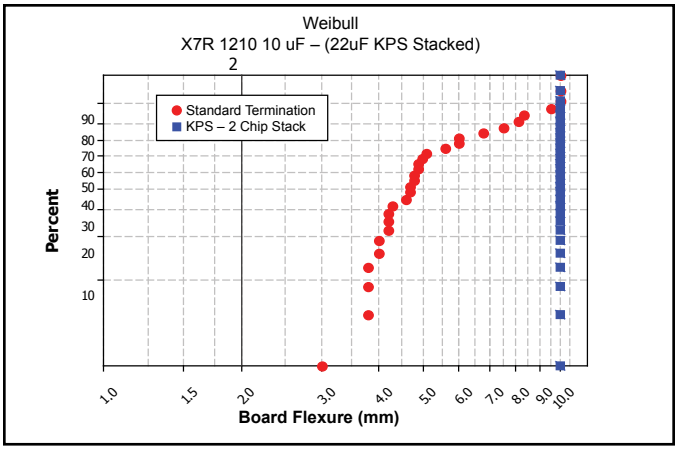
Ripple Current (Arms) 2220, 22 µF, 50 V



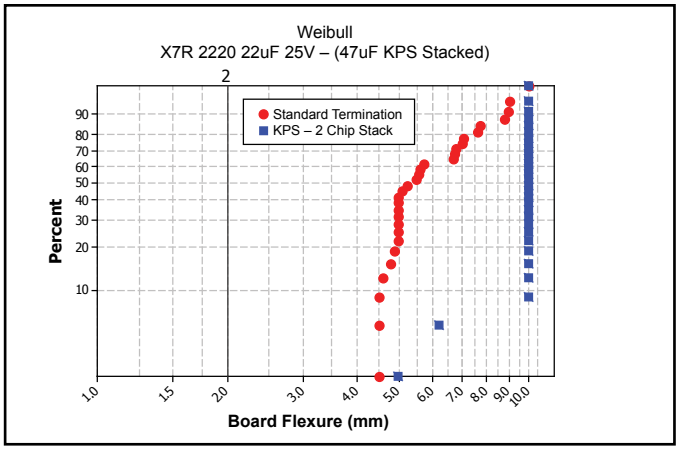
Note: Refer to Table 4 for test method.

Electrical Characteristics cont'd

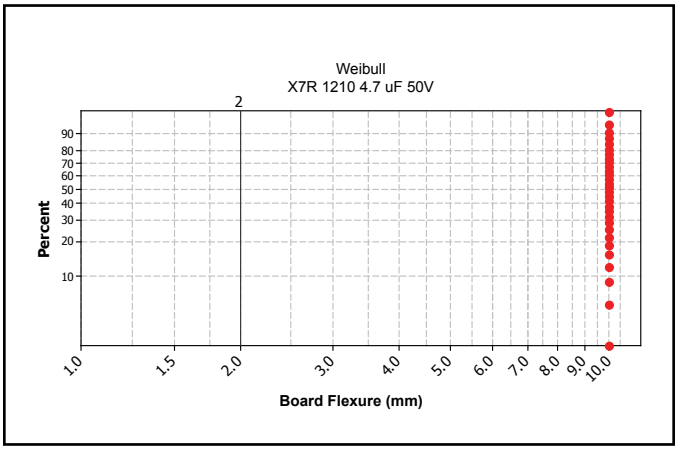
Board Flex vs. Termination Type



Board Flex vs. Termination Type



Board Flexure to 10 mm



Board Flexure to 10 mm

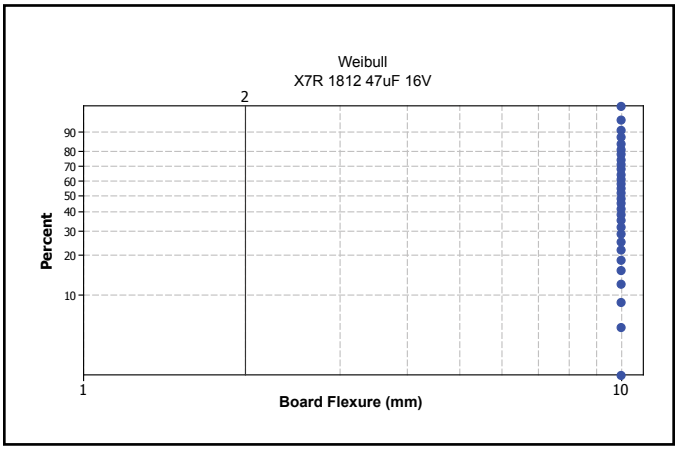


Table 1 – Capacitance Range/Selection Waterfall (1210 – 2220 Case Sizes)

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

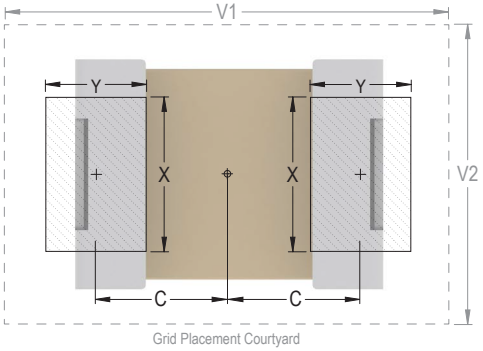
Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
FV	1210	3.35 ± 0.10	0	0	600	2,000
FW	1210	6.15 ± 0.15	0	0	300	1,000
GP	1812	2.65 ± 0.35	0	0	500	2,000
GR	1812	5.00 ± 0.50	0	0	400	1,700
JP	2220	3.50 ± 0.30	0	0	300	1,300
JR	2220	5.00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



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.

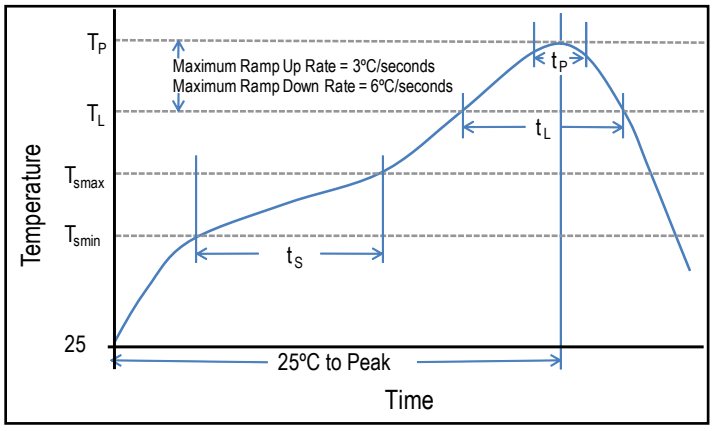


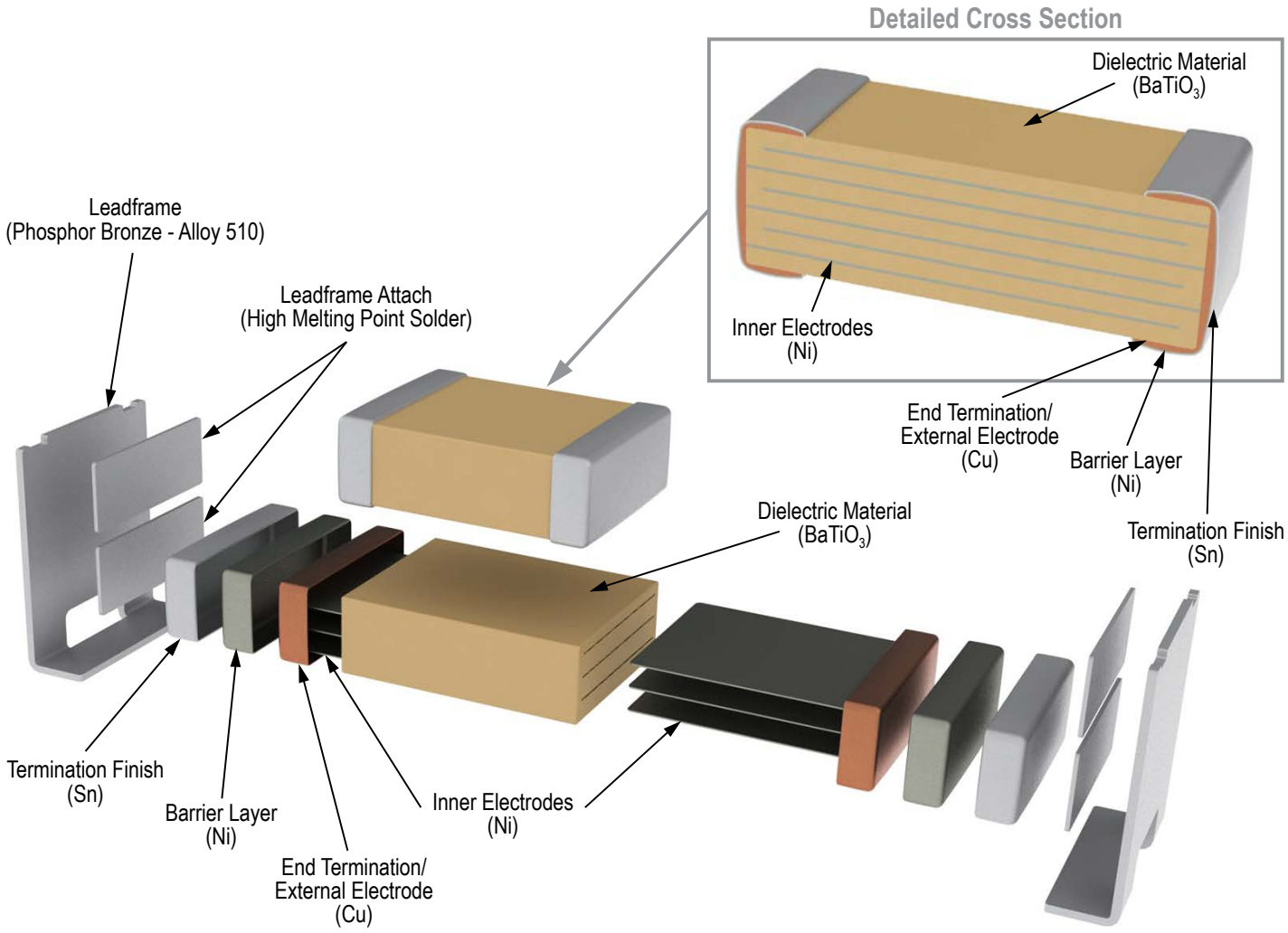
Table 4 – Performance & Reliability: Test Methods and Conditions

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.

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 + 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" below

[1] Double chip stacks ("2" in the 13th character position of the ordering code) are only available in M (±20%) capacitance tolerance. Single chip stacks ("1" in the 13th character position of the ordering code) are available in K (±10%) or M (±20%) tolerances.

[2] Additional leadframe finish options may be available. Contact KEMET for details.

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Packaging C-Spec Ordering Options Table

Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)[2]
7" Reel (Embossed Plastic Tape)/Unmarked	7186
13" Reel (Embossed Plastic Tape)/Unmarked	7289

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

Benefits cont'd

- 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

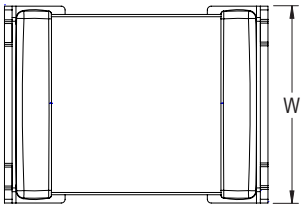
Commercial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4 , Performance and Reliability.

Environmental Compliance

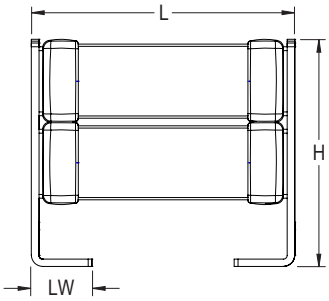
Lead (Pb)-Free, RoHS, and REACH compliant without exemptions.

Dimensions – Millimeters (Inches)

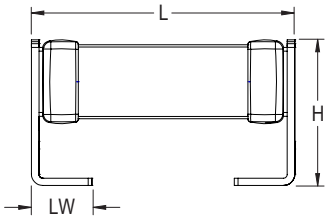
Single or Double Chip Stack



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 (.197) ±0.50 (.020)	3.50 (.138) ±0.30 (.012)	1.60 (.063) ±0.30 (.012)	Solder Reflow Only
Double	2220	5650	6.00 (0.236) ±0.50 (0.020)	5.00 (.197) ±0.50 (.020)	5.00 (.197) ±0.50 (.020)	1.60 (.063) ±0.30 (.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 @ 25°C	2.5%
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (500VDC applied for 120 ± 5 secs @ 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	100 Megohm Microfarads or 10 GΩ
0805	< 0.0039 µF	≥ 0.0039 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	All	N/A

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.

Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

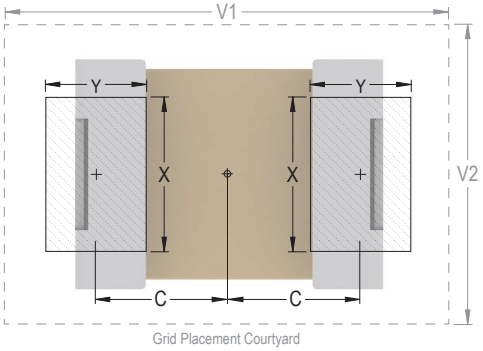
Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
JP	2220	3.50 ± 0.30	0	0	300	1,300
JR	2220	5.00 ± 0.50	0	0	200	800

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
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.



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.

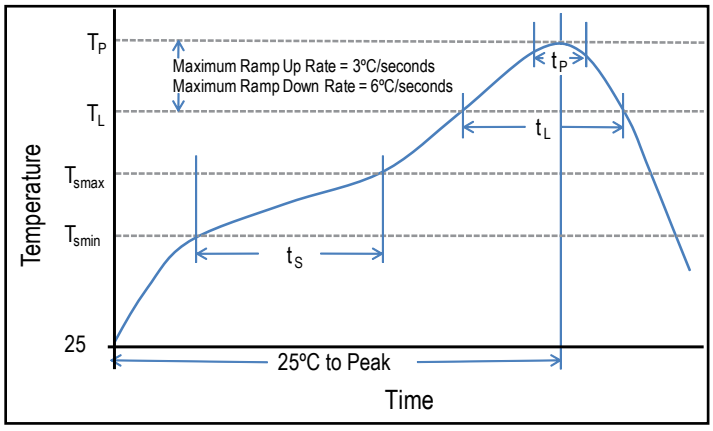


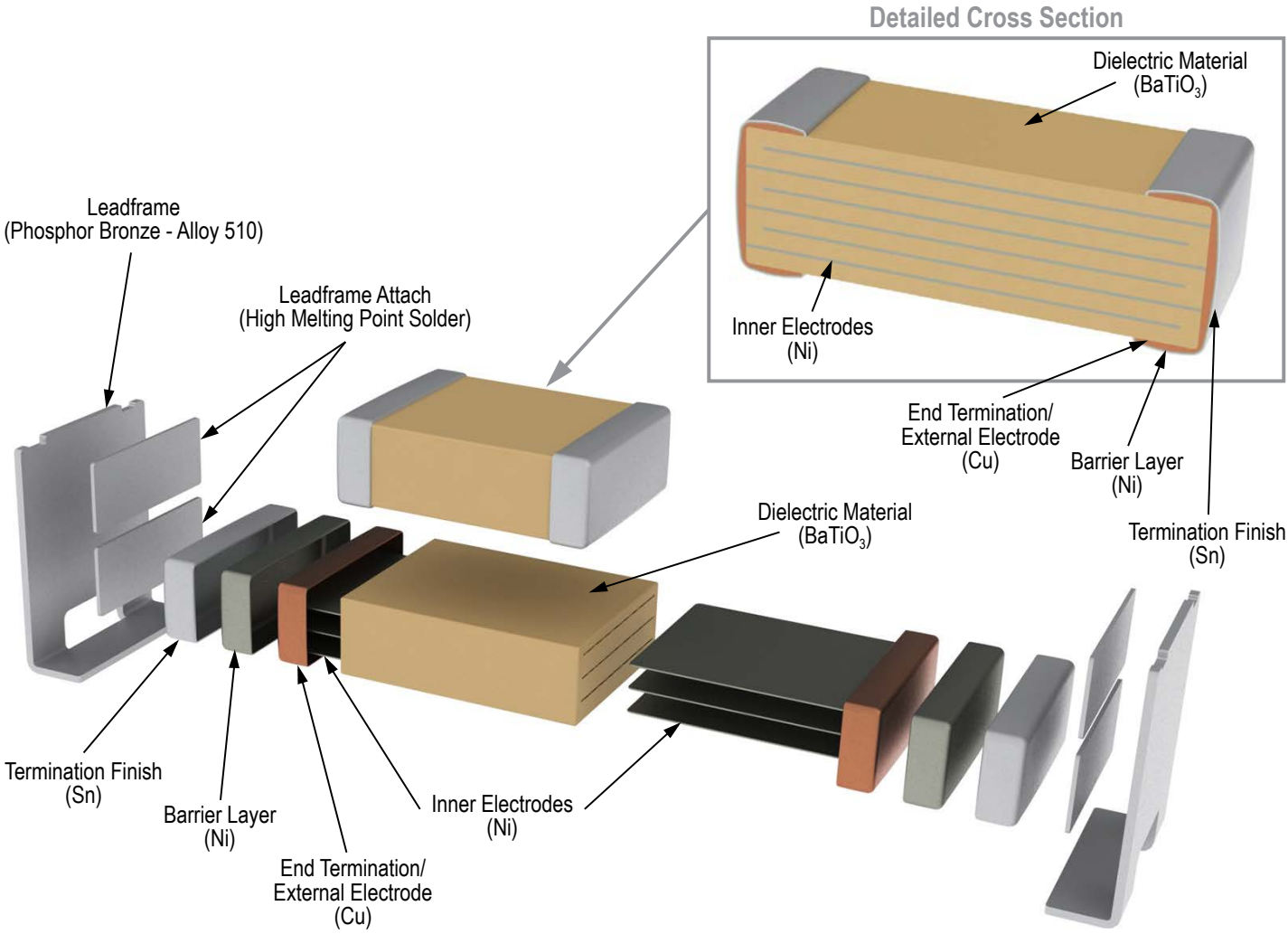
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 155°C, dry heat @ 235°C
		b) Method B @ 215°C category 3
		c) Method D, category 3 @ 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 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

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.

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	Failure Rate/ Design	Leadframe Finish[2]	Packaging/Grade (C-Spec)
	1210 2220	C = Standard	Two significant digits + 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" below

[1] Double chip stacks ("2" in the 13th character position of the ordering code) are only available in M (±20%) capacitance tolerance. Single chip stacks ("1" in the 13th character position of the ordering code) are available in K (±10%) or M (±20%) tolerances.

[2] Additional leadframe finish options may be available. Contact KEMET for details.

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Packaging C-Spec Ordering Options Table

Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)[2]
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

- 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 & 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.

Qualification/Certification

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

Environmental Compliance

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

Automotive C-Spec Information

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

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO". This C-Spec was developed in order to better serve small and medium sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET's 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 record 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

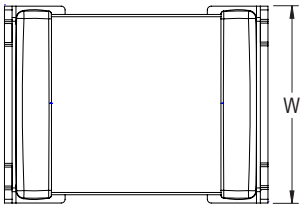
KEMET Automotive C-Spec	PPAP (Product Part Approval Process) Level				
	1	2	3	4	5
KEMET assigned[1]	●	●	●	●	●
AUTO	○		○		

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

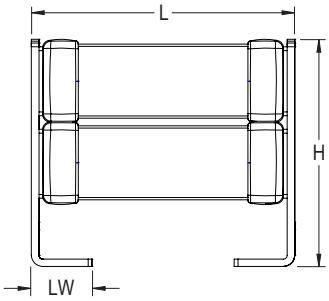
● Part Number specific PPAP available
○ Product family PPAP only

Dimensions – Millimeters (Inches)

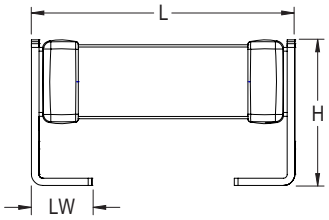
Single or Double Chip Stack



Double Chip Stack



Single Chip Stack



Chip Stack	EIA Size Code	Metric Size Code	L Length	W Width	H Height	LW Lead Width	Mounting Technique
Single	1210	3225	3.50 (.138) ±0.30 (.012)	2.60 (.102) ±0.30 (.012)	3.35 (.132) ±0.10 (.004)	0.80 (.032) ±0.15 (.006)	Solder Reflow Only
	2220	5650	6.00 (.236) ±0.50 (.020)	5.00 (.197) ±0.50 (.020)	3.50 (.138) ±0.30 (.012)	1.60 (.063) ±0.30 (.012)	
Double	1210	3225	3.50 (.138) ±0.30 (.012)	2.60 (.102) ±0.30 (.012)	6.15 (.242) ±0.15 (.006)	0.80 (.031) ±0.15 (.006)	
	2220	5650	6.00 (.236) ±0.50 (.020)	5.00 (.197) ±0.50 (.020)	5.00 (.197) ±0.50 (.020)	1.60 (.063) ±0.30 (.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 @ 25°C	3.5% (≤ 16V) and 2.5% (≥ 25V)
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	500 megohm microfarads or 10 GΩ (Rated voltage applied for 120 ±5 seconds @ 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						C2220C					
		Voltage Code			8	4	3	5	1	A	8	4	3	5	1	A
		Rated Voltage (VDC)			10	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				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	10	16	25	50	100	250
		Voltage Code			8	4	3	5	1	A	8	4	3	5	1	A
		Case Size/Series			C1210C						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

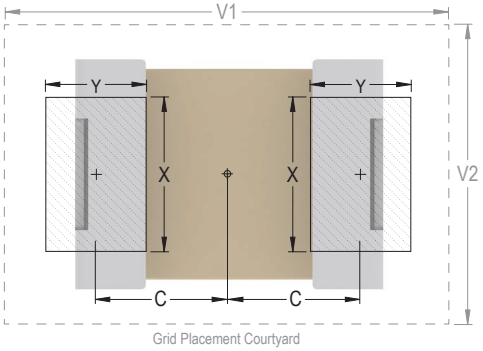
Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
FV	1210	3.35 ± 0.10	0	0	600	2,000
FW	1210	6.15 ± 0.15	0	0	300	1,000
JP	2220	3.50 ± 0.30	0	0	300	1,300
JR	2220	5.00 ± 0.50	0	0	200	800

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.



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.

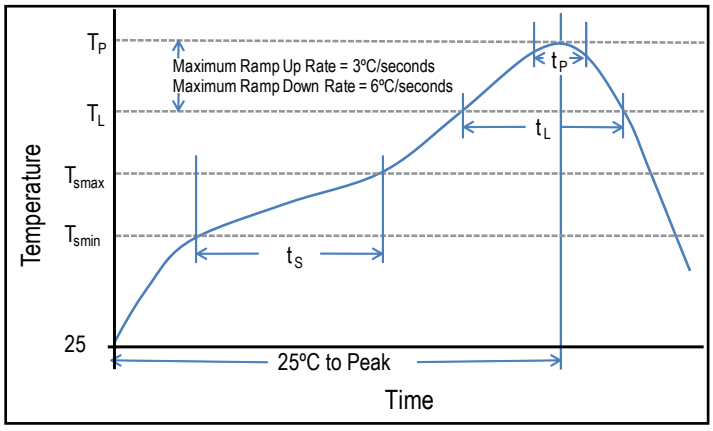


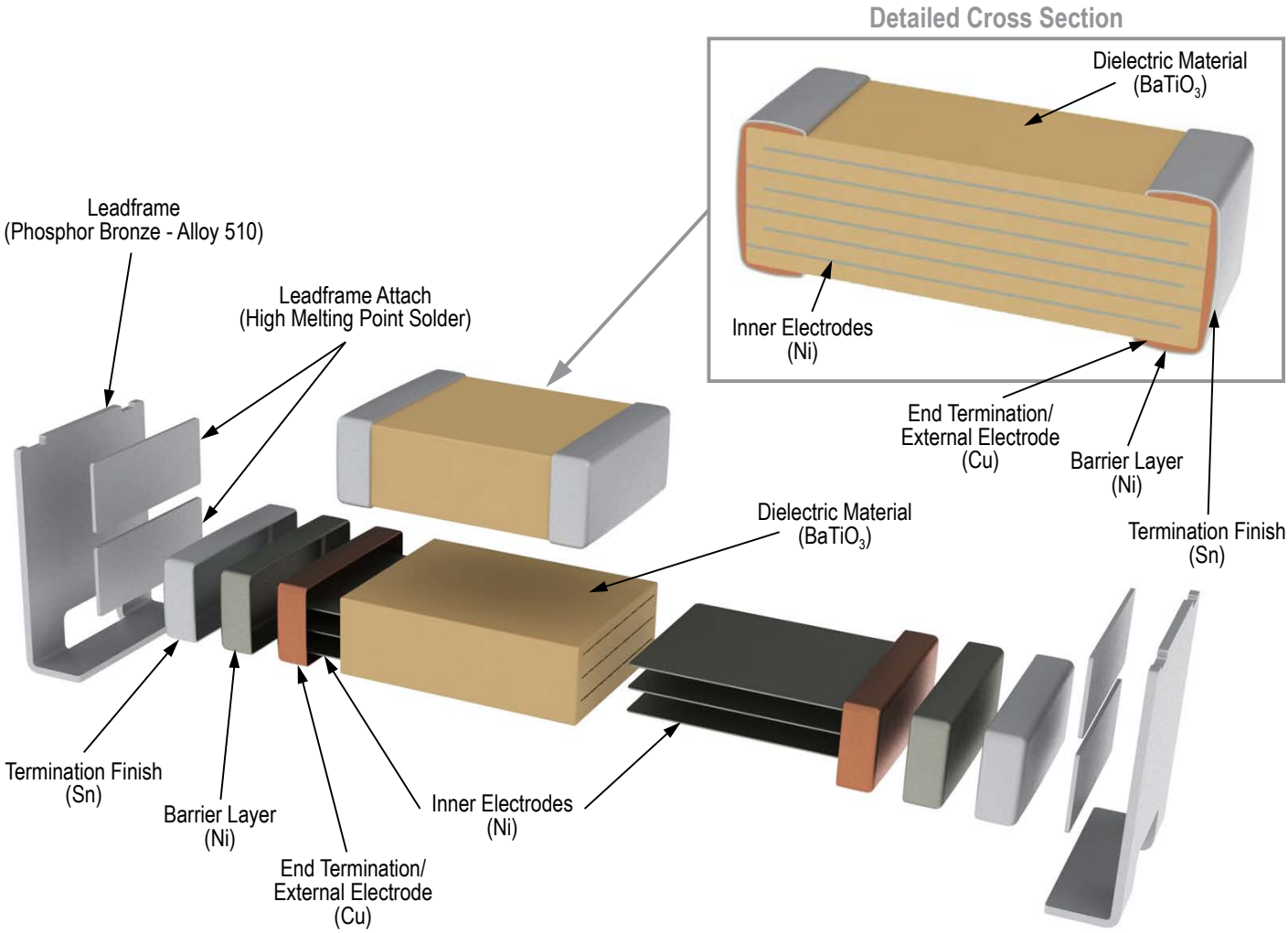
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 155°C, dry heat @ 235°C
		b) Method B @ 215°C category 3
		c) Method D, category 3 @ 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.

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

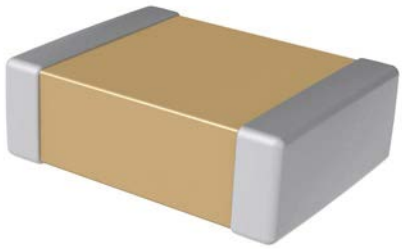
Overview

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 1808 1812 1825 2220 2225	C = Standard	Two significant digits + 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	L = SnPb (5% Pb 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

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Packaging C-Spec Ordering Options Table

Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)
Bulk Bag/Unmarked	Not required (Blank)
7" Reel/Unmarked	TU
13" Reel/Unmarked	7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes)
7" Reel/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".

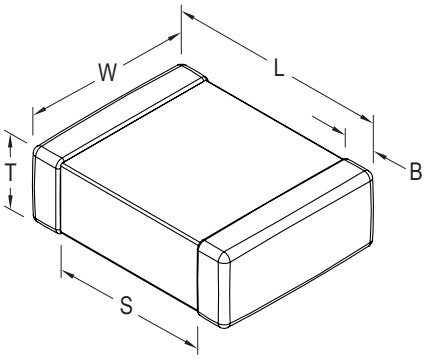
Benefits cont'd

- 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
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	
1210	3225	3.20 (.126) ± 0.20 (.008)	2.50 (.098) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)		Solder Reflow Only
1808	4520	4.70 (.185) ± 0.50 (.020)	2.00 (.079) ± 0.20 (.008)		0.60 (.024) ± 0.35 (.014)		
1812	4532	4.50 (.177) ± 0.30 (.012)	3.20 (.126) ± 0.30 (.012)		0.60 (.024) ± 0.35 (.014)		
1825	4564	4.50 (.177) ± 0.30 (.012)	6.40 (.252) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2220	5650	5.70 (.224) ± 0.40 (.016)	5.00 (.197) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2225	5664	5.60 (.220) ± 0.40 (.016)	6.40 (.248) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.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 @ 25°C	0.1%
[3]Insulation Resistance (IR) Limit @ 25°C	1,000 megohm microfarads or 100 GΩ (Rated voltage applied for 120 ±5 seconds @ 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
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		
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'd

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																											
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						

Table 1B – Capacitance Range/Selection Waterfall (1210 – 2225 Case Sizes)

Cap	Cap Code	Case Size/ Series	C1210C							C1808C				C1812C				C1825C				C2220C				C2225C			
		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	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	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 – 301*	F G J K M	FB	FB	FB	FB	FB	FB	FB																					
330 – 430 pF*	331 – 431*	F G J K M	FB	FB	FB	FB	FB	FB	FB	LF	LF	LF	LF																	
470 – 910 pF*	471 – 911*	F G J K M	FB	FB	FB	FB	FB	FB	FB	LF	LF	LF	LF	GB	GB	GB	GB													
1,000 pF	102	F G J K M	FB	FB	FB	FB	FB	FB	FB	LF	LF	LF	LF	GB	GB	GB	GB													
1,100 pF	112	F G J K M	FB	FB	FB	FB	FB	FB	FB	LF	LF	LF	LF	GB	GB	GB	GB													
1,200 pF	122	F G J K M	FB	FB	FB	FB	FB	FB	FB	LF	LF	LF	LF	GB	GB	GB	GB													
1,300 pF	132	F G J K M	FB	FB	FB	FB	FB	FC	FC	LF	LF	LF	LF	GB	GB	GB	GB													
1,500 pF	152	F G J K M	FB	FB	FB	FB	FB	FE	FE	LF	LF	LF	LF	GB	GB	GB	GB													
1,600 pF	162	F G J K M	FB	FB	FB	FB	FB	FE	FE	LF	LF	LF	LF	GB	GB	GB	GB													
1,800 pF	182	F G J K M	FB	FB	FB	FB	FB	FE	FE	LF	LF	LF	LF	GB	GB	GB	GB													
2,000 pF	202	F G J K M	FB	FB	FB	FB	FC	FE	FE	LF	LF	LF	LF	GB	GB	GB	GB													
2,200 pF	222	F G J K M	FB	FB	FB	FB	FC	FG	FG	LF	LF	LF	LF	GB	GB	GB	GB													
2,400 pF	242	F G J K M	FB	FB	FB	FB	FC	FC	FC	LF	LF	LF	LF																	
2,700 pF	272	F G J K M	FB	FB	FB	FB	FC	FC	FC	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	HB	HB	HB	HB									
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	HB	HB	HB	HB					KE	KE	KE	KE
Cap	Cap Code	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	50	100	200	250
		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	5	1	2	A
		Case Size/Series	C1210C							C1808C				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 (1210 – 2225 Case Sizes)

Cap	Cap Code	Case Size/ Series	C1210C							C1808C				C1812C				C1825C				C2220C				C2225C			
		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	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	50	100	200	250
		Capacitance Tolerance	Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																										
5,100 pF	512	F G J K M	FB	FB	FB	FB	FG	FG	FG																	KE	KE	KE	KE
5,600 pF	562	F G J K M	FB	FB	FB	FB	FG	FG	FG					GB	GB	GH	GH	HB	HB	HB	HB					KE	KE	KE	KE
6,200 pF	622	F G J K M	FB	FB	FB	FB	FG	FB	FB																	KE	KE	KE	KE
6,800 pF	682	F G J K M	FB	FB	FB	FB	FG	FB	FB					GB	GB	GJ	GJ	HB	HB	HB	HB	JE	JE	JB		KE	KE	KE	KE
7,500 pF	752	F G J K M	FC	FC	FC	FC	FC	FB	FB																	KE	KE	KE	KE
8,200 pF	822	F G J K M	FC	FC	FC	FC	FC	FB	FB					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	FB	FB																	KE	KE	KE	KE
10,000 pF	103	F G J K M	FF	FF	FF	FF	FF	FB	FB					GB	GH	GB	GB	HB	HB	HE	HE	JE	JE	JB		KE	KE	KE	KE
12,000 pF	123	F G J K M	FG	FG	FG	FG	FB	FB	FB					GB	GG	GB	GB	HB	HB	HE	HE	JE	JE	JB		KE	KE	KE	KE
15,000 pF	153	F G J K M	FG	FG	FG	FG	FB	FC	FC					GB	GB	GB	GB	HB	HB			JE	JE	JB		KE	KE	KE	KE
18,000 pF	183	F G J K M	FB	FB	FB	FB	FB	FC	FC					GB	GB	GB	GB	HB	HE			JE	JE	JB		KE	KE		
22,000 pF	223	F G J K M	FB	FB	FB	FB	FB	FF	FF					GB	GB	GB	GB	HB	HE			JE	JB	JB		KE	KE		
27,000 pF	273	F G J K M	FB	FB	FB	FB	FB	FG	FG					GB	GB	GB	GB	HB	HG			JE	JB	JB		KE	KE		
33,000 pF	333	F G J K M	FB	FB	FB	FB	FB	FH	FH					GB	GB	GB	GB					JB	JB	JB		KE			
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					
0.10 µF	104	F G J K M	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	50	100	200	250	50	100	200	250	50	100	200	250	50	100	200	250	50	100	200	250
		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	5	1	2	A
		Case Size/Series	C1210C							C1808C				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 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	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
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	1706	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**	**Thickness ± Range (mm)**	**7" Reel**	**13" Reel**	**7" Reel**	**13" Reel**
			Paper Quantity		**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 out 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

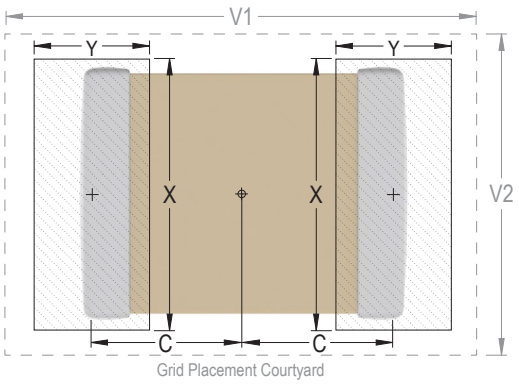
[1] *Only for capacitance values ≥ 22 µF*

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.

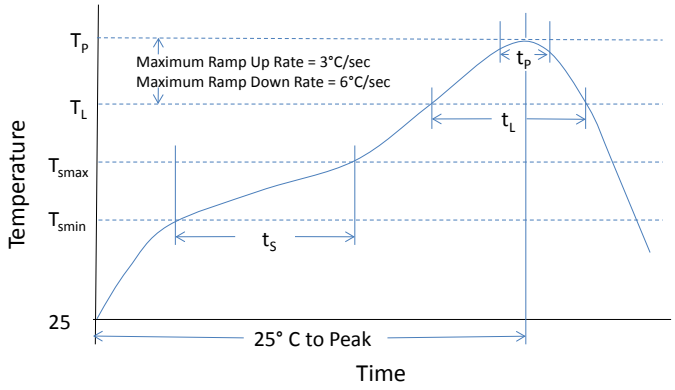


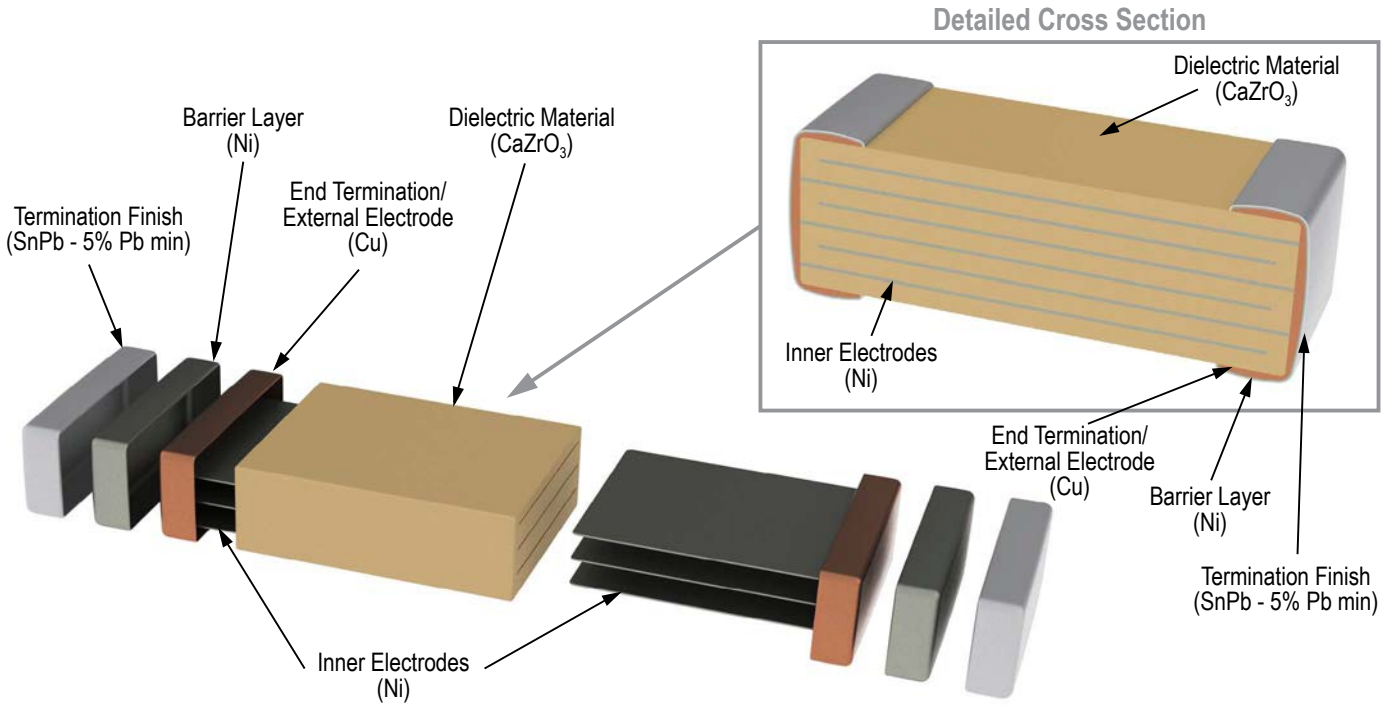
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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 +/- 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.

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

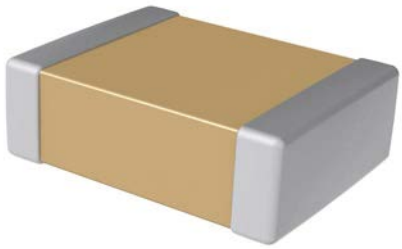
Overview

KEMET's Commercial "L" Series with Tin/Lead Termination surface mount capacitors in X7R 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 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.

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



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 1808 1812 1825 2220 2225	C = Standard	Two Significant Digits + 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" below

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

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Packaging C-Spec Ordering Options Table

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

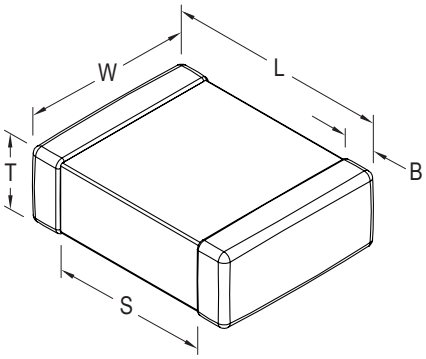
Benefits cont'd

- 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.

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	
1210[1]	3225	3.20 (.126) ± 0.20 (.008)	2.50 (.098) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)		Solder Reflow Only
1808	4520	4.70 (.185) ± 0.50 (.020)	2.00 (.079) ± 0.20 (.008)		0.60 (.024) ± 0.35 (.014)		
1812	4532	4.50 (.177) ± 0.30 (.012)	3.20 (.126) ± 0.30 (.012)		0.60 (.024) ± 0.35 (.014)		
1825	4564	4.50 (.177) ± 0.30 (.012)	6.40 (.252) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2220	5650	5.70 (.224) ± 0.40 (.016)	5.00 (.197) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2225	5664	5.60 (.220) ± 0.40 (.016)	6.40 (.248) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		

[1] *For capacitance values ≥ 12 µF add 0.02 (0.001) to the width 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 50mA)
[3]Dissipation Factor (DF) Maximum Limit @ 25°C	5%(6.3V & 10V), 3.5%(16V & 25V) and 2.5%(50V to 250V)
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (Rated voltage applied for 120 ± 5 secs @ 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 – 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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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		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		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		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		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		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			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	
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	
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		
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		
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			
0.68 µF	684	J K M													DP	DP	DP	DG	DH	DH				EE	EE	EE	EE	ED	ED			
0.82 µF	824	J K M													DP	DP	DP	DG						EF	EF	EF	EF	ED	ED			
1 µF	105	J K M													DP	DP	DP	DG						EF	EF	EF	EH	ED	ED			
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	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	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 – 2225 Case Sizes)

Cap	Cap Code	Case Size/ Series	C1210C								C1808C			C1812C					C1825C				C2220C					C2225C			
		Voltage Code	9	8	4	3	5	1	2	A	5	1	2	3	5	1	2	A	5	1	2	A	3	5	1	2	A	5	1	2	A
		Rated Voltage (VDC)	6.3	10	16	25	50	100	200	250	50	100	200	25	50	100	200	250	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																												
10 – 91 pF*	100 – 910*	J K M	FB	FB	FB	FB	FB	FB	FB																						
100 – 270 pF**	101 – 271**	J K M	FB	FB	FB	FB	FB	FB	FB																						
330 pF	331	J K M	FB	FB	FB	FB	FB	FB	FB		LF	LF	LF																		
390 pF	391	J K M	FB	FB	FB	FB	FB	FB	FB		LF	LF	LF																		
470 – 1,200 pF**	471 – 122**	J K M	FB	FB	FB	FB	FB	FB	FB		LF	LF	LF	GB	GB	GB	GB														
1,500 pF	152	J K M	FB	FB	FB	FB	FB	FB	FE		LF	LF	LF	GB	GB	GB	GB														
1,800 pF	182	J K M	FB	FB	FB	FB	FB	FB	FE		LF	LF	LF	GB	GB	GB	GB														
2,200 pF	222	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LF	LF	LF	GB	GB	GB	GB														
2,700 pF	272	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LF	LF	LF	GB	GB	GB	GB														
3,300 pF	332	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LF	LF		GB	GB	GB	GB														
3,900 pF	392	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LF	LF		GB	GB	GB	GB		HB	HB	HB										
4,700 pF	472	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD	LD	GB	GB	GB	GD		HB	HB	HB							KE	KE	KE	
5,600 pF	562	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD	LD	GB	GB	GB	GH		HB	HB	HB							KE	KE	KE	
6,800 pF	682	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD	LD	GB	GB	GB	GB	GB	HB	HB	HB		JE	JE	JE			KE	KE	KE	
8,200 pF	822	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD	LD	GB	GB	GB	GB	GB	HB	HB	HB		JE	JE	JE			KE	KE	KE	
10,000 pF	103	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD	LD	GB	GB	GB	GB	GB	HB	HB	HE		JE	JE	JE			KE	KE	KE	
12,000 pF	123	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD	LD	GB	GB	GB	GB	GB	HB	HB	HE		JE	JE	JE			KE	KE	KE	
15,000 pF	153	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD	LD	GB	GB	GB	GB	GB	HB	HB			JE	JE	JE			KE	KE	KE	
18,000 pF	183	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD	LD	GB	GB	GB	GB	GB	HB	HE			JE	JE	JE			KE	KE		
22,000 pF	223	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JE	JE	JE			KE	KE		
27,000 pF	273	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JE	JE	JE			KE	KE		
33,000 pF	333	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JB			KE			
39,000 pF	393	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JB						
47,000 pF	473	J K M	FB	FB	FB	FB	FB	FB	FC	FC	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JB						
56,000 pF	563	J K M	FB	FB	FB	FB	FB	FB	FC	FC	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JB						
68,000 pF	683	J K M	FB	FB	FB	FB	FB	FB	FC	FC	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JB						
82,000 pF	823	J K M	FB	FB	FB	FB	FB	FC	FF	FF	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB	JC	JC	JC	JC	JC				
0.10 µF	104	J K M	FB	FB	FB	FB	FB	FD	FG	FG	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	FB	FB	FB	FB	FB	FD	FH	FH	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	FC	FC	FC	FC	FC	FD	FM	FM	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	FC	FC	FC	FC	FC	FD	FK	FK	LD			GB	GB	GB	GG	GG	HB	HB	HB	HB	JC	JC	JC	JC	JC	KC	KC	KC	KC
0.22 µF	224	J K M	FC	FC	FC	FC	FC	FD	FK	FK				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	FC	FC	FC	FC	FC	FD						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	FD	FD	FD	FD	FD	FD						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	FD	FD	FD	FD	FD	FD						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	FD	FD	FD	FD	FD	FD						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	FD	FD	FD	FD	FD	FF						GC	GC	GG			HB	HD	HD	HD	JC	JC	JC	JD	JD	KB	KC	KD	KD
0.68 µF	684	J K M	FD	FD	FD	FD	FD	FG						GC	GC	GG			HB	HD	HD	HD	JC	JC	JD	JD	JD	KB	KC	KD	KD
0.82 µF	824	J K M	FF	FF	FF	FF	FF	FL						GE	GE	GG			HB	HF	HF	HF	JC	JC	JF	JF	JF	KB	KC	KE	KE
1.0 µF	105	J K M	FH	FH	FH	FH	FH	FM						GE	GE	GG			HB	HF	HF	HF	JC	JC	JF	JF	JF	KB	KD	KE	KE
1.2 µF	125	J K M	FH	FH	FH	FH	FG												HB				JC	JC				KB	KE	KE	KE
1.5 µF	155	J K M	FH	FH	FH	FH	FG												HC				JC	JC				KC			
1.8 µF	185	J K M	FH	FH	FH	FH	FG												HD				JD	JD				KD			
2.2 µF	225	J K M	FJ	FJ	FJ	FJ	FG							GO	GO				HF				JF	JF				KD			
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							GK	GK								JF	JF							
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																									
Cap	Cap Code	Rated Voltage (VDC)	6.3	10	16	25	50	100	200	250	50	100	200	25	50	100	200	250	50	100	200	250	25	50	100	200	250	50	100	200	250
		Voltage Code	9	8	4	3	5	1	2	A	5	1	2	3	5	1	2	A	5	1	2	A	3	5	1	2	A	5	1	2	A
		Case Size/ Series	C1210C								C1808C			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)*

***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'd

Cap	Cap Code	Case Size/ Series	C1210C								C1808C			C1812C					C1825C				C2220C					C2225C			
		Voltage Code	9	8	4	3	5	1	2	A	5	1	2	3	5	1	2	A	5	1	2	A	3	5	1	2	A	5	1	2	A
		Rated Voltage (VDC)	6.3	10	16	25	50	100	200	250	50	100	200	25	50	100	200	250	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																												
10 µF	106	J K M	FH[1]	FH[1]	FH[1]	FS								GK									JF	JO							
12 µF	126	J K M																													
15 µF	156	J K M	FM	FM																			JO	JO							
18 µF	186	J K M																													
22 µF	226	J K M	FS	FS																			JO								
Cap	Cap Code	Rated Voltage (VDC)	6.3	10	16	25	50	100	200	250	50	100	200	25	50	100	200	250	50	100	200	250	25	50	100	200	250	50	100	200	250
		Voltage Code	9	8	4	3	5	1	2	A	5	1	2	3	5	1	2	A	5	1	2	A	3	5	1	2	A	5	1	2	A
		Case Size/ Series	C1210C								C1808C			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)*
***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	4,000	10,000	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
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'd

Thickness Code	Case Size[1]	Thickness ± Range (mm)	Paper Quantity[1]		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
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	1706	0.90 ± 0.10	0	0	4,000	10,000
NC	1706	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
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 out 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

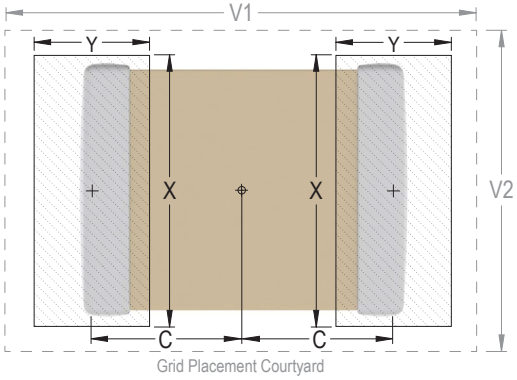
[1] *Only for capacitance values ≥ 22 µF*

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.

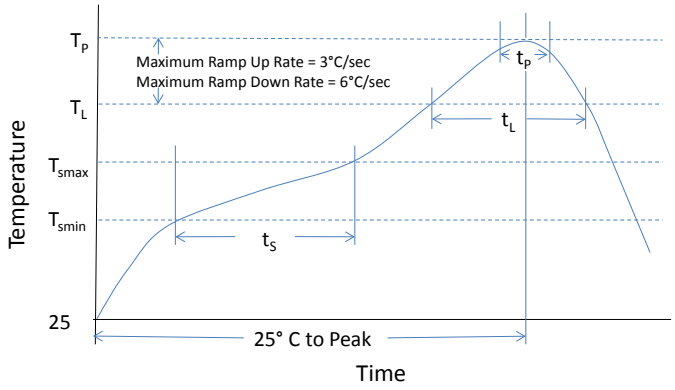


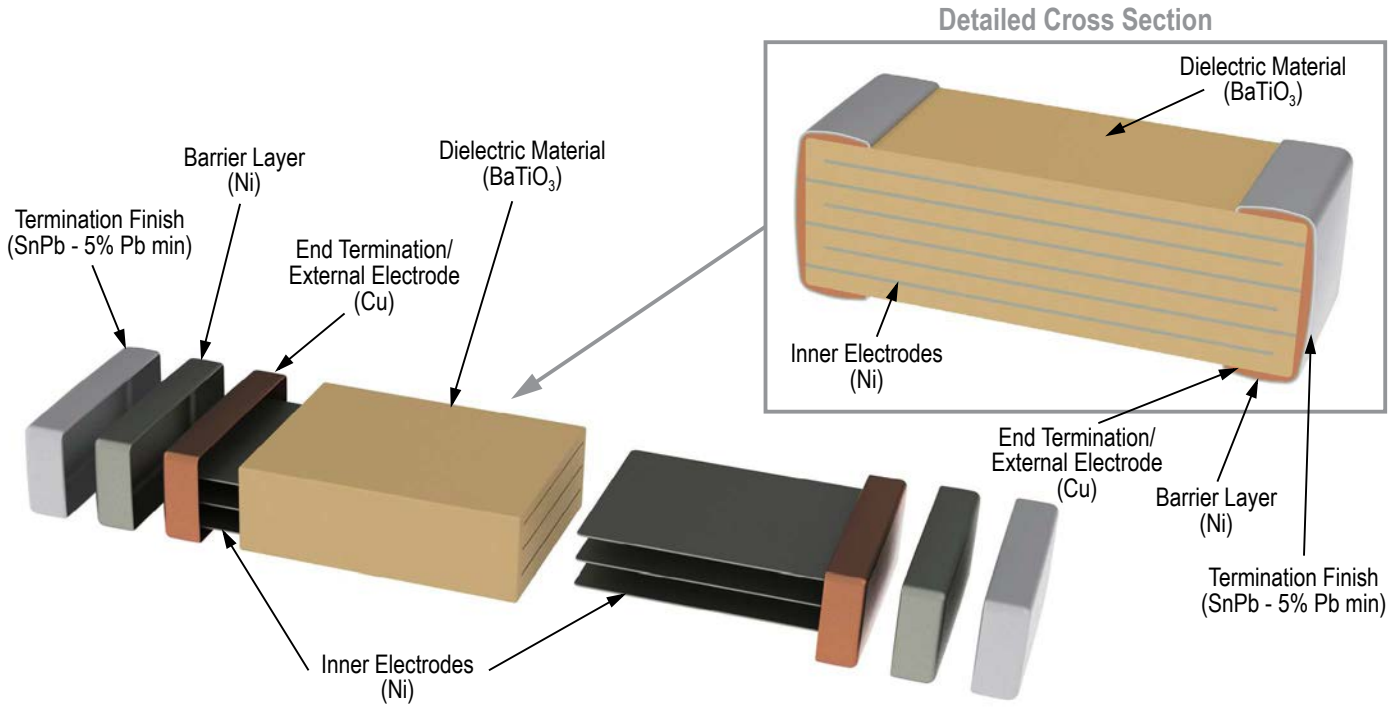
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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 +/- 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



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.

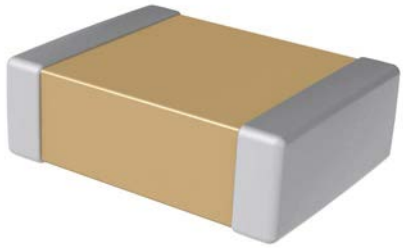
KEMET's X5R dielectric features an 85°C maximum operating temperature and is considered "semi-stable." The Electronics Industries Alliance (EIA) characterizes X5R dielectric as a Class II material. Components of this classification are fixed, ceramic dielectric capacitors suited for bypass and decoupling 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 + 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" below

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

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Packaging C-Spec Ordering Options Table

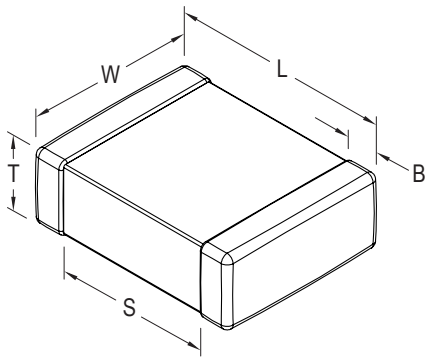
Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)
Bulk Bag/Unmarked	Not required (Blank)
7" Reel/Unmarked	TU
13" Reel/Unmarked	7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes)
7" Reel/Marked	TM
13" Reel/Marked	7040 (EIA 0603 and smaller case sizes) 7215 (EIA 0805 and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

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

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

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

Dimensions – Millimeters (Inches)



EIA Size Code	Metric Size Code	L Length	W Width	T Thickness	B Bandwidth	S Separation Minimum	Mounting Technique
0402	1005	1.00 (0.040) ±0.05 (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

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 @ 25°C	See Dissipation Factor Limit Table
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (Rated voltage applied for 120 ± 5 secs @ 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
X5R	> 25	All	3.0	±20%	10% of Initial Limit
	25	< 2.2 µF	7.5		
		≥ 2.2 µF	20.0		
	< 25	< 0.56 µF	7.5		
	< 25	≥ 0.56 µF	20.0		

Dissipation Factor Limit Table

Rated DC Voltage	Capacitance	Dissipation Factor (Maximum %)
> 25	All	2.5
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
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

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	3	5	7	9	8	4	3	5	7	9	8	4	3	5	9	8	4	3	5	9	8	4	3	6	5
		Rated Voltage (VDC)		4	6.3	10	16	25	50	4	6.3	10	16	25	50	4	6.3	10	16	25	50	6.3	10	16	25	50	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																										
0.12 µF	124	K	M																														
0.15 µF	154	K	M																														
0.18 µF	184	K	M																														
0.22 µF	224	K	M																														
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			DE	DE	DE	DE	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		
12 µF	126	K	M																														
15 µF	156	K	M																														
18 µF	186	K	M																														
22 µF	226	K	M																								FH	FH	FJ				
Capacitance	Cap Code	Rated Voltage (VDC)		4	6.3	10	16	25	50	4	6.3	10	16	25	50	4	6.3	10	16	25	50	6.3	10	16	25	50	6.3	10	16	25	35	50
		Voltage Code		7	9	8	3	5	4	7	9	8	4	3	5	7	9	8	4	3	5	9	8	4	3	5	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	4,000	10,000	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 out 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

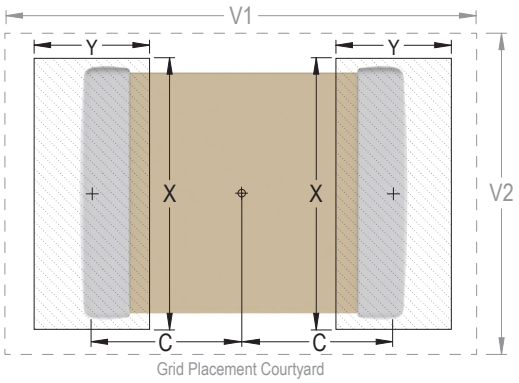
[1] *Only for capacitance values ≥ 22 µF*

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.

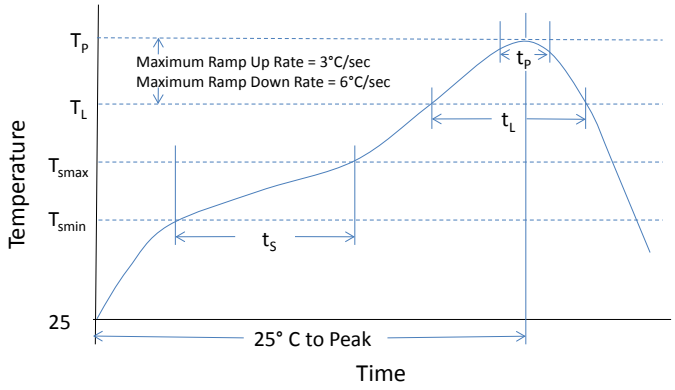


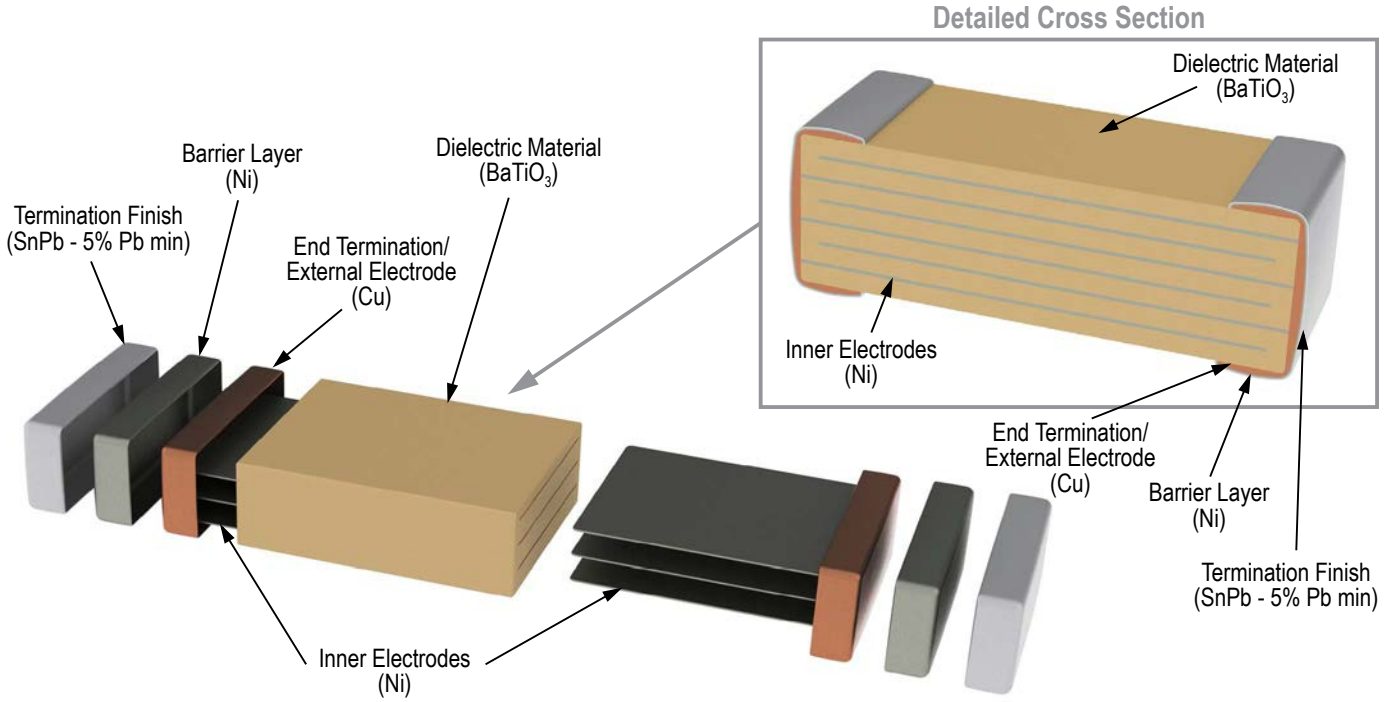
Table 4 – Performance & Reliability: Test Methods and Conditions

<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.

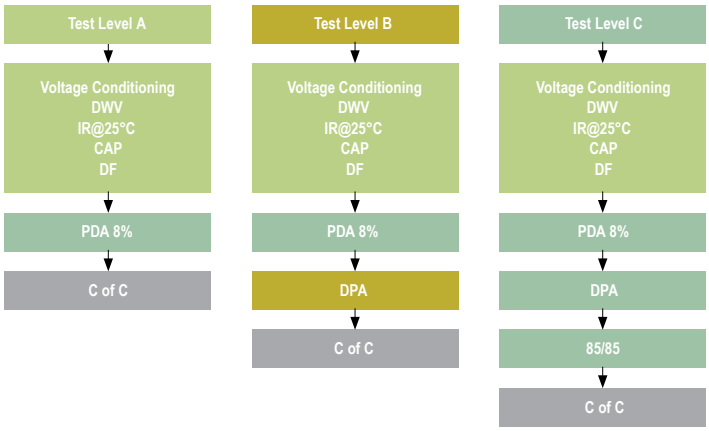
Construction (Typical)



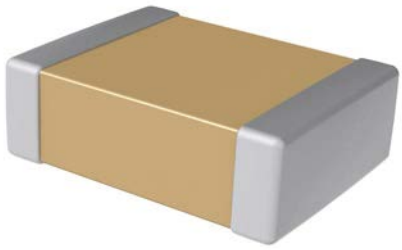
Commercial Off-The-Shelf (COTS) for Higher Reliability Applications, C0G Dielectric, 10 – 250 VDC

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 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	Failure Rate/Design	Termination Finish[2]	Packaging/Grade (C-Spec)
	0402 0603 0805 1206 1210 1812 2220	T = COTS	Two significant digits + 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 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)	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.

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Packaging C-Spec Ordering Options Table

Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)
Bulk Bag/Unmarked	Not required (Blank)
7" Reel/Unmarked	TU
13" Reel/Unmarked	7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes)
7" Reel/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".

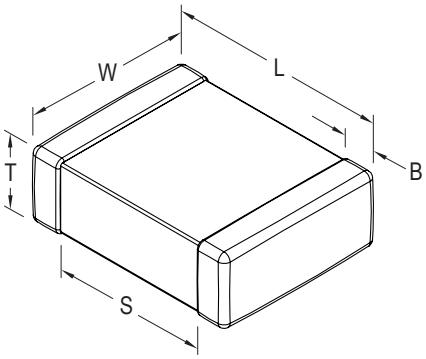
Benefits

- −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.

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	
1210	3225	3.20 (.126) ± 0.20 (.008)	2.50 (.098) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)		Solder Reflow Only
1812	4532	4.50 (.177) ± 0.30 (.012)	3.20 (.126) ± 0.30 (.012)		0.60 (.024) ± 0.35 (.014)		
2220	5650	5.70 (.224) ± 0.40 (.016)	5.00 (.197) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.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 @ 25°C	0.1%
[3]Insulation Resistance (IR) Limit @ 25°C	1,000 megohm microfarads or 100 GΩ (Rated voltage applied for 120 ±5 seconds @ 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	402	0.50 ± 0.05	10000	50000	0	0
BD	402	0.55 ± 0.05	10000	50000	0	0
CF	603	0.80 ± 0.07	4000	15000	0	0
CH	603	0.85 ± 0.07	4000	10000	0	0
DN	805	0.78 ± 0.10	4000	15000	0	0
DP	805	0.90 ± 0.10	4000	15000	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
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 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 out 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

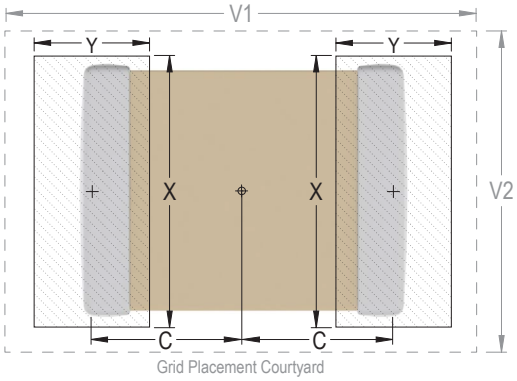
[1] *Only for capacitance values ≥ 22 µF*

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.

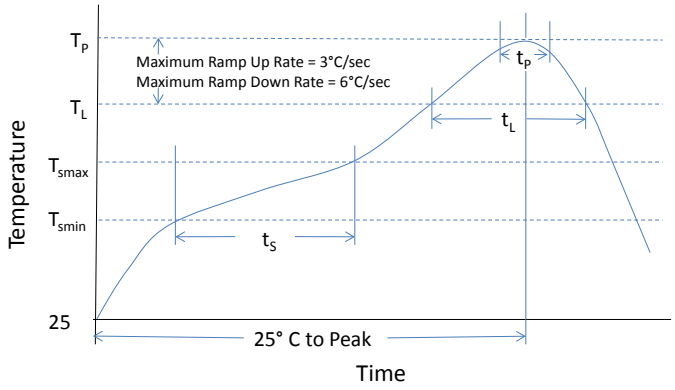


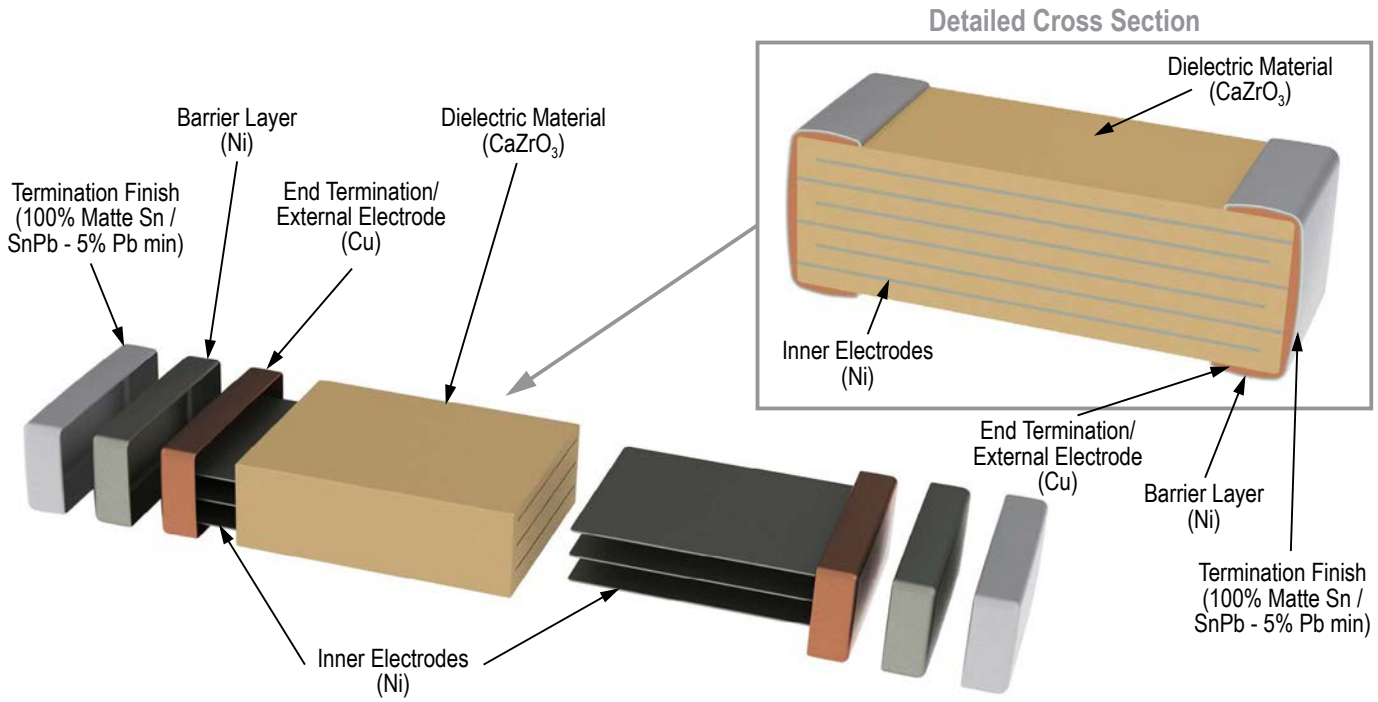
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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 +/- 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.

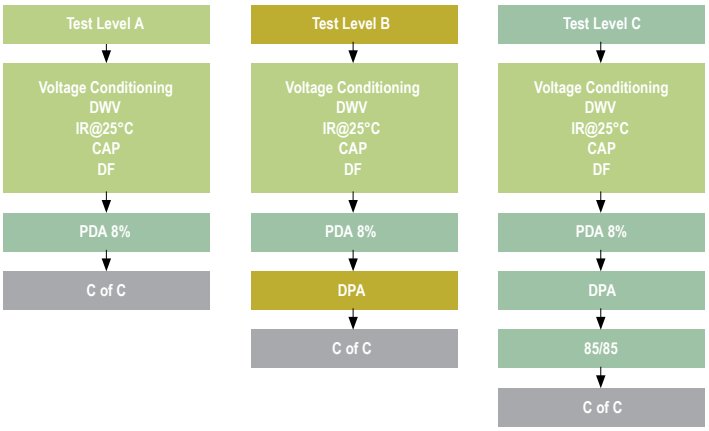
Commercial Off-The-Shelf (COTS) for Higher Reliability Applications, X7R Dielectric, 6.3 – 250 VDC

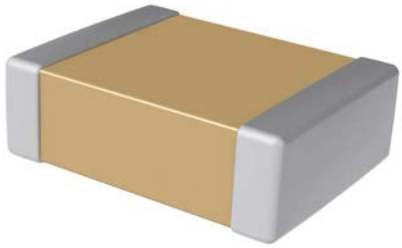
Overview

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 ±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	Failure Rate/Design	Termination Finish[1]	Packaging/Grade (C-Spec)
	0402 0603 0805 1206 1210 1812 2220	T = COTS	Two significant digits + 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)	See "Packaging C-Spec Ordering Options Table" below

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

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Packaging C-Spec Ordering Options Table

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

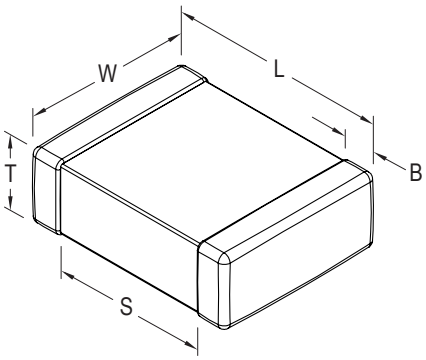
Benefits

- −55°C to +125°C operating temperature range
- 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.

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	
1210[1]	3225	3.20 (.126) ± 0.20 (.008)	2.50 (.098) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)		Solder Reflow Only
1812	4532	4.50 (.177) ± 0.30 (.012)	3.20 (.126) ± 0.30 (.012)		0.60 (.024) ± 0.35 (.014)		
2220	5650	5.70 (.224) ± 0.40 (.016)	5.00 (.197) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		

[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 @ 25°C	5%(6.3V & 10V), 3.5%(16V & 25V) and 2.5%(50V to 250V)
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (Rated voltage applied for 120 ± 5 secs @ 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
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	C0402T					C0603T							C0805T								C1206T							
		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	C0402T					C0603T							C0805T								C1206T							

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'd

Capacitance	Cap Code	Case Size/ Series	C0402T					C0603T							C0805T								C1206T							
		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	C0402T					C0603T							C0805T								C1206T							

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)

Capacitance	Cap Code	Case Size/ Series	C1210T								C1808T			C1812T					C1825T				C2220T				
		Voltage Code	9	8	4	3	5	1	2	A	5	1	2	3	5	1	2	A	5	1	2	A	3	5	1	2	A
		Rated Voltage (VDC)	6.3	10	16	25	50	100	200	250	50	100	200	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																								
10 - 91 pF*	100 - 910*	J K M	FB	FB	FB	FB	FB	FB	FB																		
100 - 270 pF**	101 - 391**	J K M	FB	FB	FB	FB	FB	FB	FB																		
330 pF	331	J K M	FB	FB	FB	FB	FB	FB	FB		LF	LF	LF														
390 pF	391	J K M	FB	FB	FB	FB	FB	FB	FB		LF	LF	LF														
470 - 820 pF**	471 - 821**	J K M	FB	FB	FB	FB	FB	FB	FB		LF	LF	LF	GB	GB	GB	GB										
1,000 pF	102	J K M	FB	FB	FB	FB	FB	FB	FB		LF	LF	LF	GB	GB	GB	GB										
1,200 pF	122	J K M	FB	FB	FB	FB	FB	FB	FB		LF	LF	LF	GB	GB	GB	GB										
1,500 pF	152	J K M	FB	FB	FB	FB	FB	FB	FE		LF	LF	LF	GB	GB	GB	GB										
1,800 pF	182	J K M	FB	FB	FB	FB	FB	FB	FE		LF	LF	LF	GB	GB	GB	GB										
2,200 pF	222	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LF	LF	LF	GB	GB	GB	GB										
2,700 pF	272	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LF	LF	LF	GB	GB	GB	GB										
3,300 pF	332	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LF	LF		GB	GB	GB	GB										
3,900 pF	392	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LF	LF		GB	GB	GB	GB										
4,700 pF	472	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GD										
5,600 pF	562	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GH										
6,800 pF	682	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB					JE	JE	JE		
8,200 pF	822	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB					JE	JE	JE		
10,000 pF	103	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB					JE	JE	JE		
12,000 pF	123	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB					JE	JE	JE		
15,000 pF	153	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB					JE	JE	JE		
18,000 pF	183	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB					JE	JE	JE		
22,000 pF	223	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JE	JE	JE		
27,000 pF	273	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JE	JE	JE		
Capacitance	Cap Code	Rated Voltage (VDC)	6.3	10	16	25	50	100	200	250	50	100	200	25	50	100	200	250	50	100	200	250	25	50	100	200	250
		Voltage Code	9	8	4	3	5	1	2	A	5	1	2	3	5	1	2	A	5	1	2	A	3	5	1	2	A
		Case Size/ Series	C1210T								C1808T			C1812T					C1825T				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)
***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'd

Capacitance	Cap Code	Case Size/ Series	C1210T								C1808T			C1812T					C1825T				C2220T				
		Voltage Code	9	8	4	3	5	1	2	A	5	1	2	3	5	1	2	A	5	1	2	A	3	5	1	2	A
		Rated Voltage (VDC)	6.3	10	16	25	50	100	200	250	50	100	200	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																								
33,000 pF	333	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JB		
39,000 pF	393	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JB		
47,000 pF	473	J K M	FB	FB	FB	FB	FB	FB	FB	FB	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JB		
56,000 pF	563	J K M	FB	FB	FB	FB	FB	FB	FC	FC	LD	LD		GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JB		
68,000 pF	683	J K M	FB	FB	FB	FB	FB	FB	FC	FC	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JB		
82,000 pF	823	J K M	FB	FB	FB	FB	FB	FC	FF	FF	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JC	JC	JC
0.10 µF	104	J K M	FB	FB	FB	FB	FB	FD	FG	FG	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JC	JC	JC
0.12 µF	124	J K M	FB	FB	FB	FB	FB	FD	FH	FH	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB	JB	JB	JC	JC	JC
0.15 µF	154	J K M	FC	FC	FC	FC	FC	FD	FM	FM	LD			GB	GB	GB	GE	GE	HB	HB	HB	HB	JB	JB	JC	JC	JC
0.18 µF	184	J K M	FC	FC	FC	FC	FC	FD	FK	FK	LD			GB	GB	GB	GG	GG	HB	HB	HB	HB	JB	JB	JC	JC	JC
0.22 µF	224	J K M	FC	FC	FC	FC	FC	FD	FK	FK				GB	GB	GB	GG	GG	HB	HB	HB	HB	JB	JB	JC	JC	JC
0.27 µF	274	J K M	FC	FC	FC	FC	FC	FD						GB	GB	GG	GG	GG	HB	HB	HB	HB	JC	JC	JC	JC	JC
0.33 µF	334	J K M	FD	FD	FD	FD	FD	FD						GB	GB	GG	GG	GG	HB	HB	HB	HB	JC	JC	JC	JC	JC
0.39 µF	394	J K M	FD	FD	FD	FD	FD	FD						GB	GB	GG	GG	GG	HD	HD	HD	HD	JC	JC	JC	JC	JC
0.47 µF	474	J K M	FD	FD	FD	FD	FD	FD						GB	GB	GG	GJ	GJ	HD	HD	HD	HD	JC	JC	JC	JC	JC
0.56 µF	564	J K M	FD	FD	FD	FD	FD	FF						GC	GC	GG			HD	HD	HD	HD	JC	JD	JD	JD	JD
0.68 µF	684	J K M	FD	FD	FD	FD	FD	FG						GC	GC	GG			HD	HD	HD	HD	JC	JD	JD	JD	JD
0.82 µF	824	J K M	FF	FF	FF	FF	FF	FL						GE	GE	GG			HF	HF	HF	HF	JC	JF	JF	JF	JF
1.0 µF	105	J K M	FH	FH	FH	FH	FH	FM						GE	GE	GG			HF	HF	HF	HF	JC	JF	JF	JF	JF
1.2 µF	125	J K M	FH	FH	FH	FH	FG																JC	JC			
1.5 µF	155	J K M	FH	FH	FH	FH	FG																JC	JC			
1.8 µF	185	J K M	FH	FH	FH	FH	FG																JD	JD			
2.2 µF	225	J K M	FJ	FJ	FJ	FJ	FG							GO	GO								JF	JF			
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							GK	GK								JF	JF			
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								GK									JF	JO			
12 µF	126	J K M																									
15 µF	156	J K M																					JO				
18 µF	186	J K M																									
22 µF	226	J K M	FS	FS																			JO				
Capacitance	Cap Code	Rated Voltage (VDC)	6.3	10	16	25	50	100	200	250	50	100	200	25	50	100	200	250	50	100	200	250	25	50	100	200	250
		Voltage Code	9	8	4	3	5	1	2	A	5	1	2	3	5	1	2	A	5	1	2	A	3	5	1	2	A
		Case Size/ Series	C1210T								C1808T			C1812T					C1825T				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)*
***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	4,000	10,000	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
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 out 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

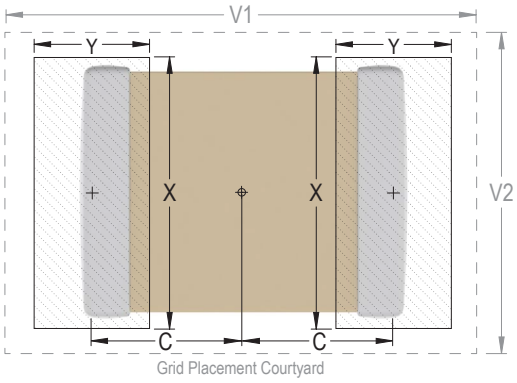
[1] *Only for capacitance values ≥ 22 µF*

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.

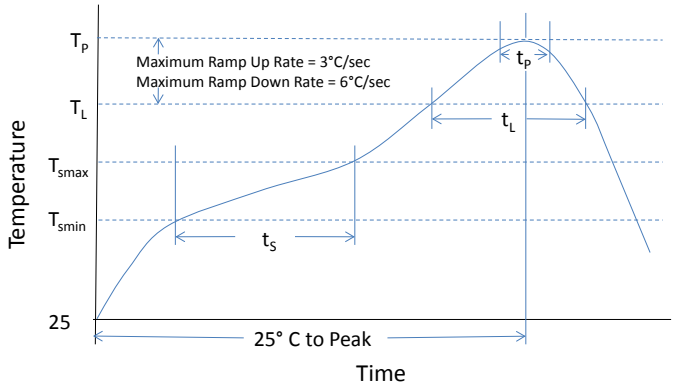


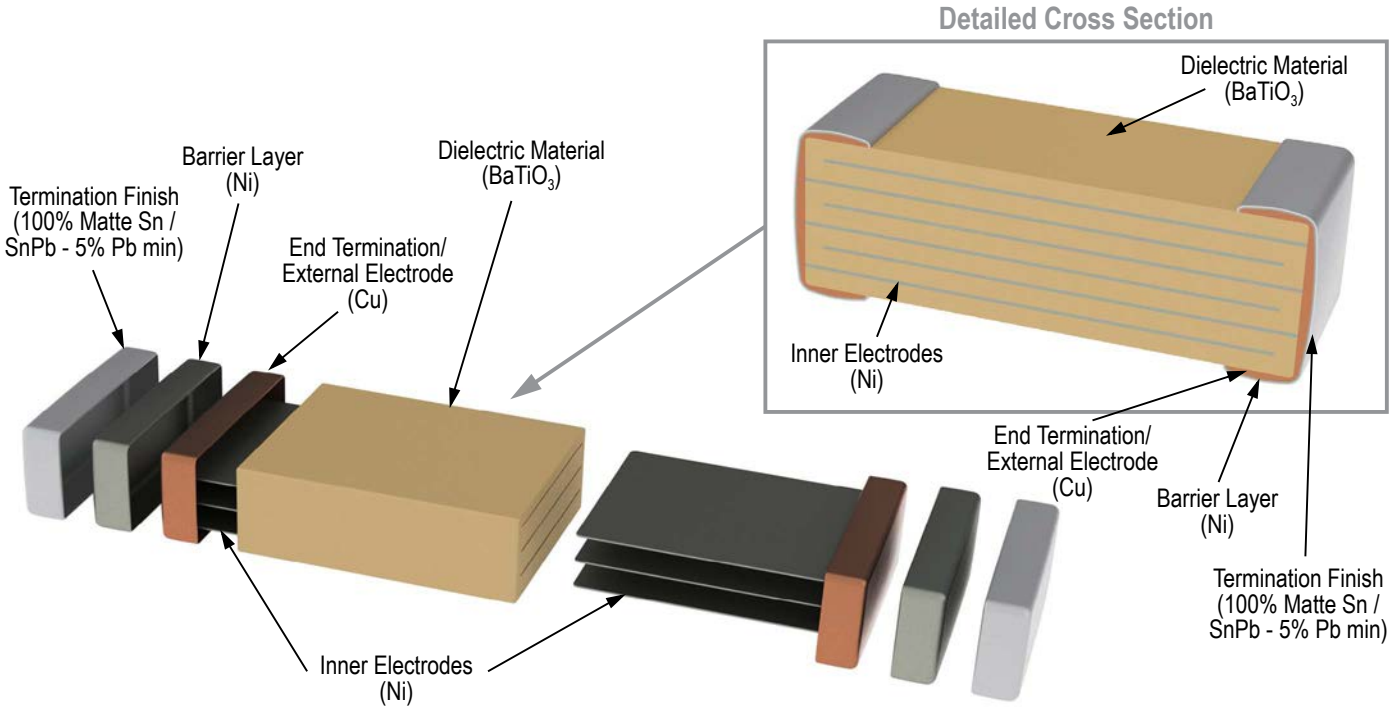
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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 +/- 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



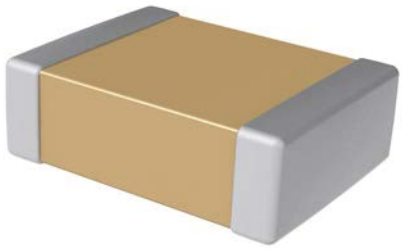
High Temperature 150°C, Ultra-Stable X8R Dielectric, 25 – 100 VDC (Commercial & Automotive Grade)

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 + number of zeros	F = ±1% G = ±2% J = ±5% K = ±10% M = ±20%	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" below

[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.*

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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 25 V, 50 V, and 100 V
- Capacitance offerings ranging from 100 pF to 0.22 µF
- Available capacitance tolerances of ±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's 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:

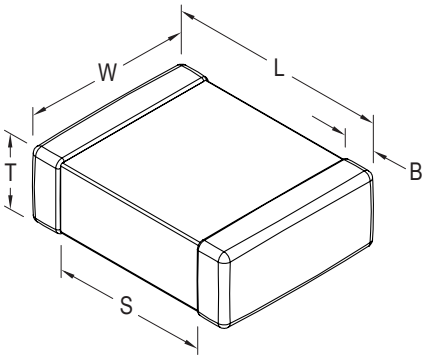
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design record and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

Qualification/Certification

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

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%
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 @ 25ºC	2.5%
Insulation Resistance (IR) Limit @ 25°C	1,000 megohm microfarads or 100 GΩ (Rated voltage applied for 120 ±5 seconds @ 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 Vrms if capacitance ≤ 1,000 pF.

1 kHz ±50 Hz and 1.0 ±0.2 Vrms 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					3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	5	1
		Rated Voltage (VDC)					25	50	100	25	50	100	25	50	100	25	50	100	25	50	100	50	100
		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														
110 pF	111	F	G	J	K	M	BB	BB	BB														
120 pF	121	F	G	J	K	M	BB	BB	BB														
130 pF	131	F	G	J	K	M	BB	BB	BB														
150 pF	151	F	G	J	K	M	BB	BB	BB														
160 pF	161	F	G	J	K	M	BB	BB	BB														
180 pF	181	F	G	J	K	M	BB	BB	BB														
200 pF	201	F	G	J	K	M	BB	BB	BB														
220 pF	221	F	G	J	K	M	BB	BB	BB														
240 pF	241	F	G	J	K	M	BB	BB	BB														
270 pF	271	F	G	J	K	M	BB	BB	BB														
300 pF	301	F	G	J	K	M	BB	BB	BB														
330 pF	331	F	G	J	K	M	BB	BB	BB														
360 pF	361	F	G	J	K	M	BB	BB	BB														
390 pF	391	F	G	J	K	M	BB	BB	BB														
430 pF	431	F	G	J	K	M	BB	BB	BB	CF	CF	CF											
470 pF	471	F	G	J	K	M	BB	BB	BB	CF	CF	CF											
510 pF	511	F	G	J	K	M	BB	BB	BB	CF	CF	CF											
560 pF	561	F	G	J	K	M	BB	BB	BB	CF	CF	CF											
620 pF	621	F	G	J	K	M	BB	BB	BB	CF	CF	CF											
680 pF	681	F	G	J	K	M	BB	BB	BB	CF	CF	CF											
750 pF	751	F	G	J	K	M	BB	BB	BB	CF	CF	CF											
820 pF	821	F	G	J	K	M	BB	BB	BB	CF	CF	CF											
910 pF	911	F	G	J	K	M	BB	BB	BB	CF	CF	CF											
1,000 pF	102	F	G	J	K	M	BB	BB	BB	CF	CF	CF											
1,100 pF	112	F	G	J	K	M	BB	BB		CF	CF	CF											
1,200 pF	122	F	G	J	K	M	BB	BB		CF	CF	CF											
1,300 pF	132	F	G	J	K	M	BB	BB		CF	CF	CF											
1,500 pF	152	F	G	J	K	M	BB	BB		CF	CF	CF											
1,600 pF	162	F	G	J	K	M				CF	CF	CF											
1,800 pF	182	F	G	J	K	M				CF	CF	CF											
2,000 pF	202	F	G	J	K	M				CF	CF	CF	DN	DN	DN								
2,200 pF	222	F	G	J	K	M				CF	CF	CF	DN	DN	DN								
2,400 pF	242	F	G	J	K	M				CF	CF	CF	DN	DN	DN								
2,700 pF	272	F	G	J	K	M				CF	CF	CF	DN	DN	DN								
3,000 pF	302	F	G	J	K	M				CF	CF	CF	DN	DN	DN								
3,300 pF	332	F	G	J	K	M				CF	CF	CF	DN	DN	DN								
3,600 pF	362	F	G	J	K	M				CF	CF	CF	DN	DN	DN								
3,900 pF	392	F	G	J	K	M				CF	CF	CF	DN	DN	DN								
4,300 pF	432	F	G	J	K	M				CF	CF	CF	DN	DN	DN								
4,700 pF	472	F	G	J	K	M				CF	CF	CF	DN	DN	DN								
5,100 pF	512	F	G	J	K	M				CF	CF		DN	DN	DN								
5,600 pF	562	F	G	J	K	M				CF	CF		DN	DN	DN								
6,200 pF	622	F	G	J	K	M				CF	CF		DN	DN	DN								
6,800 pF	682	F	G	J	K	M				CF	CF		DN	DN	DN	EB	EB	EB					
7,500 pF	752	F	G	J	K	M				CF			DN	DN	DN	EB	EB	EB					
8,200 pF	822	F	G	J	K	M				CF			DN	DN	DN	EB	EB	EB					
9,100 pF	912	F	G	J	K	M				CF			DN	DN	DN	EB	EB	EB					
10,000 pF	103	F	G	J	K	M				CF			DN	DN	DP	EB	EB	EB					
12,000 pF	123	F	G	J	K	M							DN	DN	DE	EB	EB	EB	FB	FB	FB		
15,000 pF	153	F	G	J	K	M							DN	DP	DG	EB	EB	EB	FB	FB	FB	GB	GB
18,000 pF	183	F	G	J	K	M							DN	DP		EB	EB	EB	FB	FB	FB	GB	GB
22,000 pF	223	F	G	J	K	M							DP	DF		EB	EB	EC	FB	FB	FB	GB	GB
27,000 pF	273	F	G	J	K	M							DF			EB	EB	EE	FB	FB	FB	GB	GB
33,000 pF	333	F	G	J	K	M							DG			EB	EB	EE	FB	FB	FB	GB	GB
Capacitance	Cap Code	Rated Voltage (VDC)					25	50	100	25	50	100	25	50	100	25	50	100	25	50	100	50	100
		Voltage Code					3	5	1	3	5	1	3	5	1	3	5	1	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'd

Capacitance	Cap Code	Case Size/ Series	C0402C			C0603C			C0805C			C1206C			C1210C			C1812C	
		Voltage Code	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	5	1
		Rated Voltage (VDC)	25	50	100	25	50	100	25	50	100	25	50	100	25	50	100	50	100
		Capacitance Tolerance	Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																
47,000 pF	473	F G J K M										EC	EE	EH	FB	FB	FE	GB	GB
56,000 pF	563	F G J K M										ED	EF	EH	FB	FB	FF	GB	GB
68,000 pF	683	F G J K M										EF	EH		FB	FC	FG	GB	GB
82,000 pF	823	F G J K M										EH	EH		FC	FF	FH	GB	GB
100,000 pF	104	F G J K M										EH			FE	FG	FM	GB	GD
120,000 pF	124	F G J K M													FG	FH		GB	GH
150,000 pF	154	F G J K M													FH	FM		GD	GN
180,000 pF	184	F G J K M													FJ			GH	
220,000 pF	224	F G J K M																GK	
Capacitance	Cap Code	Rated Voltage (VDC)	25	50	100	25	50	100	25	50	100	25	50	100	25	50	100	50	100
		Voltage Code	3	5	1	3	5	1	3	5	1	3	5	1	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	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
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
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 out 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

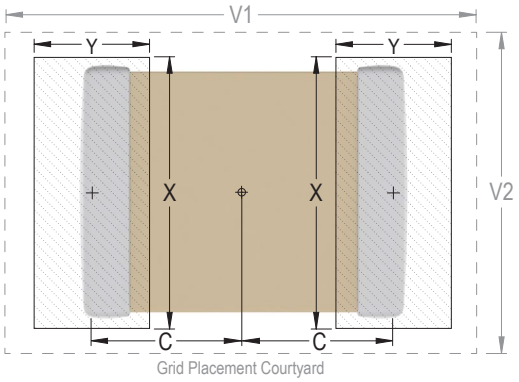
[1] *Only for capacitance values ≥ 22 µF*

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.

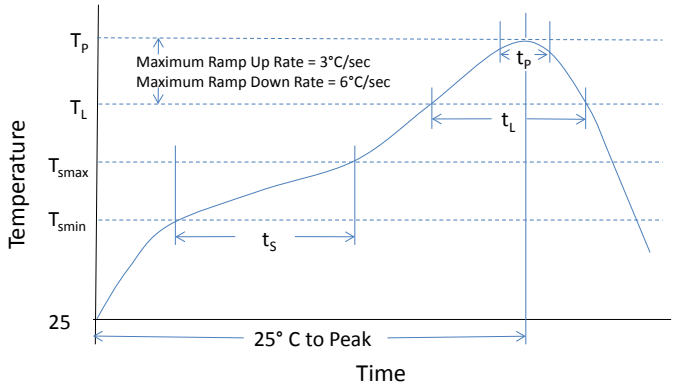


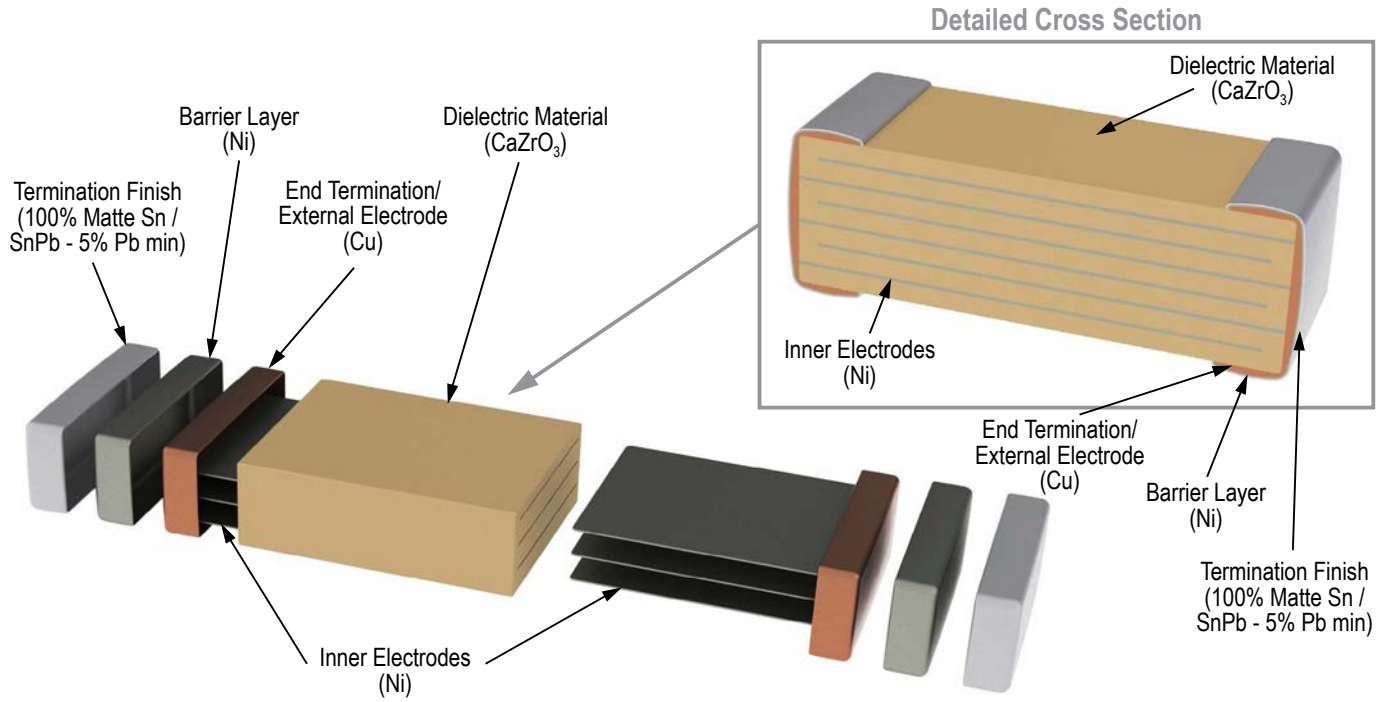
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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 +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



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.

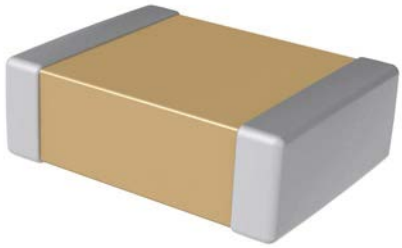
High Temperature 150°C, X8L Dielectric, 10 – 50 VDC (Commercial & Automotive Grade)

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 + number of zeros	J = ±5% K = ±10% M = ±20%	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" below

[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.*

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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 and smaller case sizes) 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 & 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's 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:

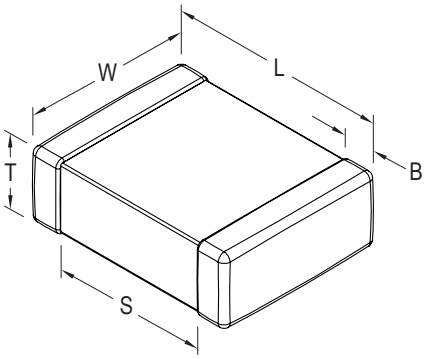
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design record and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

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)	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 (0.020) ±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

Qualification/Certification

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

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 @ 25°C	3.5% (≤ 16V) and 2.5% (≥ 25V)
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	500 megohm microfarads or 10 GΩ (Rated voltage applied for 120 ±5 seconds @ 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		

Insulation Resistance Limit Table (X8L Dielectric)

EIA Case Size	1,000 Megohm Microfarads or 100 GΩ	500 Megohm Microfarads or 10 GΩ
0201	N/A	ALL
0402	< .012 µF	≥ .012 µF
0603	< .047 µF	≥ .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 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																						
33,000 pF	333	J	K	M	BB	BB																						
39,000 pF	393	J	K	M	BB	BB																						
47,000 pF	473	J	K	M	BB	BB			CF	CF	CF	CF	CF															
56,000 pF	563	J	K	M																								
68,000 pF	683	J	K	M																								
82,000 pF	823	J	K	M																								
0.10 µF	104	J	K	M					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				DG	DG	DG	DG	DG										
0.22 µF	224	J	K	M					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 out 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.

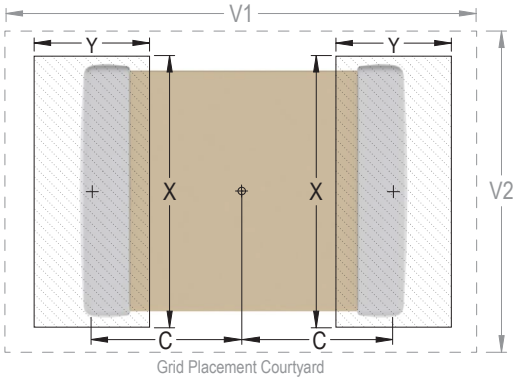
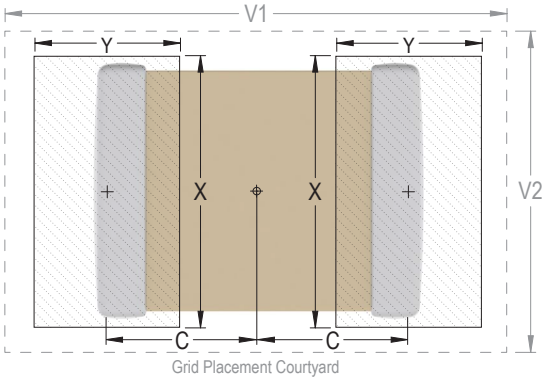


Table 3B – Land Pattern Design Recommendations per IPC–7351 – Flexible Termination

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.

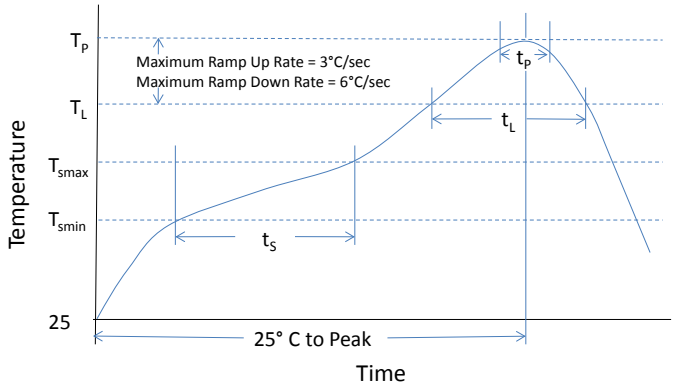


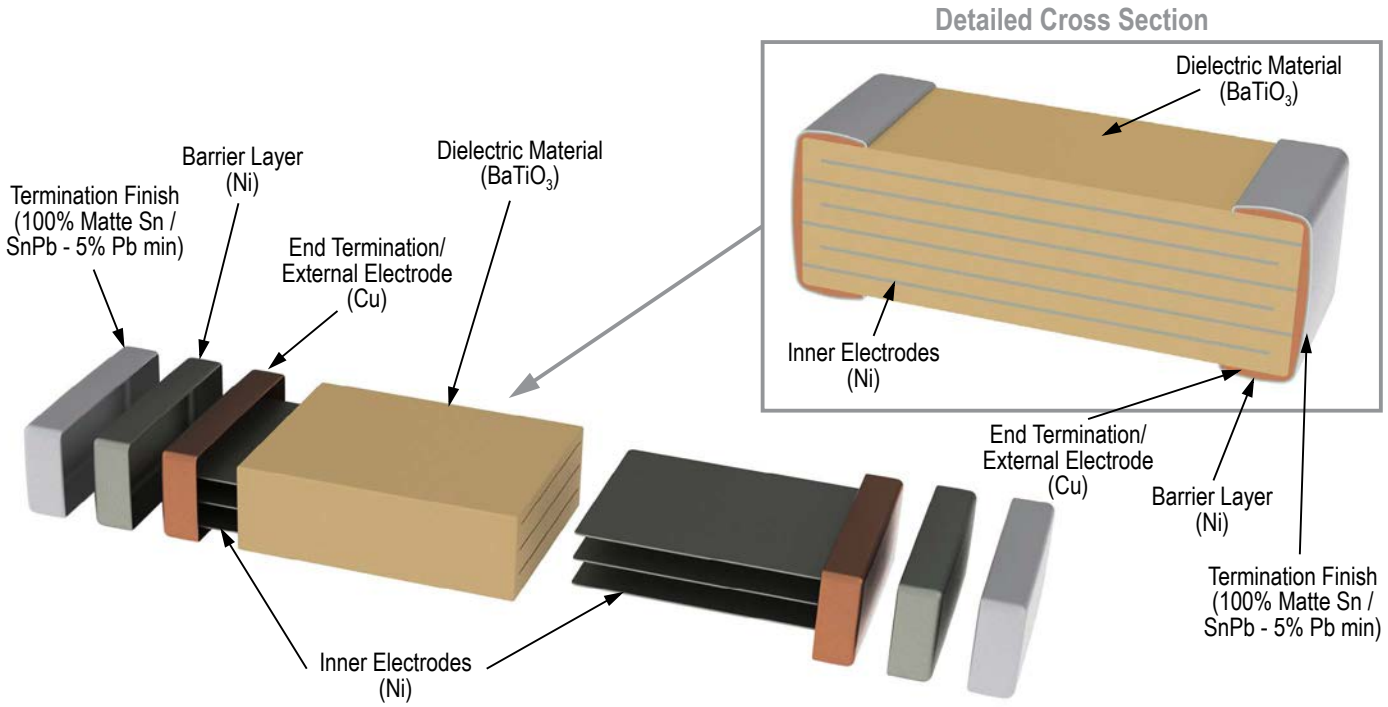
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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 +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.

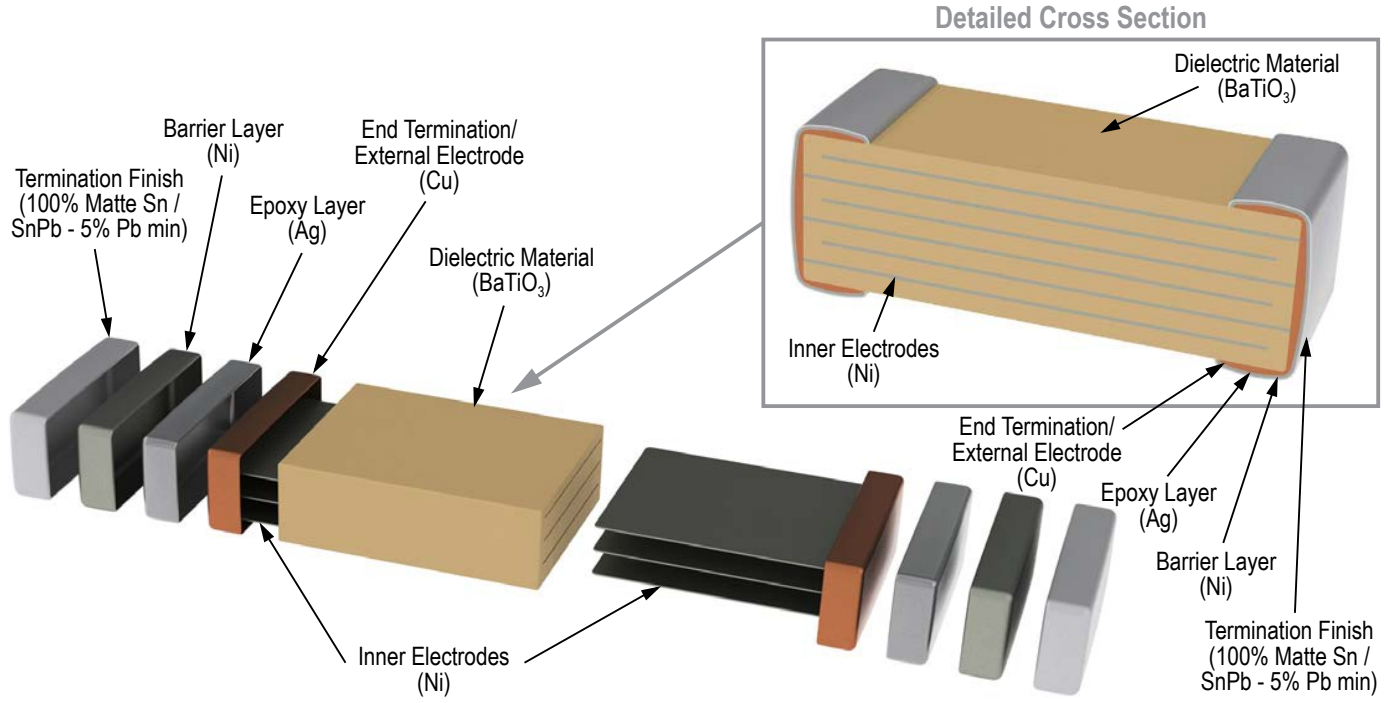
Storage and Handling

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



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

Overview

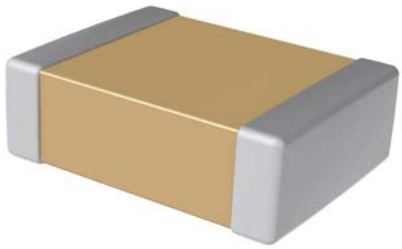
KEMET's 250V DC Tip and Ring MLCCs in X7R dielectric are designed and rated for telecommunication ringer circuits where the capacitor is used to block -48V to -52V DC of line voltage and pass a 16-25 Hz AC signal pulse of 70 Vrms to 90 Vrms. Serving as an excellent replacement for high voltage leaded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

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 0805, 1206, 1210, 1812, 1825, 2220, and 2225 case sizes
- DC voltage rating of 250 V
- Capacitance offerings ranging from 1,000 pF to 6.8 µF
- Available capacitance tolerances of ±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



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)
	0805 1206 1210 1812 1825 2220 2225	C = Standard X = Flexible Termination	Two significant digits + number of zeros	J = ±5% K = ±10% M = ±20%	A = 250	R = X7R	A = N/A	C = 100% Matte Sn L = SnPb (5% Pb minimum)	See "Packaging C-Spec Ordering Options Table" below

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

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Packaging C-Spec Ordering Options Table

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

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.

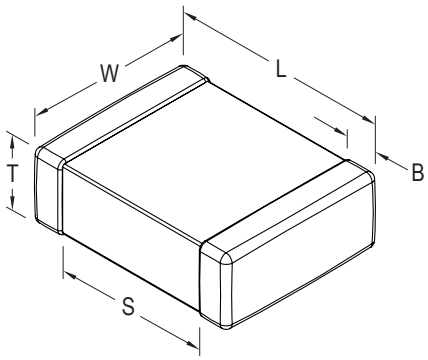
Qualification/Certification

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).

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 (.079) ± 0.20 (.008)	1.25 (.049) ± 0.20 (.008)	See Table 2 for Thickness	0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	Solder Wave or Solder Reflow
1206	3216	3.20 (.126) ± 0.20 (.008)	1.60 (.063) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)	N/A	
1210	3225	3.20 (.126) ± 0.20 (.008)	2.50 (.098) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)		Solder Reflow Only
1812	4532	4.50 (.177) ± 0.30 (.012)	3.20 (.126) ± 0.30 (.012)		0.60 (.024) ± 0.35 (.014)		
1825	4564	4.50 (.177) ± 0.30 (.012)	6.40 (.252) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2220	5650	5.70 (.224) ± 0.40 (.016)	5.00 (.197) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2225	5664	5.60 (.220) ± 0.40 (.016)	6.40 (.248) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.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 (.079) ± 0.30 (.012)	1.25 (.049) ± 0.30 (.012)	See Table 2 for Thickness	0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	Solder Wave or Solder Reflow
1206	3216	3.30 (.130) ± 0.40 (.016)	1.60 (.063) ± 0.35(.013)		0.60 (.024) ± 0.25 (.010)	N/A	
1210	3225	3.30 (.130) ± 0.40 (.016)	2.60(.102) ± 0.30(.012)		0.60 (.024) ± 0.25 (.010)		Solder Reflow Only
1812	4532	4.50 (.178) ± 0.40 (.016)	3.20 (.126) ± 0.30 (.012)		0.70 (.028) ± 0.35 (.014)		
1825	4564	4.60 (.181) ± 0.40 (.016)	6.40 (.252) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		
2220	5650	5.90 (.232) ± 0.75 (.030)	5.00 (.197) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		
2225	5664	5.90 (.232) ± 0.75 (.030)	6.40 (.248) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.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 @ 25°C	5%(6.3V & 10V), 3.5%(16V & 25V) and 2.5%(50V to 250V)
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (Rated voltage applied for 120 ± 5 secs @ 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
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 1 – Capacitance Range/Selection Waterfall (0805 – 2225 Case Sizes)

Capacitance	Capacitance Code	Case Size/ Series			C0805C	C1206C	C1210C	C1812C	C1825C	C2220C	C2225C
		Voltage Code			A	A	A	A	A	A	A
		Rated Voltage (VDC)			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	DR	EQ					
1,200 pF	122	J	K	M	DR	EQ					
1,500 pF	152	J	K	M	DR	EQ					
1,800 pF	182	J	K	M	DR	EQ					
2,200 pF	222	J	K	M	DR	EQ	FN				
2,700 pF	272	J	K	M	DR	EQ	FN				
3,300 pF	332	J	K	M	DR	EQ	FN				
3,900 pF	392	J	K	M	DR	EQ	FN				
4,700 pF	472	J	K	M	DR	EQ	FN				
5,600 pF	562	J	K	M	DR	EQ	FN				
6,800 pF	682	J	K	M	DR	EQ	FN	GB			
8,200 pF	822	J	K	M	DR	EQ	FN	GB			
10,000 pF	103	J	K	M	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		EQ	FN	GB	HB		
33,000 pF	333	J	K	M		EQ	FN	GB	HB		
39,000 pF	393	J	K	M		EQ	FN	GB	HB		
47,000 pF	473	J	K	M		ES	FQ	GB	HB		KC
56,000 pF	563	J	K	M		ES	FQ	GB	HB		KC
68,000 pF	683	J	K	M		ES	FQ	GB	HB		KC
82,000 pF	823	J	K	M		ES	FA	GB	HB	JC	KC
0.10 µF	104	J	K	M		EM	FZ	GB	HB	JC	KC
0.12 µF	124	J	K	M			FU	GB	HB	JC	KC
0.15 µF	154	J	K	M			FM	GE	HB	JC	KC
0.18 µF	184	J	K	M			FK	GG	HB	JC	KC
0.22 µF	224	J	K	M			FK	GG	HB	JC	KC
0.27 µF	274	J	K	M				GG	HB	JC	KC
0.33 µF	334	J	K	M				GG	HB	JC	KC
0.39 µF	394	J	K	M				GG	HD	JC	KC
0.47 µF	474	J	K	M				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
		Voltage Code			A	A	A	A	A	A	A
		Case Size/Series			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
DR	0805	0.78 ± 0.20	0	0	4,000	10,000
EQ	1206	0.78 ± 0.20	4,000	10,000	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
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
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
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 out 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.

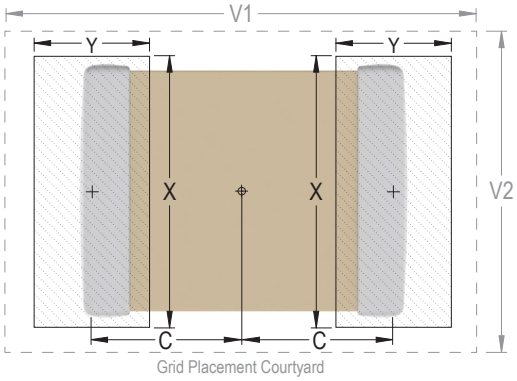
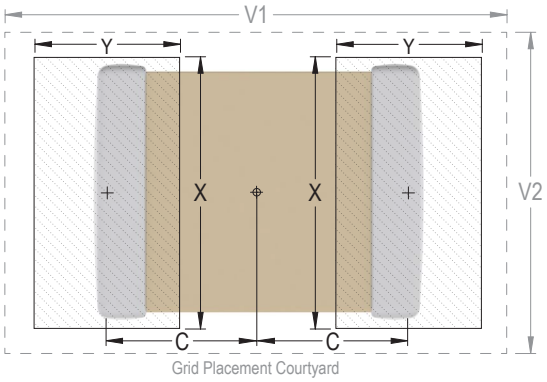


Table 3B – Land Pattern Design Recommendations per IPC–7351 – Flexible Termination

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

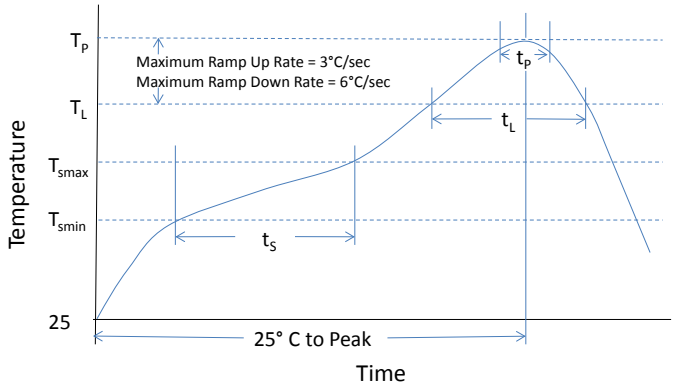


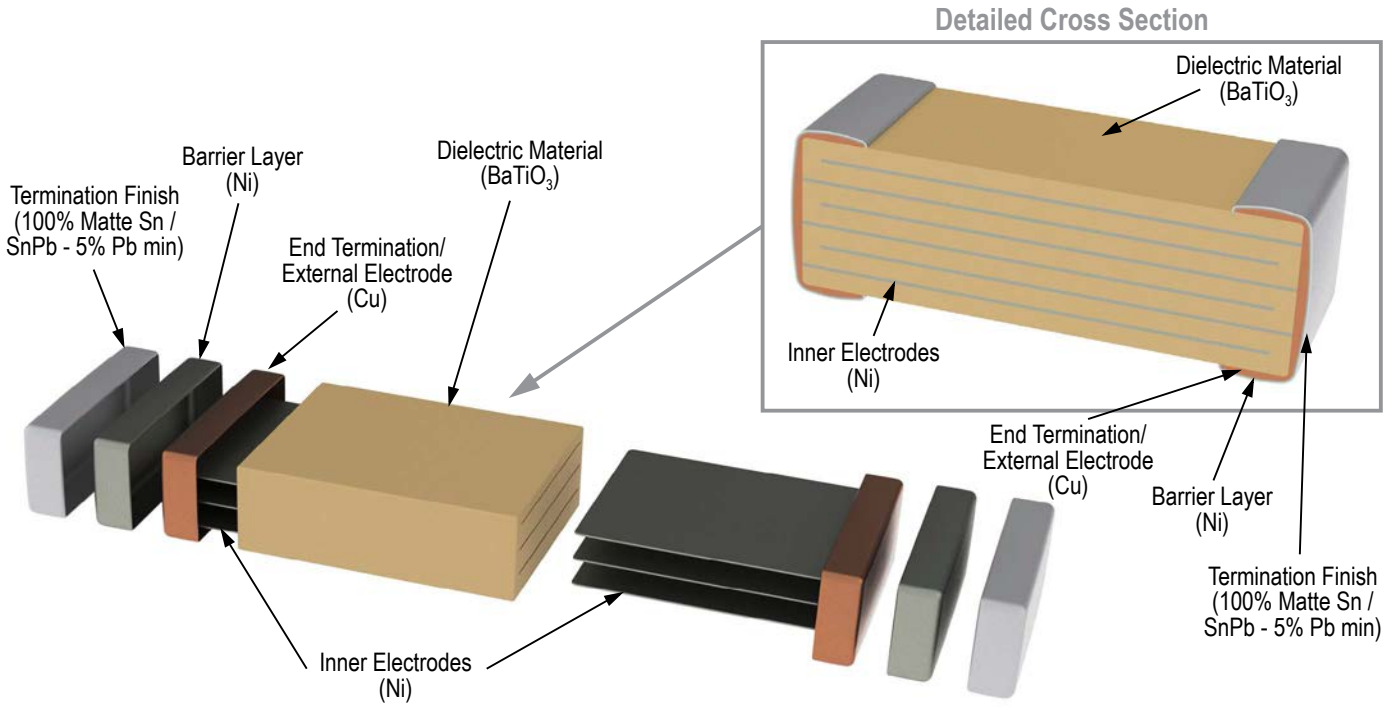
Table 4 – Performance & Reliability: Test Methods and Conditions

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 +/- 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.

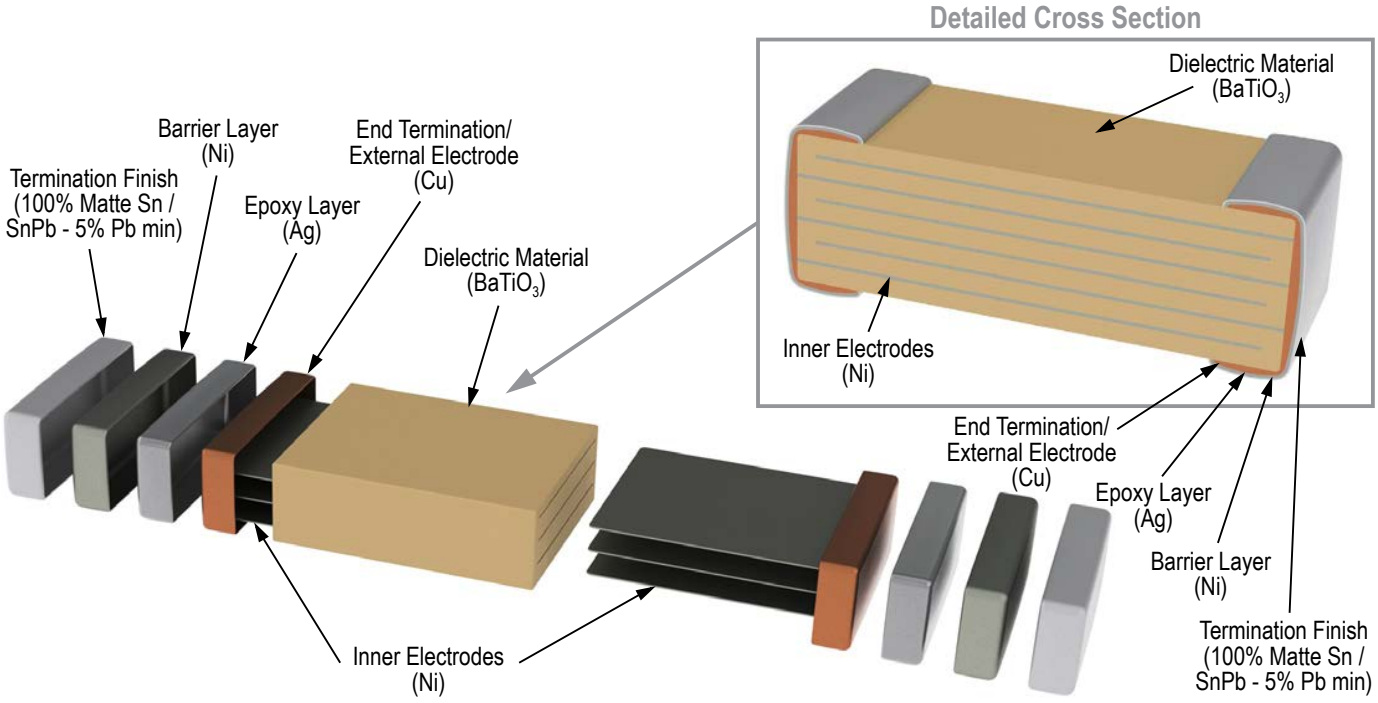
Storage and Handling

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



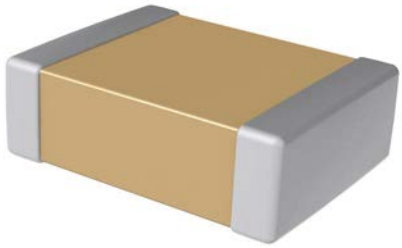
Open Mode Design (FO-CAP), X7R Dielectric, 16 – 200 VDC (Commercial & Automotive Grade)

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 + 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" below

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

[1] *SnPb termination finish option is not available on automotive grade product.*

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Packaging C-Spec Ordering Options Table

Packaging Type	Packaging/Grade Ordering Code (C-Spec)
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 and smaller case sizes) 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's 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:

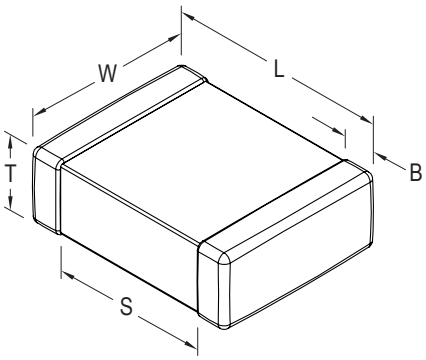
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design record and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that 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 (.079) ± 0.20 (.008)	1.25 (.049) ± 0.20 (.008)	See Table 2 for Thickness	0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	Solder Wave or Solder Reflow
1206	3216	3.20 (.126) ± 0.20 (.008)	1.60 (.063) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)	N/A	
1210	3225	3.20 (.126) ± 0.20 (.008)	2.50 (.098) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)		Solder Reflow Only
1812	4532	4.50 (.177) ± 0.30 (.012)	3.20 (.126) ± 0.30 (.012)		0.60 (.024) ± 0.35 (.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 (.079) ± 0.30 (.012)	1.25 (.049) ± 0.30 (.012)	See Table 2 for Thickness	0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	Solder Wave or Solder Reflow
1206	3216	3.30 (.130) ± 0.40 (.016)	1.60 (.063) ± 0.35 (.013)		0.60 (.024) ± 0.25 (.010)	N/A	
1210	3225	3.30 (.130) ± 0.40 (.016)	2.60 (.102) ± 0.30 (.012)		0.60 (.024) ± 0.25 (.010)		Solder Reflow Only
1812	4532	4.50 (.178) ± 0.40 (.016)	3.20 (.126) ± 0.30 (.012)		0.70 (.028) ± 0.35 (.014)		

Qualification/Certification

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

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.

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 @ 25°C	5%(6.3V & 10V), 3.5%(16V & 25V) and 2.5%(50V to 250V)
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (Rated voltage applied for 120 ± 5 secs @ 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 1 – Capacitance Range/Selection Waterfall (0805 – 1812 Case Sizes)

Capacitance	Capacitance Code	Case Size/ Series		C0805F					C1206F					C1210F					C1812F			
		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		EC	EC	EC	EC	EC									
22,000 pF	223	K	M	DP	DP	DP	DG		EC	EC	EC	EC	EC									
27,000 pF	273	K	M	DP	DP	DP	DG		EC	EC	EC	EC	EC									
33,000 pF	333	K	M	DP	DP	DP	DG		EC	EC	EC	EC	EC									
39,000 pF	393	K	M	DP	DP	DP	DG		EC	EC	EC	EC	EC									
47,000 pF	473	K	M	DP	DP	DP	DE		EC	EC	EC	EC	EG						GB	GB	GB	GB
56,000 pF	563	K	M	DP	DP	DP			EC	EC	EC	EC	EG						GB	GB	GB	GB
68,000 pF	683	K	M	DP	DP	DG	DG		EC	EC	EC	EC	EG	FD	FD	FD	FD	FD	GB	GB	GB	GB
82,000 pF	823	K	M	DP	DP	DG			EC	EC	EC	EC	EG	FD	FD	FD	FD	FD	GB	GB	GB	GB
0.10 µF	104	K	M	DG	DG	DG			EC	EC	EC	EC	EG	FD	FD	FD	FD	FG	GB	GB	GB	GB
0.12 µF	124	K	M	DG	DG				EC	EC	EC	EC		FD	FD	FD	FD	FG	GB	GB	GB	GB
0.15 µF	154	K	M	DG	DG				EC	EC	EC	EG		FD	FD	FD	FD	FH	GB	GB	GB	GB
0.18 µF	184	K	M	DG	DG				EC	EC	EC	EG		FD	FD	FD	FD	FH	GB	GB	GB	GB
0.22 µF	224	K	M	DG	DP	DG			EC	EC	EC	ED		FD	FD	FD	FG	FS	GB	GB	GB	GC
0.27 µF	274	K	M	DP	DP				EC	EC	EC			FD	FD	FD	FG		GB	GB	GB	GF
0.33 µF	334	K	M	DP	DG				EG	EG	EG	EG		FD	FD	FD	FH		GB	GB	GB	GK
0.39 µF	394	K	M	DP	DG				EG	EG				FD	FD	FG	FH		GB	GB	GB	GL
0.47 µF	474	K	M	DE	DG				EG	EG	EC			FD	FD	FG	FJ		GB	GB	GC	
0.56 µF	564	K	M						EG					FD	FD	FG	FR		GB	GB	GD	
0.68 µF	684	K	M	DG					EG					FD	FG	FH	FR		GD	GD	GF	
0.82 µF	824	K	M						EG					FD	FG	FH	FR		GD	GD	GK	
1.0 µF	105	K	M						EG	EC	EH			FD	FH	FJ	FS		GN	GN	GM	
1.2 µF	125	K	M											FG								
1.5 µF	155	K	M											FH								
1.8 µF	185	K	M											FH								
2.2 µF	225	K	M						EC	EH				FJ	FM	FM						
2.7 µF	275	K	M																			
3.3 µF	335	K	M											FM								
3.9 µF	395	K	M																			
4.7 µF	475	K	M						EH					FG	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					C1206F					C1210F					C1812F			

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
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
EC	1206	0.90 ± 0.10	0	0	4,000	10,000
ED	1206	1.00 ± 0.10	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
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
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 – 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 out 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.

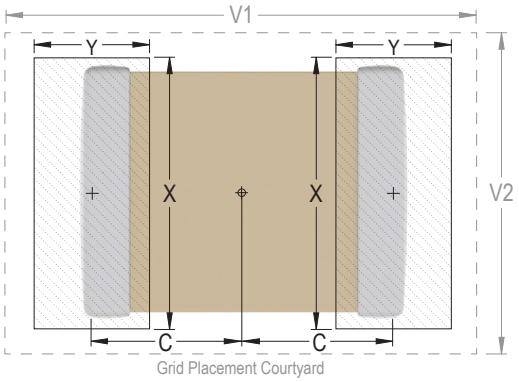
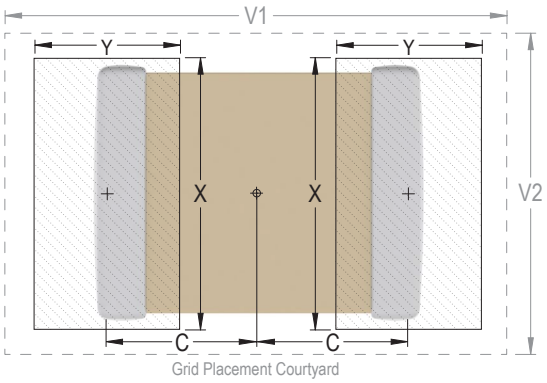


Table 3B – Land Pattern Design Recommendations per IPC–7351 – Flexible Termination

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.

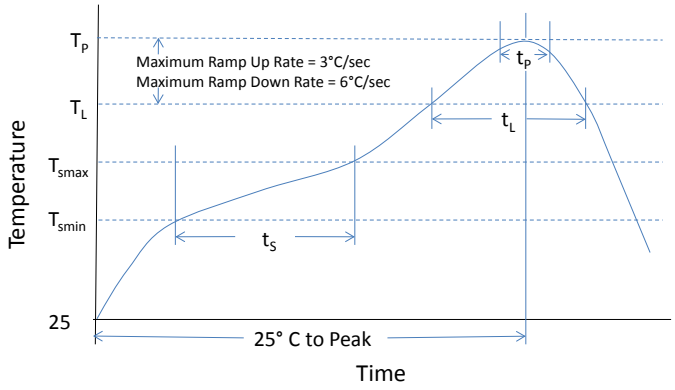


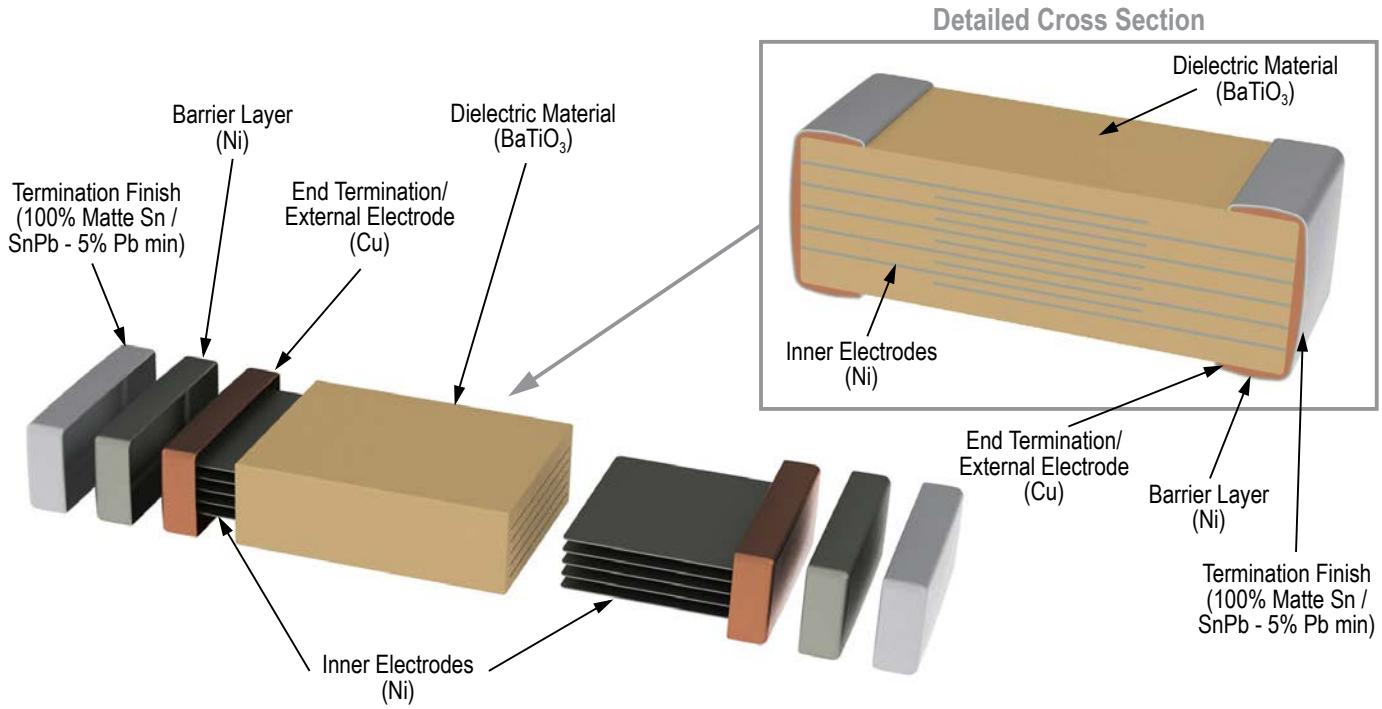
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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 +/- 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.

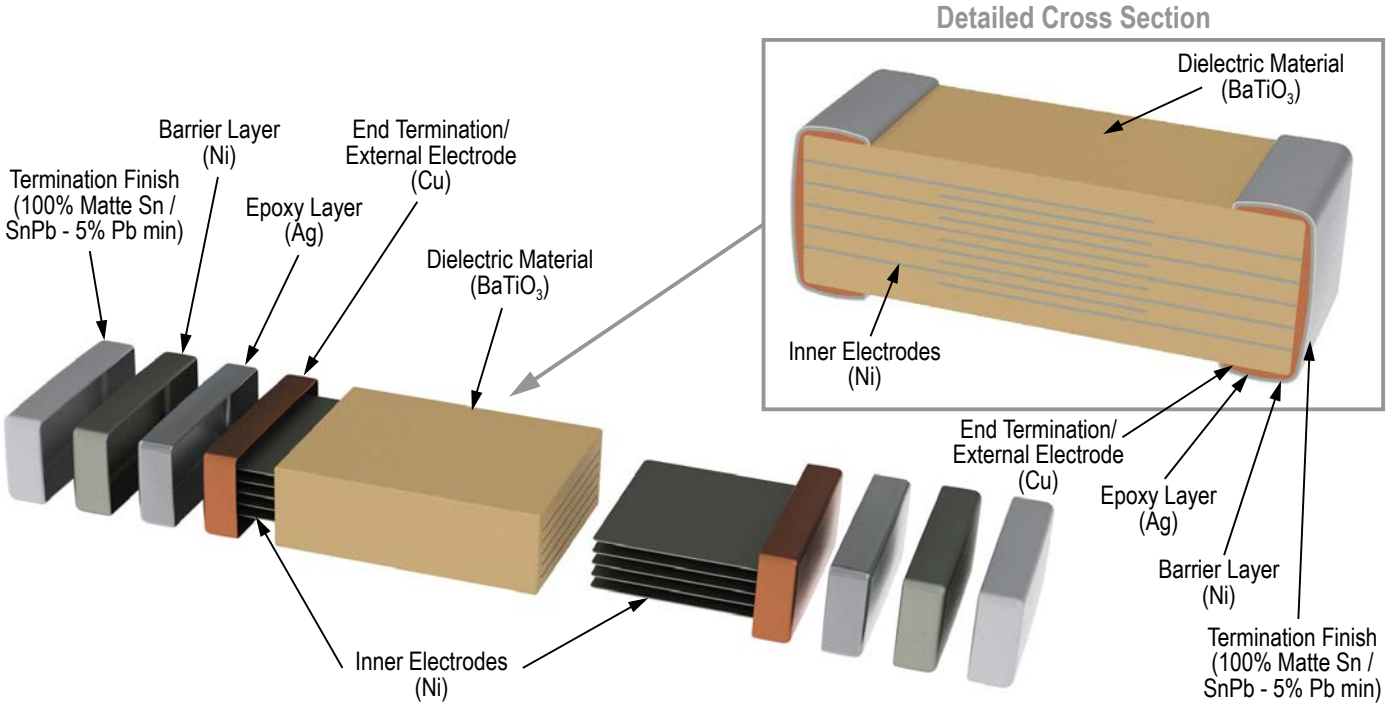
Storage and Handling

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



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

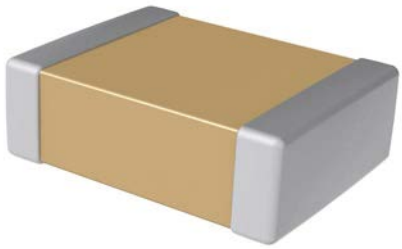
Overview

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 + 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" below

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

[1] *SnPb termination finish option is not available on automotive grade product.*

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Packaging C-Spec Ordering Options Table

Packaging Type	Packaging/Grade Ordering Code (C-Spec)
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 and smaller case sizes) 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's 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:

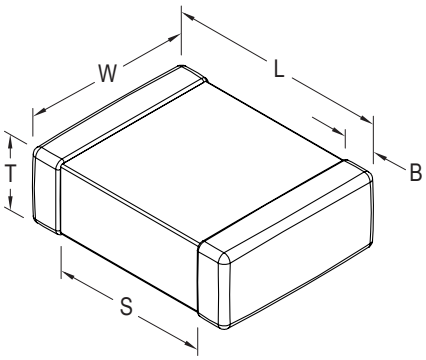
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design record and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that 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 (.126) ±0.20 (.008)	1.60 (0.063) ± 0.20 (0.008)		0.50 (0.02) ±0.25 (0.010)	N/A	
1210	3225	3.20 (.126) ±0.20 (.008)	2.50 (0.098) ± 0.20 (0.008)		0.50 (0.02) ±0.25 (0.010)		Solder Reflow Only
1812	4532	4.50 (.177) ±0.30 (.012)	3.20 (0.126) ± 0.30 (0.012)		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 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.

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 @ 25°C	5%(6.3V & 10V), 3.5%(16V & 25V) and 2.5%(50V to 250V)
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (Rated voltage applied for 120 ± 5 secs @ 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	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
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 out 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

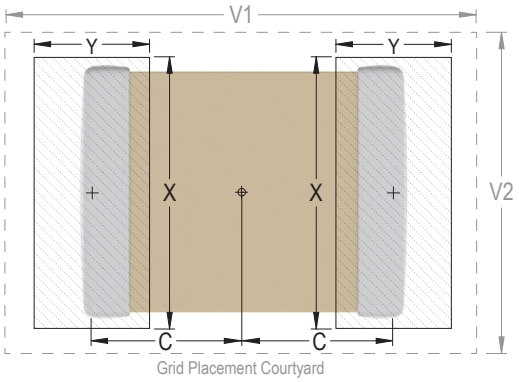
[1] *Only for capacitance values ≥ 22 µF*

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.

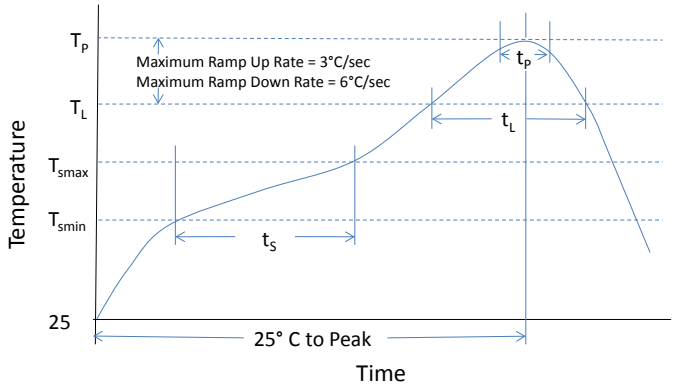


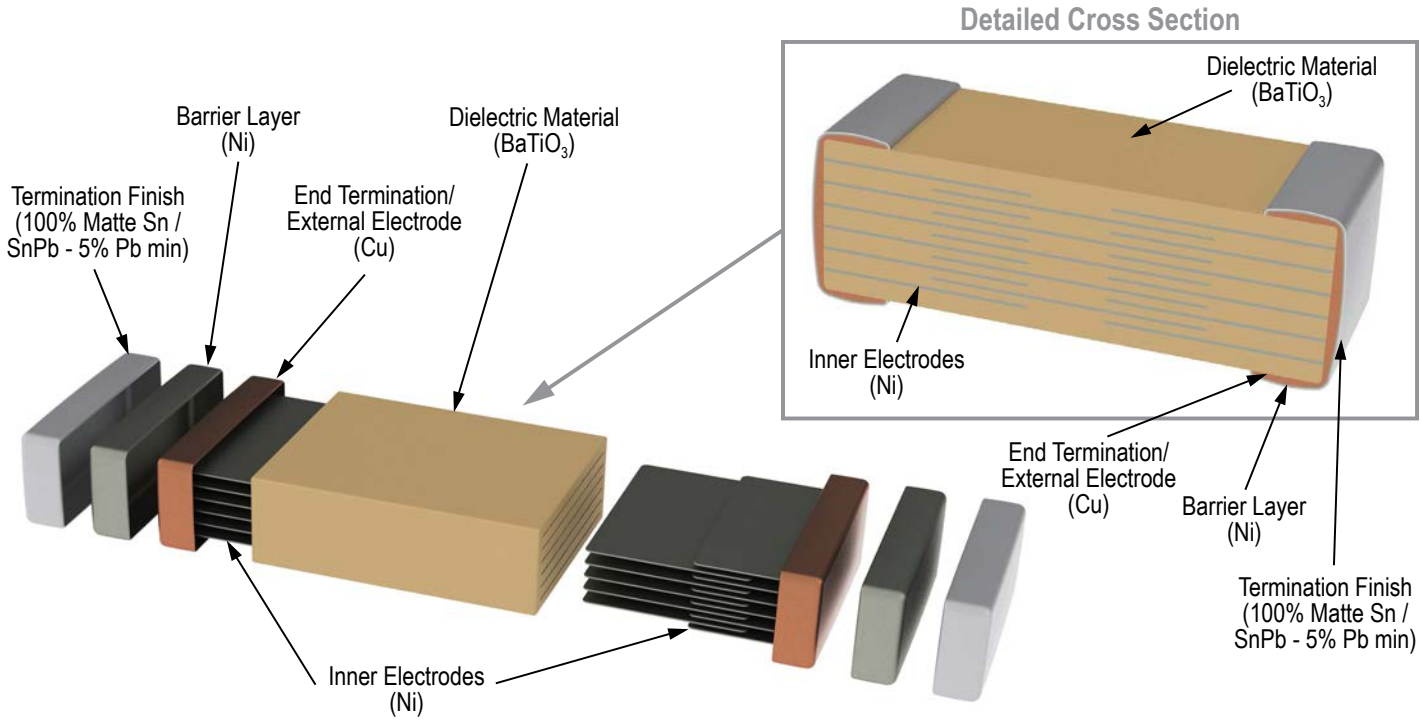
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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 +/- 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



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

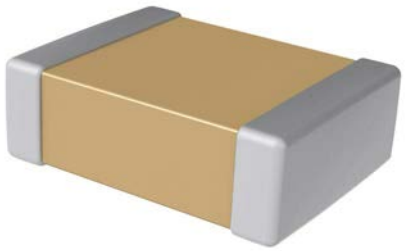
Overview

KEMET's 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.

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 + 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" below

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

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Packaging C-Spec Ordering Options Table

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

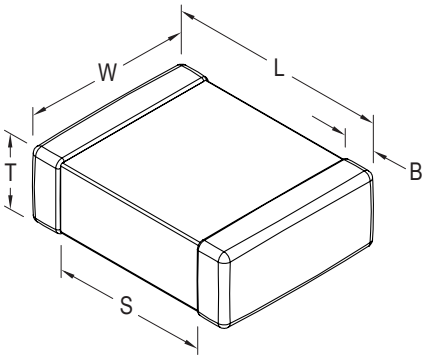
Benefits

- −55°C to +125°C operating temperature range
- 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	1608	1.60 (.063) ± 0.17 (.007)	0.80 (.032) ± 0.15 (.006)	See Table 2 for Thickness	0.45 (.018) ± 0.15 (.006)	0.58 (.023)	Solder Wave or Solder Reflow
0805	2012	2.00 (.079) ± 0.30 (.012)	1.25 (.049) ± 0.30 (.012)		0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	
1206	3216	3.30 (.130) ± 0.40 (.016)	1.60 (.063) ± 0.35 (.013)		0.60 (.024) ± 0.25 (.010)	N/A	
1210	3225	3.30 (.130) ± 0.40 (.016)	2.60 (.102) ± 0.30 (.012)		0.60 (.024) ± 0.25 (.010)		Solder Reflow Only
1808	4520	4.70 (.185) ± 0.50 (.020)	2.00 (.079) ± 0.20 (.008)		0.70 (.028) ± 0.35 (.014)		
1812	4532	4.50 (.178) ± 0.40 (.016)	3.20 (.126) ± 0.30 (.012)		0.70 (.028) ± 0.35 (.014)		
1825	4564	4.60 (.181) ± 0.40 (.016)	6.40 (.252) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		
2220	5650	5.90 (.232) ± 0.75 (.030)	5.00 (.197) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		
2225	5664	5.90 (.232) ± 0.75 (.030)	6.40 (.248) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.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)	±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 @ 25°C	5%(6.3V & 10V), 3.5%(16V & 25V) and 2.5%(50V to 250V)
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (Rated voltage applied for 120 ± 5 secs @ 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 – 1210 Case Sizes)

Cap	Cap Code	Case Size/ Series	C0603X							C0805X								C1206X								C1210X							
		Voltage Code	9	8	4	3	5	1	2	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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		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		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		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		EQ	EQ	EQ	EQ	EQ	ER	ES	ES	FN	FN	FN	FN	FN	FN	FQ	FQ
56,000 pF	563	J K M	CJ	CJ	CJ	CJ	CJ			DD	DD	DD	DD	DD	DS	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			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		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		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			FQ	FQ	FQ	FQ	FQ	FX	FK	FK
0.22 µF	224	J K M	CJ	CJ	CJ	CJ				DR	DR	DR	DR	DG	DG			ER	ER	ER	ER	ER	ER			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		
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		
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		
0.47 µF	474	J K M	CJ	CJ	CJ					DG	DG	DG	DG	DS				ER	ER	ER	ER	ER	EU			FX	FX	FX	FX	FX	FX		
0.56 µF	564	J K M								DD	DD	DD	DG	DH				ES	ES	ES	ES	ER				FX	FX	FX	FX	FX	FA		
0.68 µF	684	J K M								DD	DD	DD	DG	DH				ET	ET	ET	ET	ES				FX	FX	FX	FX	FX	FZ		
0.82 µF	824	J K M								DD	DD	DD	DG					EF	EF	EF	EF	ES				FA	FA	FA	FA	FA	FL		
1.0 µF	105	J K M								DD	DD	DD	DG					EF	EF	EF	EU	ES				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			
1.5 µF	155	J K M								DG	DG	DG						EF	EF	EF	EU	EH				FU	FU	FU	FU	FZ			
1.8 µF	185	J K M								DG	DG	DG						ES	ES	ES	EF	EH				FU	FU	FU	FU	FZ			
2.2 µF	225	J K M								DG	DG	DG						ES	ES	ES	EF	EH				FJ	FJ	FJ	FJ	FZ			
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																EF	EF	EF	EH					FQ	FQ	FQ	FZ	FS			
5.6 µF	565	J K M																EH	EH	EH						FA	FA	FA	FU				
Cap	Cap Code	Rated Voltage (VDC)	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	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	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'd

Cap	Cap Code	Case Size/ Series	C0603X							C0805X								C1206X								C1210X							
		Voltage Code	9	8	4	3	5	1	2	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	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																															
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																EH	EH	EH						FU	FU	FU	FS				
12 µF	126	J K M																															
15 µF	156	J K M																															
18 µF	186	J K M																								FS	FS						
22 µF	226	J K M																															
Cap	Cap Code	Rated Voltage (VDC)	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	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	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						KC	KC	KC	KC
56,000 pF	563	J K M	LD	LD			GB	GB	GB	GB	GB	HB	HB	HB	HB						KC	KC	KC	KC
68,000 pF	683	J K M	LD				GB	GB	GB	GB	GB	HB	HB	HB	HB						KC	KC	KC	KC
82,000 pF	823	J K M	LD				GB	GB	GB	GB	GB	HB	HB	HB	HB	JC	JC	JC	JC	JC	KC	KC	KC	KC
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										HB				JC	JC				KB	KE	KE	KE
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 1B – Capacitance Range/Selection Waterfall (1808 – 2225 Case Sizes) cont'd

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																					
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			
2.7 µF	275	J K M																						
3.3 µF	335	J K M																						
3.9 µF	395	J K M																						
4.7 µF	475	J K M					GK	GK																
5.6 µF	565	J K M																						
6.8 µF	685	J K M																						
8.2 µF	825	J K M																						
10 µF	106	J K M					GK									JF	JO							
12 µF	126	J K M																						
15 µF	156	J K M														JO	JO							
18 µF	186	J K M																						
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
EQ	1206	0.78 ± 0.20	4,000	10,000	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
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
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
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
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 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		

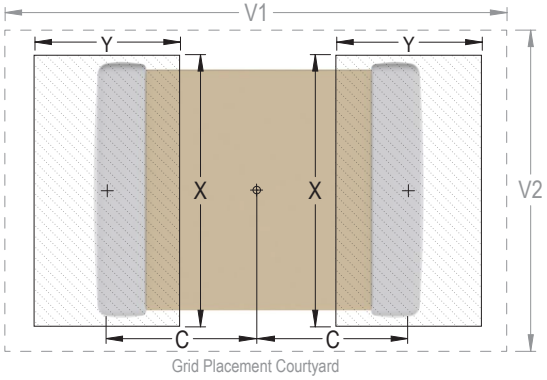
[1] The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial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

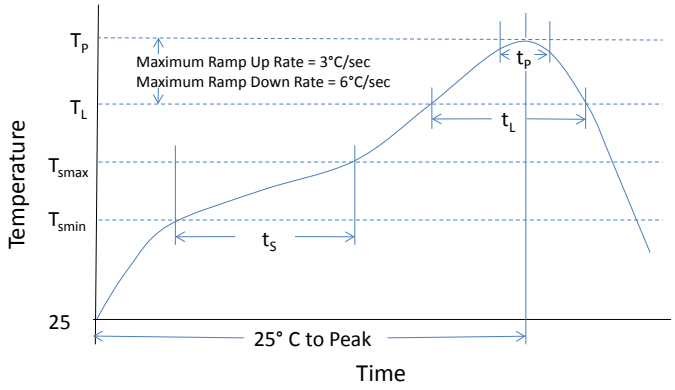


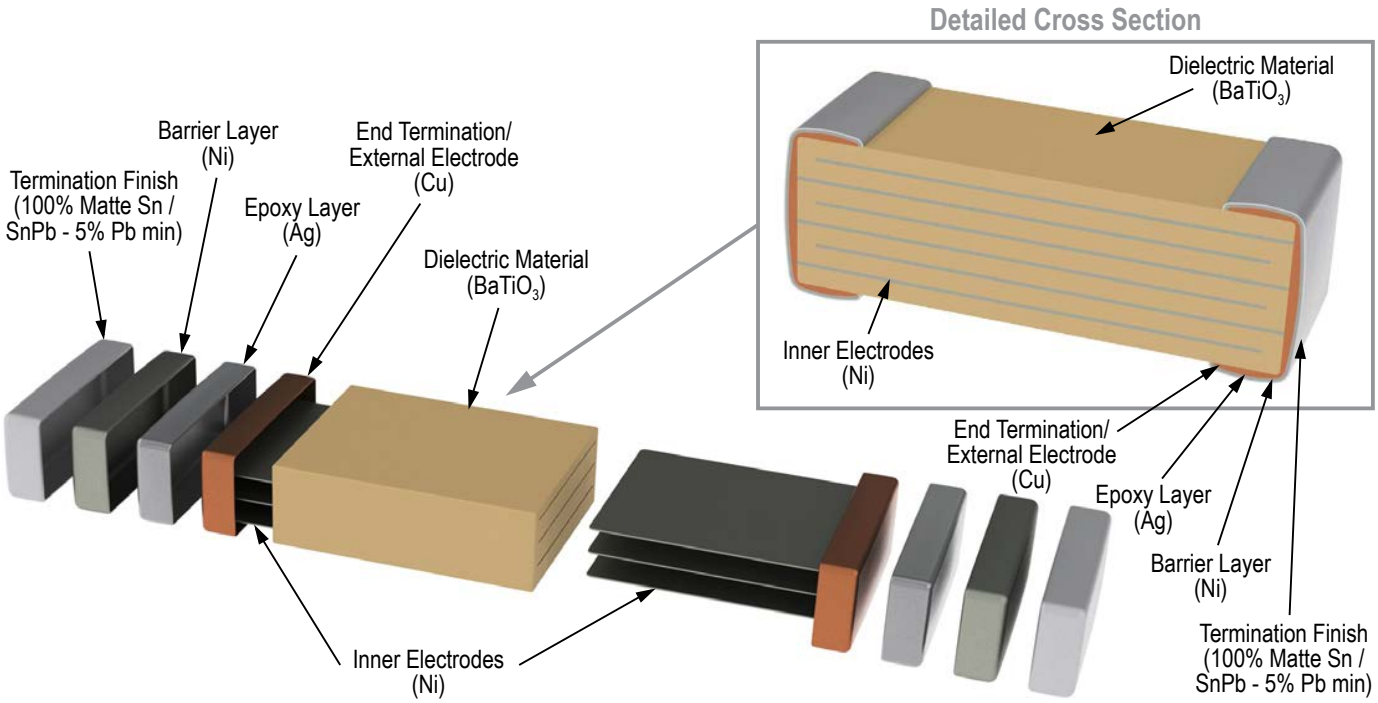
Table 4 – Performance & Reliability: Test Methods and Conditions

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 +/- 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



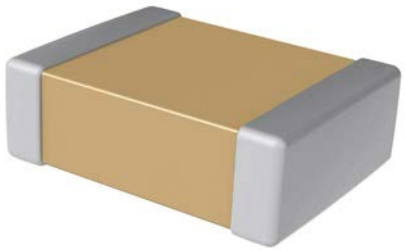
Floating Electrode Design with Flexible Termination System (FF-CAP), X7R Dielectric, 6.3 – 250 VDC (Commercial & Automotive Grade)

Overview

KEMET's Floating Electrode with Flexible Termination capacitor (FF-CAP) combines two existing KEMET technologies– Floating Electrode and Flexible Termination. The floating electrode component utilizes a cascading internal electrode design configured to form multiple capacitors in series within a single monolithic structure. This unique configuration results in enhanced voltage and ESD performance over standard capacitor designs while allowing for a fail-open condition if mechanically damaged (cracked). The flexible termination component utilizes a conductive silver epoxy between the base metal and nickel barrier layers of KEMET's standard termination system in order to establish pliability while maintaining terminal strength, solderability and electrical performance. Both technologies address the primary failure mode of 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 + 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" below

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

[1] *SnPb termination finish option is not available on automotive grade product.*

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Packaging C-Spec Ordering Options Table

Packaging Type	Packaging/Grade Ordering Code (C-Spec)
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 and smaller case sizes) 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 & 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's 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:

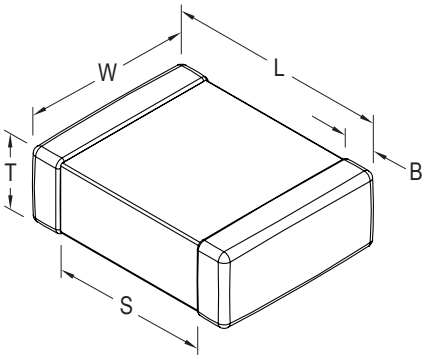
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design record and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that 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 (.063) ± 0.17 (.007)	0.80 (.032) ± 0.15 (.006)	See Table 2 for Thickness	0.45 (.018) ± 0.15 (.006)	0.58 (.023)	Solder Wave or Solder Reflow
0805	2012	2.00 (.079) ± 0.30 (.012)	1.25 (.049) ± 0.30 (.012)		0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	
1206	3216	3.30 (.130) ± 0.40 (.016)	1.60 (.063) ± 0.35 (.013)		0.60 (.024) ± 0.25 (.010)	N/A	
1210	3225	3.30 (.130) ± 0.40 (.016)	2.60 (.102) ± 0.30 (.012)		0.60 (.024) ± 0.25 (.010)		Solder Reflow Only
1812	4532	4.50 (.178) ± 0.40 (.016)	3.20 (.126) ± 0.30 (.012)		0.70 (.028) ± 0.35 (.014)		

Qualification/Certification

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

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 @ 25°C	5%(6.3V & 10V), 3.5%(16V & 25V) and 2.5%(50V to 250V)
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (Rated voltage applied for 120 ± 5 secs @ 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	4,000	10,000	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		

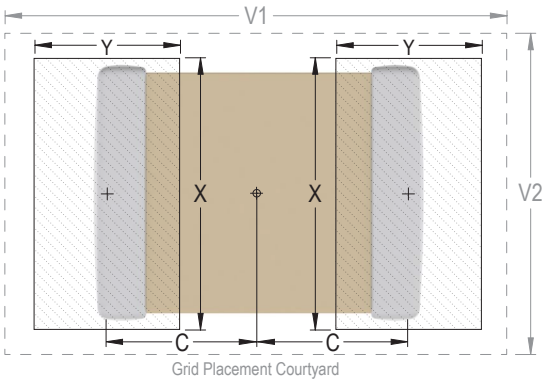
[1] The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial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



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.

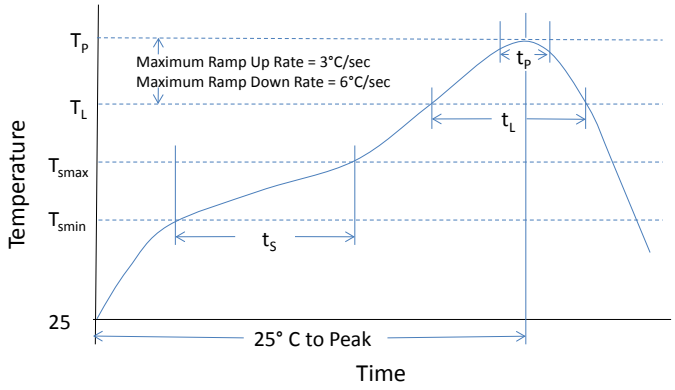


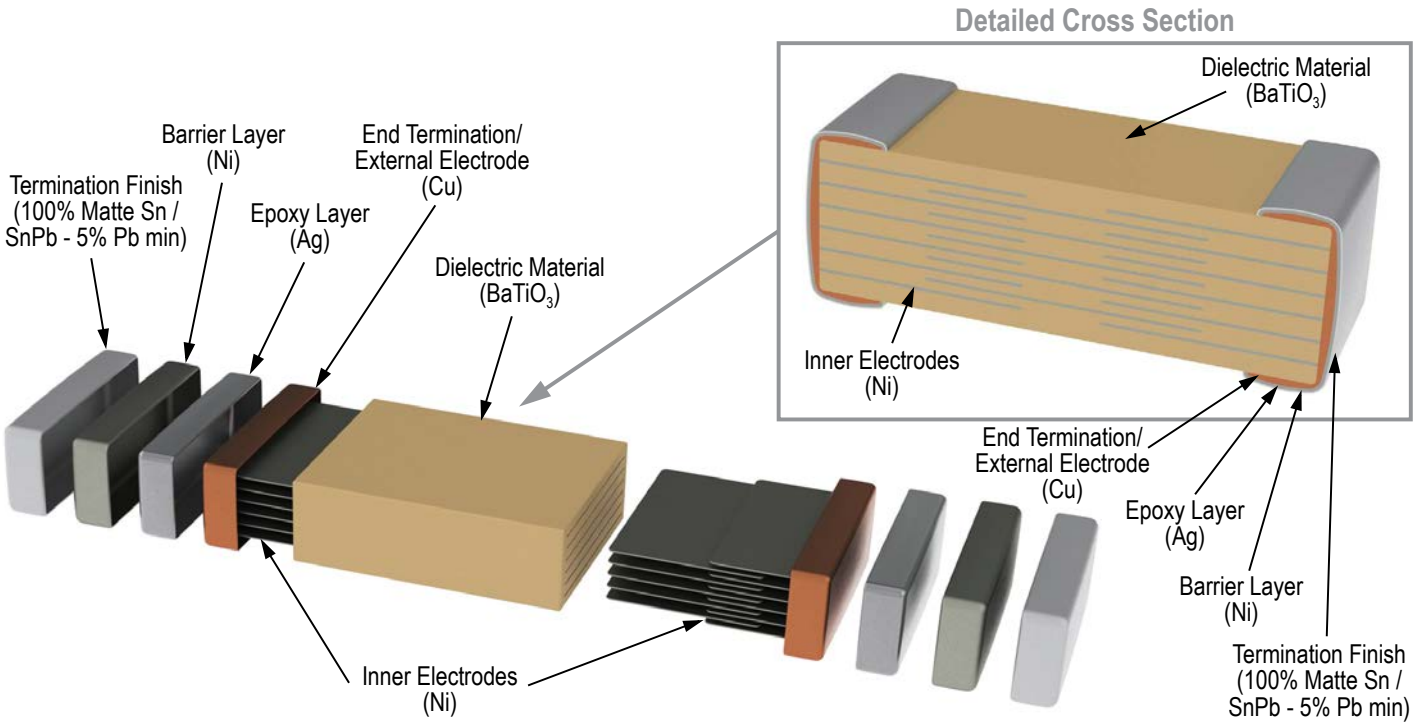
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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 +/- 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



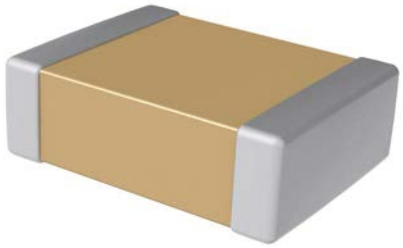
HV-HT Series, High Voltage, High Temperature 200°C, C0G Dielectric, 500 – 2,000 VDC (Industrial Grade)

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 + 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 min.) E = Gold (Au) 1.97 – 11.8 µin F = Gold (Au) 30 – 50 µin G = Gold (Au) 100 µin min.	See "Packaging C-Spec Ordering Options Table" below

[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.*

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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 – 50 µin G = Gold (Au) 100 µin min.	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 – 50 µin G = Gold (Au) 100 µin min.	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 thru 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 – 11.8 µin)

[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 & 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.

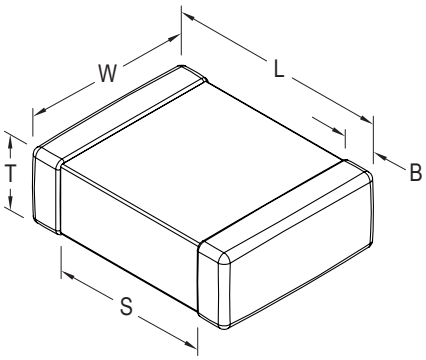
Qualification/Certification

High temperature (200ºC) Industrial grade products meet or exceed the requirements outlined in Table 4, Performance & Reliability. Qualification packages are available for review and download on our website at www.kemet.com/hightemp

Environmental Compliance

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

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 (.079) ± 0.20 (.008)	1.25 (.049) ± 0.20 (.008)	See Table 2 for Thickness	0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	"Solder Wave or Solder Reflow"
1206	3216	3.20 (.126) ± 0.20 (.008)	1.60 (.063) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)	N/A	
1210	3225	3.20 (.126) ± 0.20 (.008)	2.50 (.098) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)		Solder Reflow Only
1808	4520	4.70 (.185) ± 0.50 (.020)	2.00 (.079) ± 0.20 (.008)		0.60 (.024) ± 0.35 (.014)		
1812	4532	4.50 (.177) ± 0.30 (.012)	3.20 (.126) ± 0.30 (.012)		0.60 (.024) ± 0.35 (.014)		
1825	4564	4.50 (.177) ± 0.30 (.012)	6.40 (.252) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2220	5650	5.70 (.224) ± 0.40 (.016)	5.00 (.197) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2225	5664	5.60 (.220) ± 0.40 (.016)	6.40 (.248) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2824	7260	7.10 (.280) ± 0.40 (.016)	6.10 (.240) ± 0.40 (.016)		1.27 (.050) ± 0.40 (.016)		
3040	7610	7.60 (.300) ± 0.40 (.016)	10.20 (.402) ± 0.40 (.016)		1.27 (.050) ± 0.40 (.016)		
3640	9210	9.10 (.358) ± 0.40 (.016)	10.20 (.402) ± 0.40 (.016)		1.27 (.050) ± 0.40 (.016)		
4540	-	11.40 (.449) ± 0.40 (.016)	10.20 (.402) ± 0.40 (.016)		1.27 (.050) ± 0.40 (.016)		

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)	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)
[2]Dissipation Factor (DF) Maximum Limit @ 25°C	0.1%
[3]Insulation Resistance (IR) Minimum Limit @ 25°C	1000 megohm microfarads or 100 GΩ (500 VDC applied for 120 ±5 secs @ 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

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

**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.

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 F G J K M	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	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	LA	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				

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

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'd

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)*
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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	1,550
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 out standard "bulk bag" packaging.

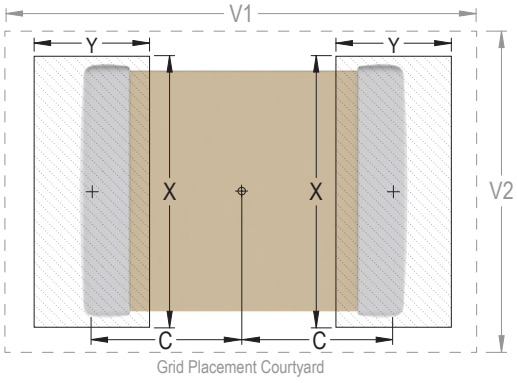
[3] Also commonly referred to as “Chip Carrier” or “Molded Tray”. All tray packaging options offer static protection.

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.

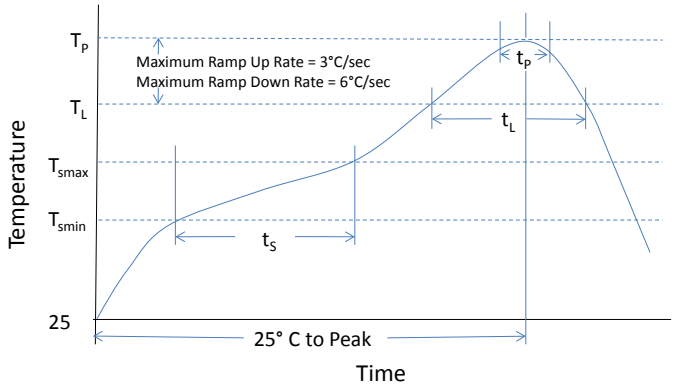


Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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

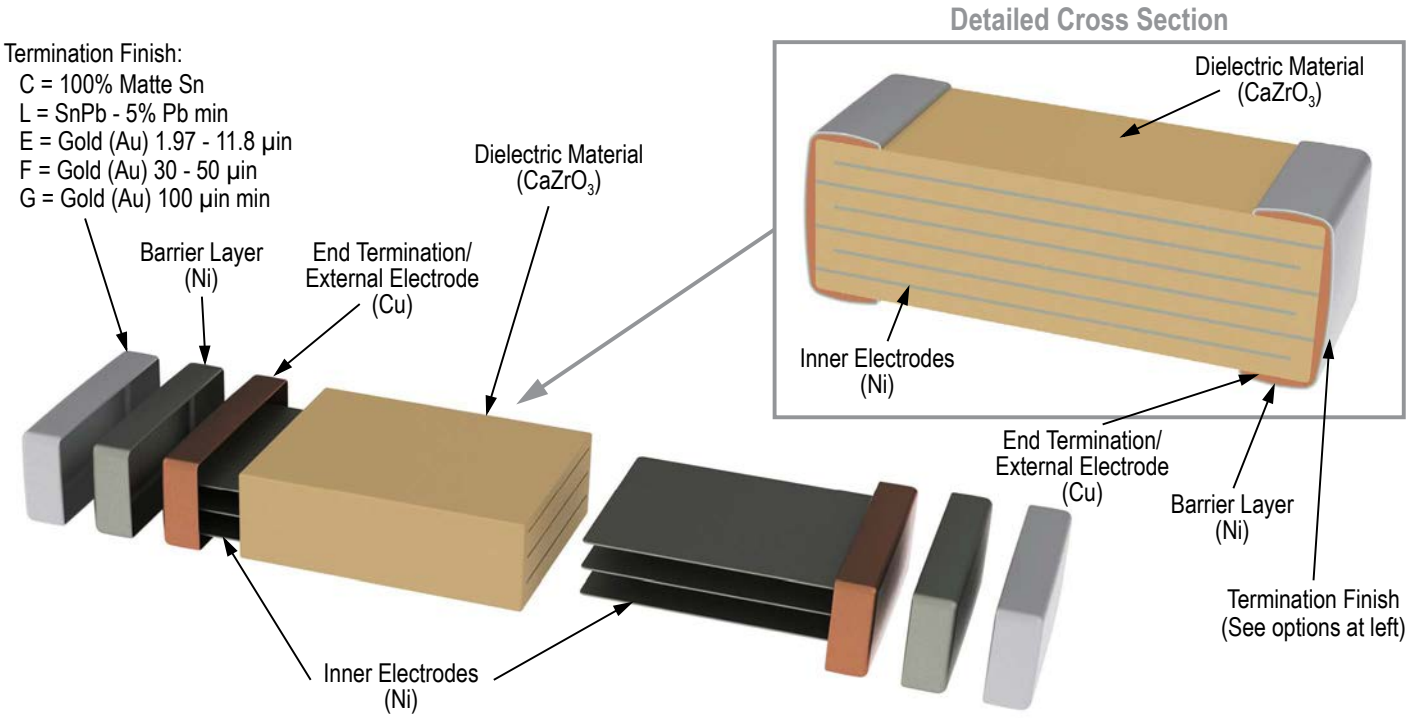
Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will 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 – 50 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.

KPS Series, 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
- 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

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 + 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" below

[1] Double chip stacks ("2" in the 13th character position of the ordering code) are only available in M (±20%) capacitance tolerance. Single chip stacks ("1" in the 13th character position of the ordering code) are available in K (±10%) or M (±20%) tolerances.

[2] Additional leadframe finish options may be available. Contact KEMET for details.

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Packaging C-Spec Ordering Options Table

Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)[2]
7" Reel (Embossed Plastic Tape) / Unmarked	7186
13" Reel (Embossed Plastic Tape) / Unmarked	7289

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

Benefits cont'd

- 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

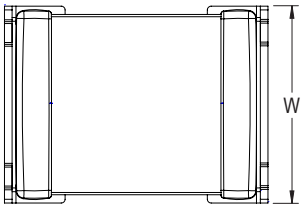
Commercial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance & Reliability.

Environmental Compliance

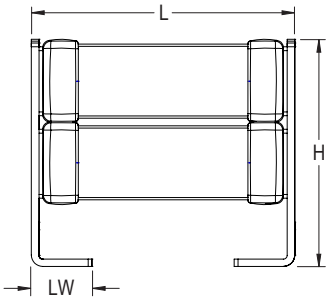
Lead (Pb)-Free, RoHS, and REACH compliant without exemptions.

Dimensions – Millimeters (Inches)

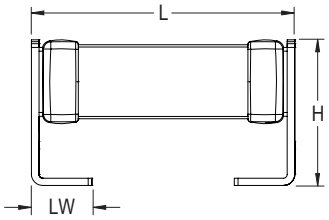
Single or Double Chip Stack



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 (.138) ±0.30 (.012)	2.60 (.102) ±0.30 (.012)	3.35 (.132) ±0.10 (.004)	0.80 (.032) ±0.15 (.006)	Solder Reflow Only
	1812	4532	5.00 (.197) ±0.50 (.020)	3.50 (.138) ±0.50 (.020)	2.65 (.104) ±0.35 (.014)	1.10 (.043) ±0.30 (.012)	
	2220	5650	6.00 (.236) ±0.50 (.020)	5.00 (.197) ±0.50 (.020)	3.50 (.138) ±0.30 (.012)	1.60 (.063) ±0.30 (.012)	
Double	1210	3225	3.50 (.138) ±0.30 (.012)	2.60 (.102) ±0.30 (.012)	6.15 (.242) ±0.15 (.006)	0.80 (.031) ±0.15 (.006)	
	1812	4532	5.00 (.197) ±0.50 (.020)	3.50 (.138) ±0.50 (.020)	5.00 (.197) ±0.50 (.020)	1.10 (.043) ±0.30 (.012)	
	2220	5650	6.00 (.236) ±0.50 (.020)	5.00 (.197) ±0.50 (.020)	5.00 (.197) ±0.50 (.020)	1.60 (.063) ±0.30 (.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 @ 25°C	5%(10V), 3.5%(16V & 25V) and 2.5%(50V to 250V)
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (Rated voltage applied for 120 ± 5 secs @ 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

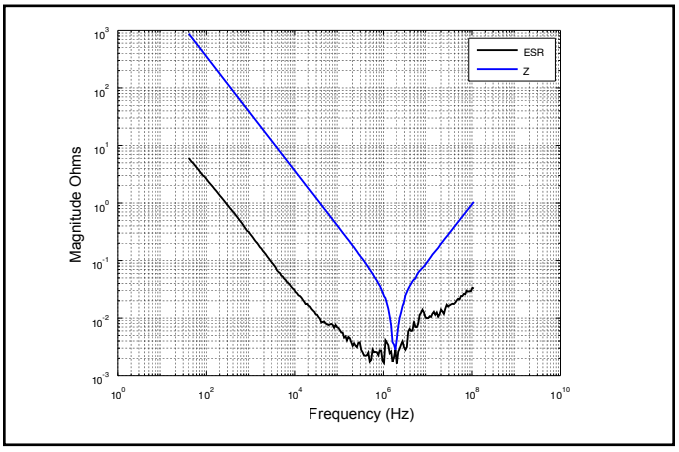
High Temperature Life, Biased Humidity, Moisture Resistance					
Dielectric	Rated DC Voltage	Capacitance Value	Dissipation Factor (Maximum %)	Capacitance Shift	Insulation Resistance
X7R	> 25	All	3.0	±20%	10% of Initial Limit
	16/25		5.0		
	< 16		7.5		

Insulation Resistance Limit Table

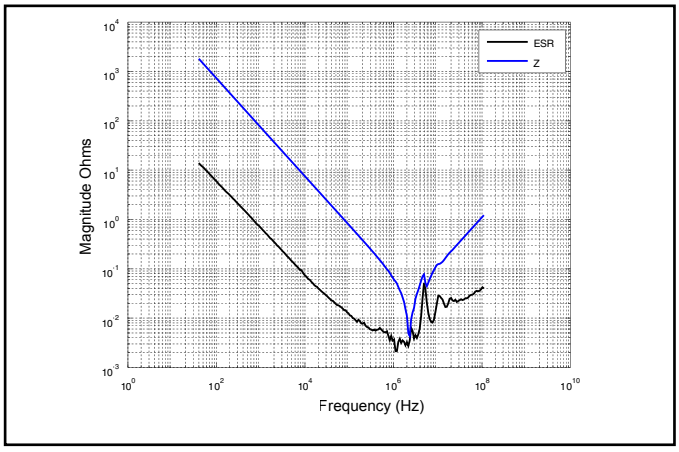
EIA Case Size	1,000 Megohm Microfarads or 100 GΩ	500 Megohm Microfarads or 10 GΩ
1210	< 0.39 µF	≥ 0.39 µF
1812	< 2.2 µF	≥ 2.2 µF
2220	< 10 µF	≥ 10 µF

Electrical Characteristics

Z and ESR C1210C475M5R1C

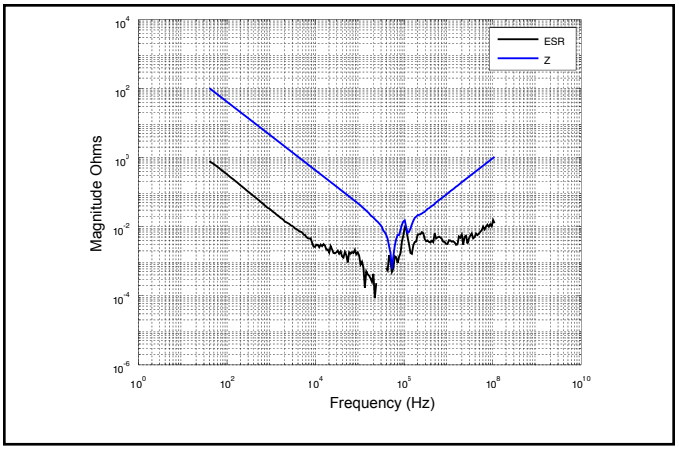


Z and ESR C2220C225MAR2C

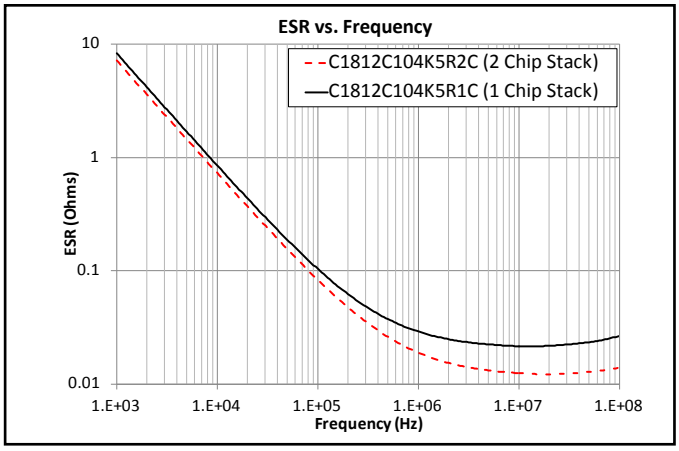


Electrical Characteristics

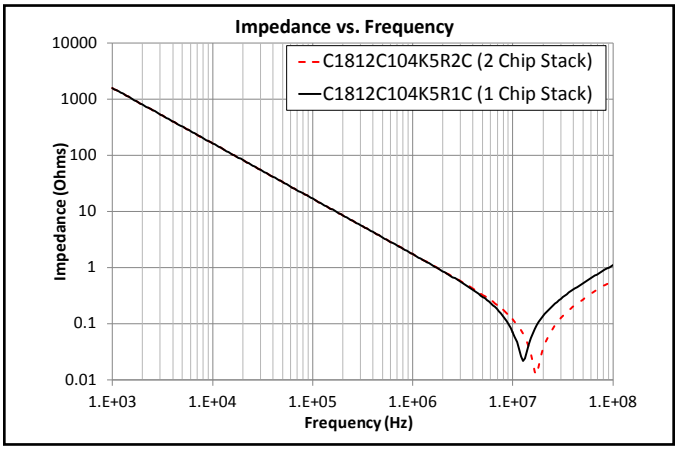
Z and ESR C2220C476M3R2C



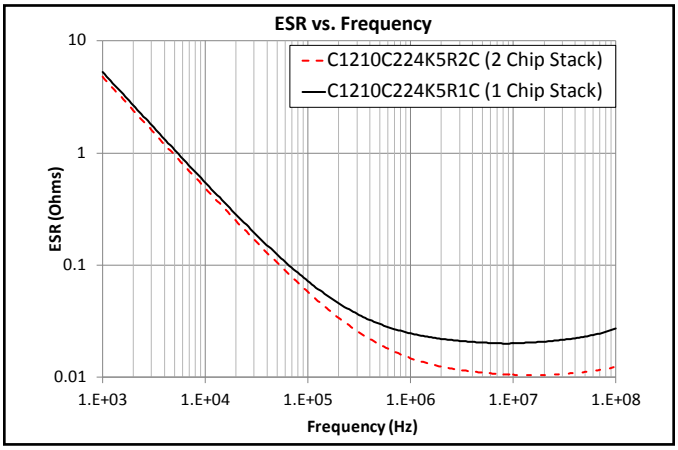
ESR – 1812, .10 µF, 50 V X7R



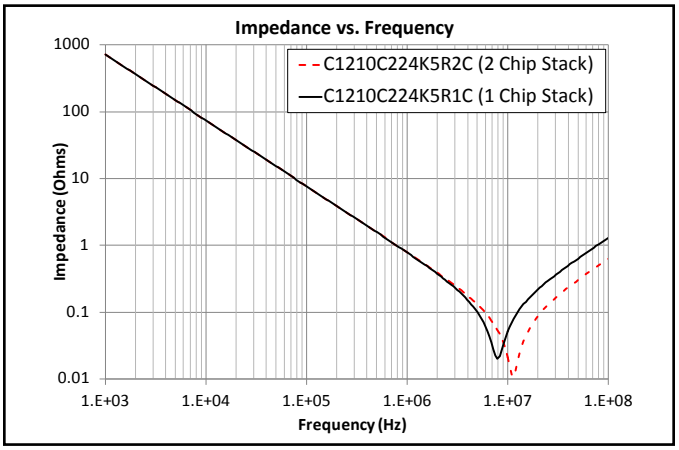
Impedance – 1812, .10 µF, 50 V X7R



ESR – 1210, .22 µF, 50 V X7R

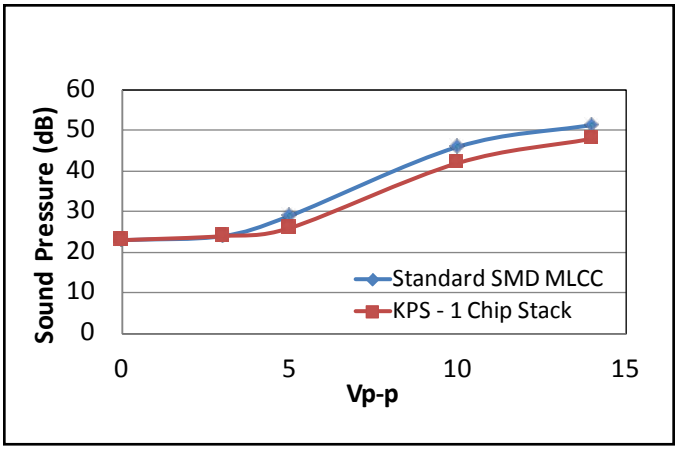


Impedance – 1210, .22 µF, 50 V X7R

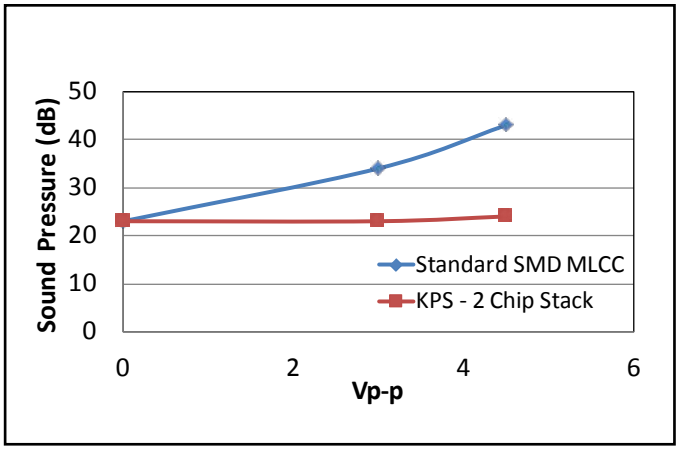


Electrical Characteristics cont'd

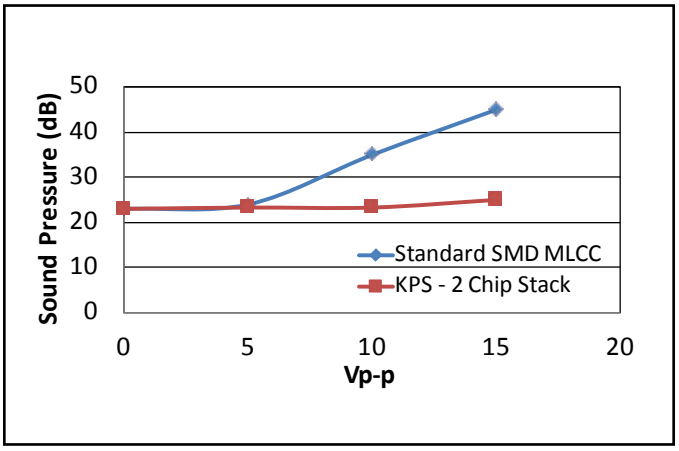
Microphonics – 1210, 4.7 µF, 50 V, X7R



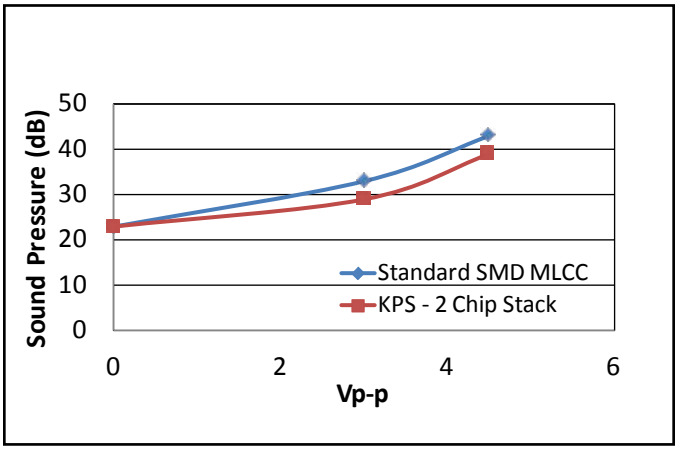
Microphonics – 2220, 22 µF, 50 V, X7R



Microphonics – 2220, 47 µF, 25 V, X7R

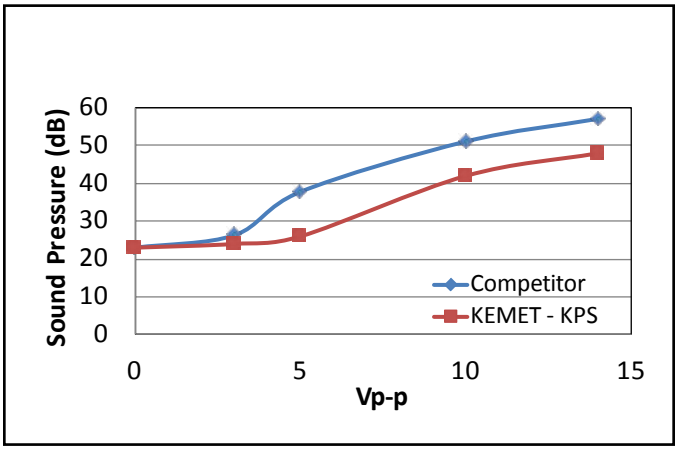


Microphonics – 1210, 22 µF, 25 V, X7R

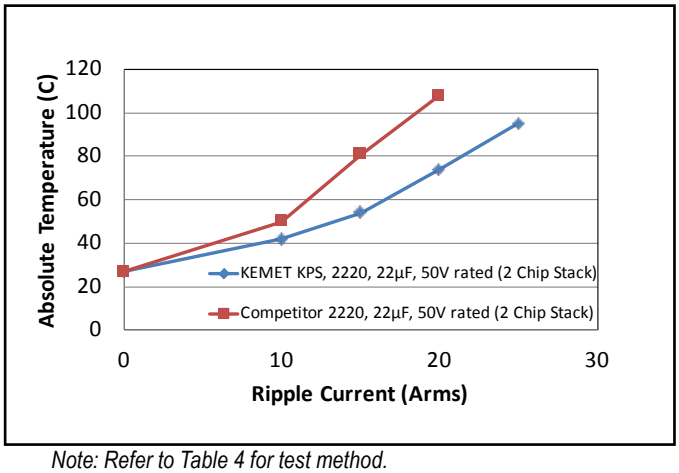


Competitive Comparision

Microphonics – 1210, 4.7 µF, 50 V, X7R



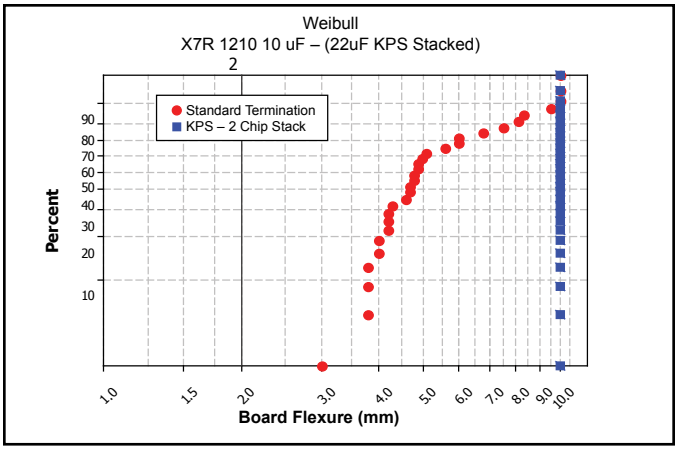
Ripple Current (Arms) 2220, 22 µF, 50 V



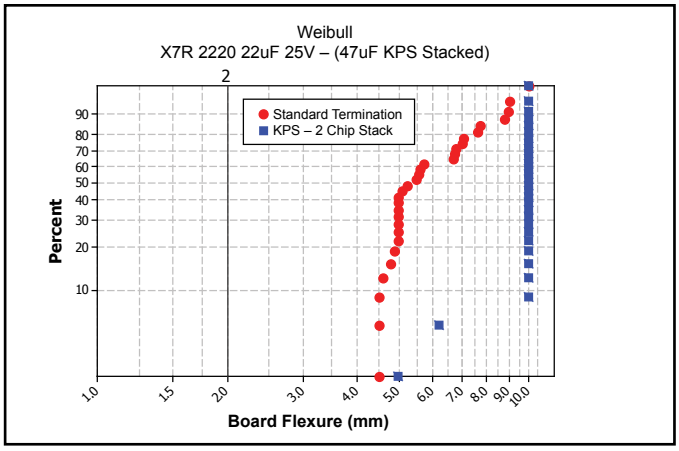
Note: Refer to Table 4 for test method.

Electrical Characteristics cont'd

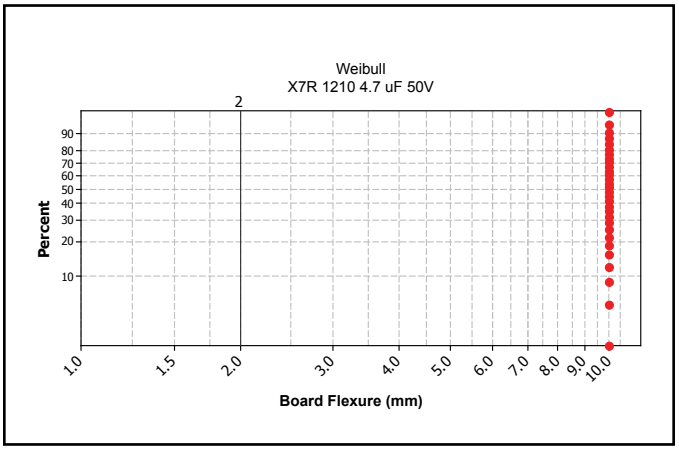
Board Flex vs. Termination Type



Board Flex vs. Termination Type



Board Flexure to 10 mm



Board Flexure to 10 mm

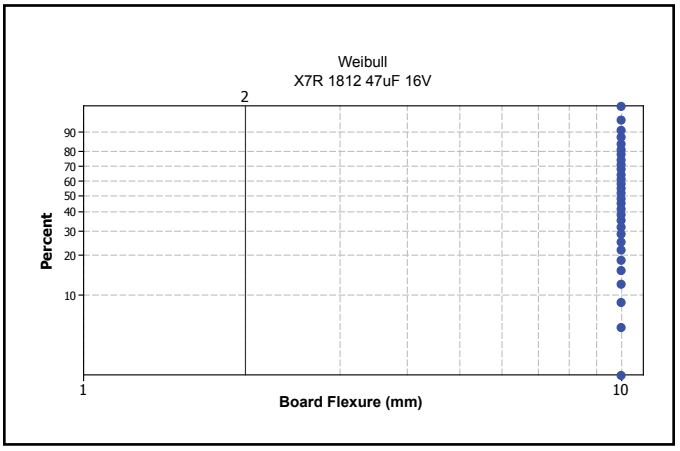


Table 1 – Capacitance Range/Selection Waterfall (1210 – 2220 Case Sizes)

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

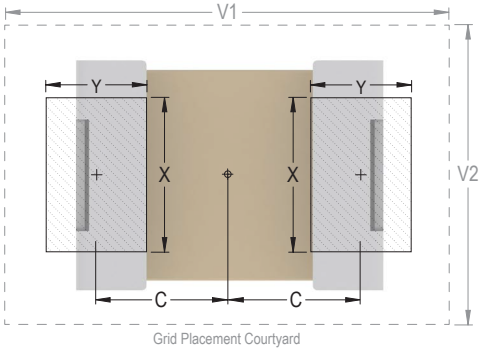
Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
FV	1210	3.35 ± 0.10	0	0	600	2,000
FW	1210	6.15 ± 0.15	0	0	300	1,000
GP	1812	2.65 ± 0.35	0	0	500	2,000
GR	1812	5.00 ± 0.50	0	0	400	1,700
JP	2220	3.50 ± 0.30	0	0	300	1,300
JR	2220	5.00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



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.

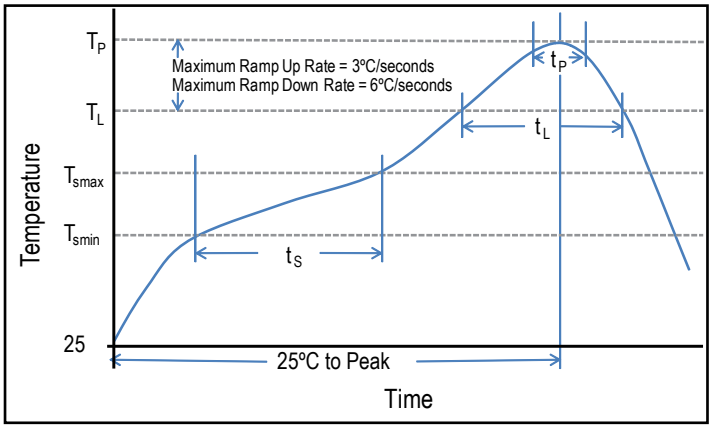


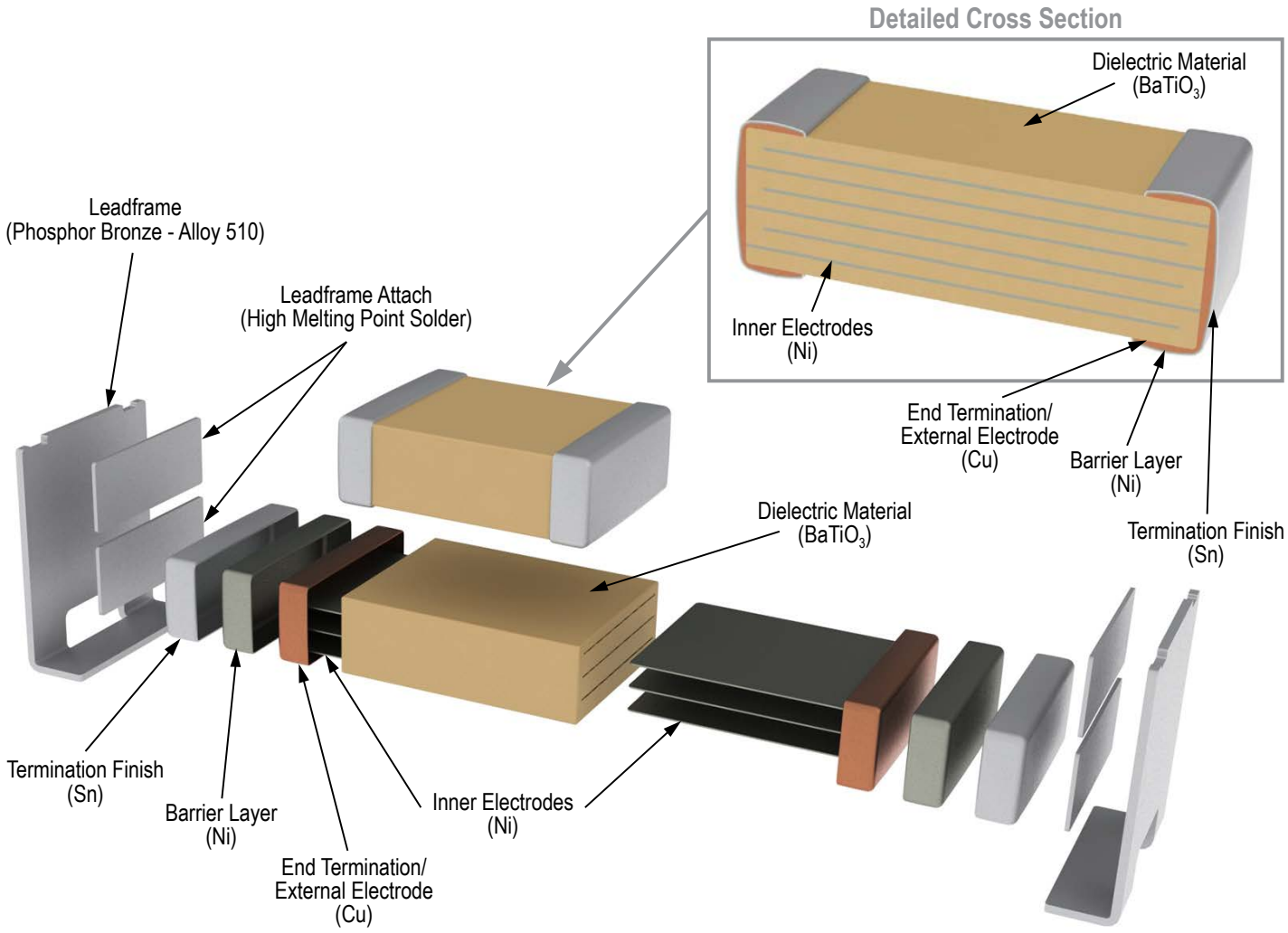
Table 4 – Performance & Reliability: Test Methods and Conditions

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.

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 + 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" below

[1] Double chip stacks ("2" in the 13th character position of the ordering code) are only available in M (±20%) capacitance tolerance. Single chip stacks ("1" in the 13th character position of the ordering code) are available in K (±10%) or M (±20%) tolerances.

[2] Additional leadframe finish options may be available. Contact KEMET for details.

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Packaging C-Spec Ordering Options Table

Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)[2]
7" Reel (Embossed Plastic Tape)/Unmarked	7186
13" Reel (Embossed Plastic Tape)/Unmarked	7289

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

Benefits cont'd

- 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

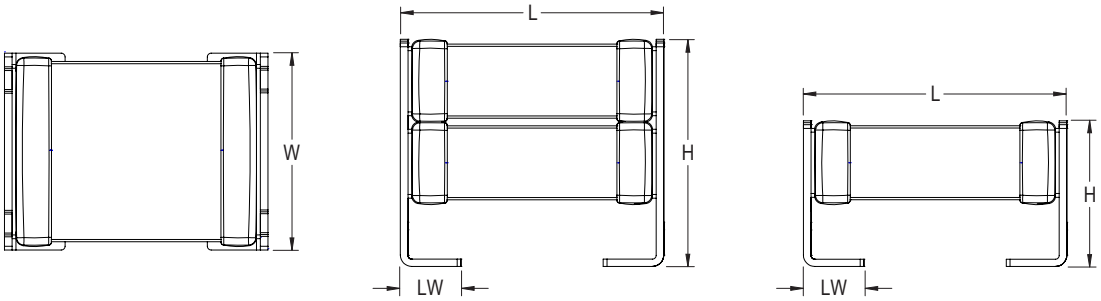
Commercial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4 , Performance and Reliability.

Environmental Compliance

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

Dimensions – Millimeters (Inches)

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 (.197) ±0.50 (.020)	3.50 (.138) ±0.30 (.012)	1.60 (.063) ±0.30 (.012)	Solder Reflow Only
Double	2220	5650	6.00 (0.236) ±0.50 (0.020)	5.00 (.197) ±0.50 (.020)	5.00 (.197) ±0.50 (.020)	1.60 (.063) ±0.30 (.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 @ 25°C	2.5%
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (500VDC applied for 120 ± 5 secs @ 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	100 Megohm Microfarads or 10 GΩ
0805	< 0.0039 µF	≥ 0.0039 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	All	N/A

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.

Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

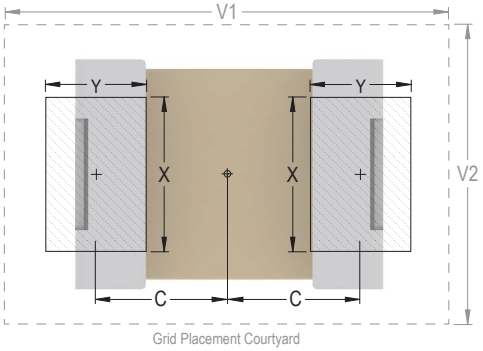
Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
JP	2220	3.50 ± 0.30	0	0	300	1,300
JR	2220	5.00 ± 0.50	0	0	200	800

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
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.



Soldering Process

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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.

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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.

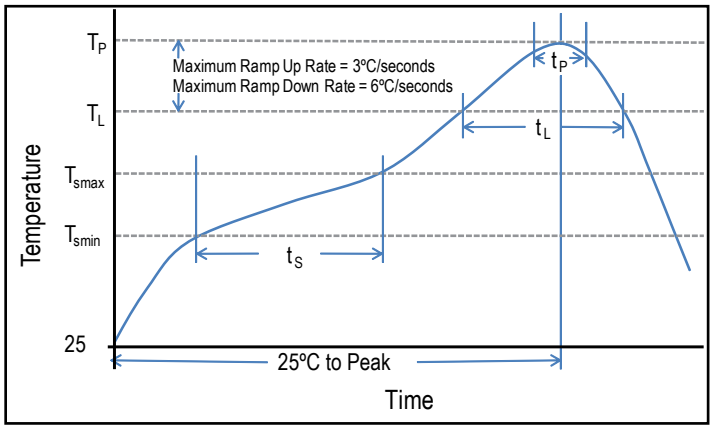


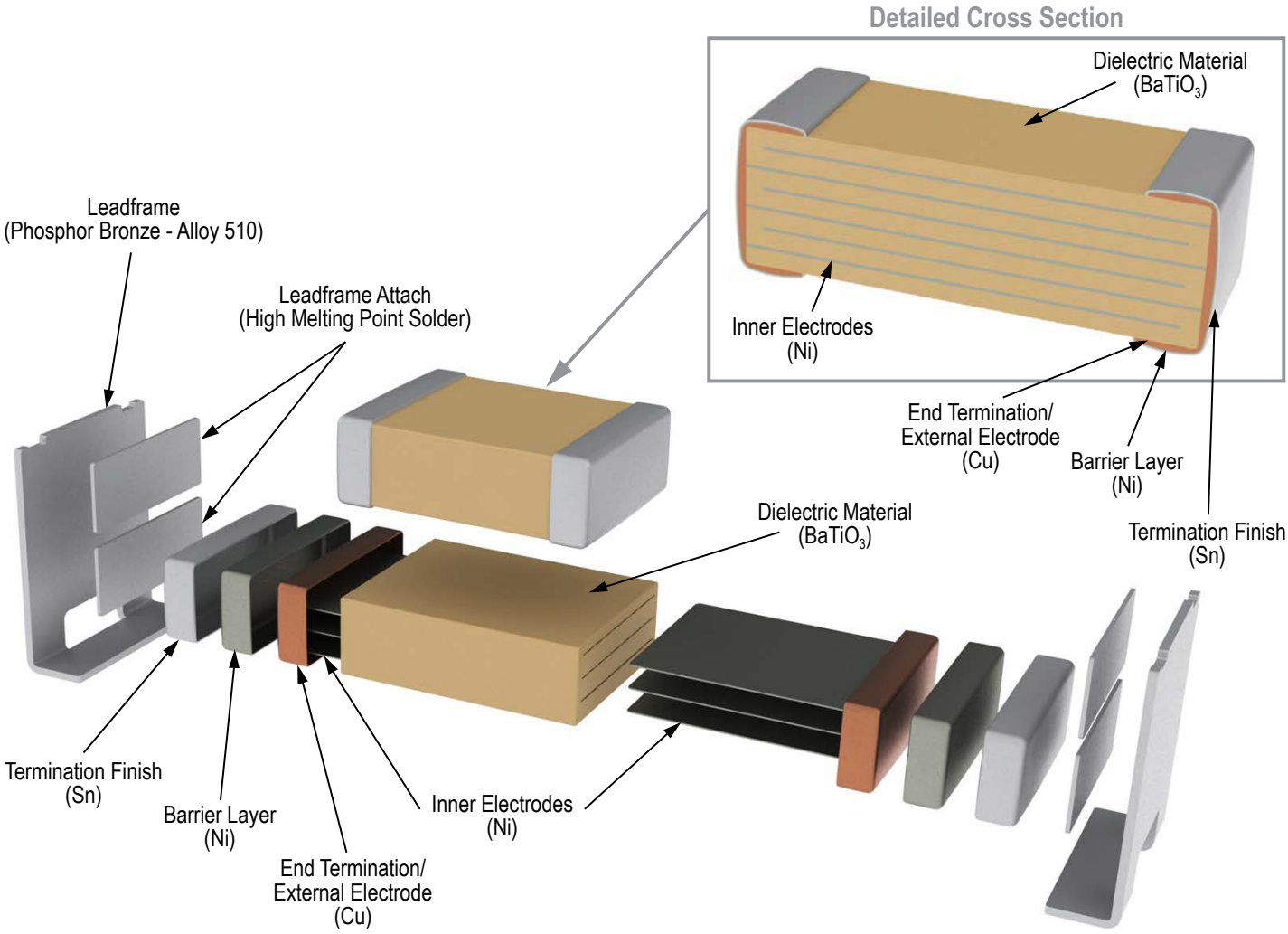
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 155°C, dry heat @ 235°C
		b) Method B @ 215°C category 3
		c) Method D, category 3 @ 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 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

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.

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	Failure Rate/ Design	Leadframe Finish[2]	Packaging/Grade (C-Spec)
	1210 2220	C = Standard	Two significant digits + 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" below

[1] Double chip stacks ("2" in the 13th character position of the ordering code) are only available in M (±20%) capacitance tolerance. Single chip stacks ("1" in the 13th character position of the ordering code) are available in K (±10%) or M (±20%) tolerances.

[2] Additional leadframe finish options may be available. Contact KEMET for details.

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Packaging C-Spec Ordering Options Table

Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)[2]
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

- 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 & 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.

Qualification/Certification

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

Environmental Compliance

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

Automotive C-Spec Information

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

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO". This C-Spec was developed in order to better serve small and medium sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET's 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 record 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

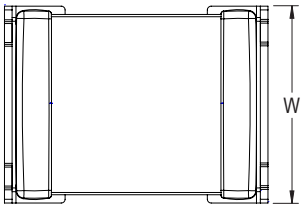
KEMET Automotive C-Spec	PPAP (Product Part Approval Process) Level				
	1	2	3	4	5
KEMET assigned[1]	●	●	●	●	●
AUTO	○		○		

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

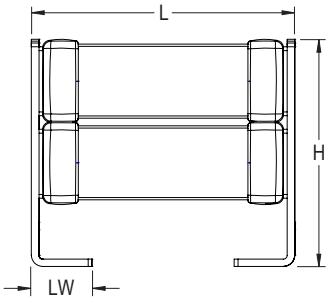
● Part Number specific PPAP available
○ Product family PPAP only

Dimensions – Millimeters (Inches)

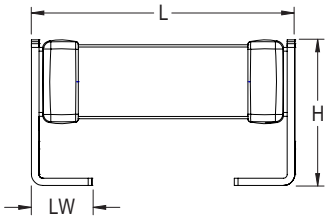
Single or Double Chip Stack



Double Chip Stack



Single Chip Stack



Chip Stack	EIA Size Code	Metric Size Code	L Length	W Width	H Height	LW Lead Width	Mounting Technique
Single	1210	3225	3.50 (.138) ±0.30 (.012)	2.60 (.102) ±0.30 (.012)	3.35 (.132) ±0.10 (.004)	0.80 (.032) ±0.15 (.006)	Solder Reflow Only
	2220	5650	6.00 (.236) ±0.50 (.020)	5.00 (.197) ±0.50 (.020)	3.50 (.138) ±0.30 (.012)	1.60 (.063) ±0.30 (.012)	
Double	1210	3225	3.50 (.138) ±0.30 (.012)	2.60 (.102) ±0.30 (.012)	6.15 (.242) ±0.15 (.006)	0.80 (.031) ±0.15 (.006)	
	2220	5650	6.00 (.236) ±0.50 (.020)	5.00 (.197) ±0.50 (.020)	5.00 (.197) ±0.50 (.020)	1.60 (.063) ±0.30 (.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 @ 25°C	3.5% (≤ 16V) and 2.5% (≥ 25V)
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	500 megohm microfarads or 10 GΩ (Rated voltage applied for 120 ±5 seconds @ 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						C2220C					
		Voltage Code			8	4	3	5	1	A	8	4	3	5	1	A
		Rated Voltage (VDC)			10	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				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	10	16	25	50	100	250
		Voltage Code			8	4	3	5	1	A	8	4	3	5	1	A
		Case Size/Series			C1210C						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

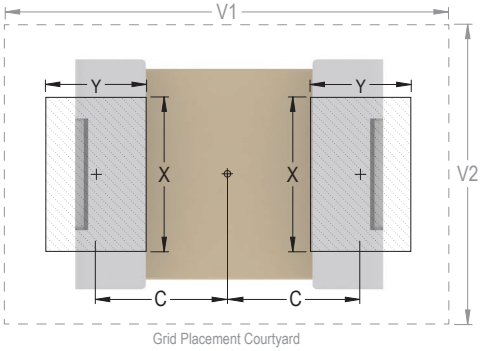
Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
FV	1210	3.35 ± 0.10	0	0	600	2,000
FW	1210	6.15 ± 0.15	0	0	300	1,000
JP	2220	3.50 ± 0.30	0	0	300	1,300
JR	2220	5.00 ± 0.50	0	0	200	800

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.



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.

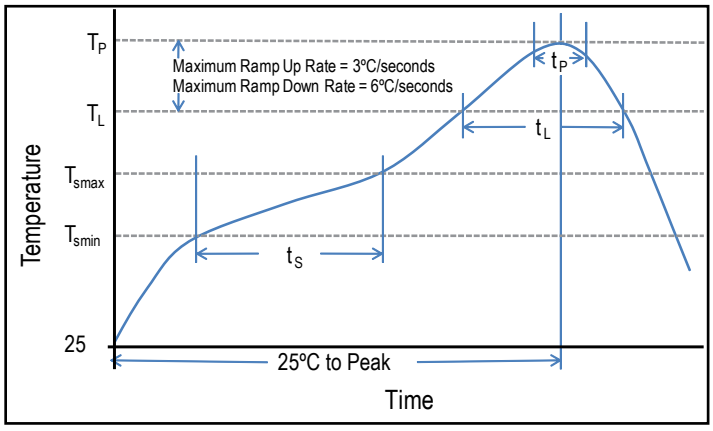
To prevent degradation of temperature cycling capability, care must be taken to prevent solder from flowing into the inner side of the lead frames (inner side of "J" lead in contact with the circuit board).

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.



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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 @ 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.
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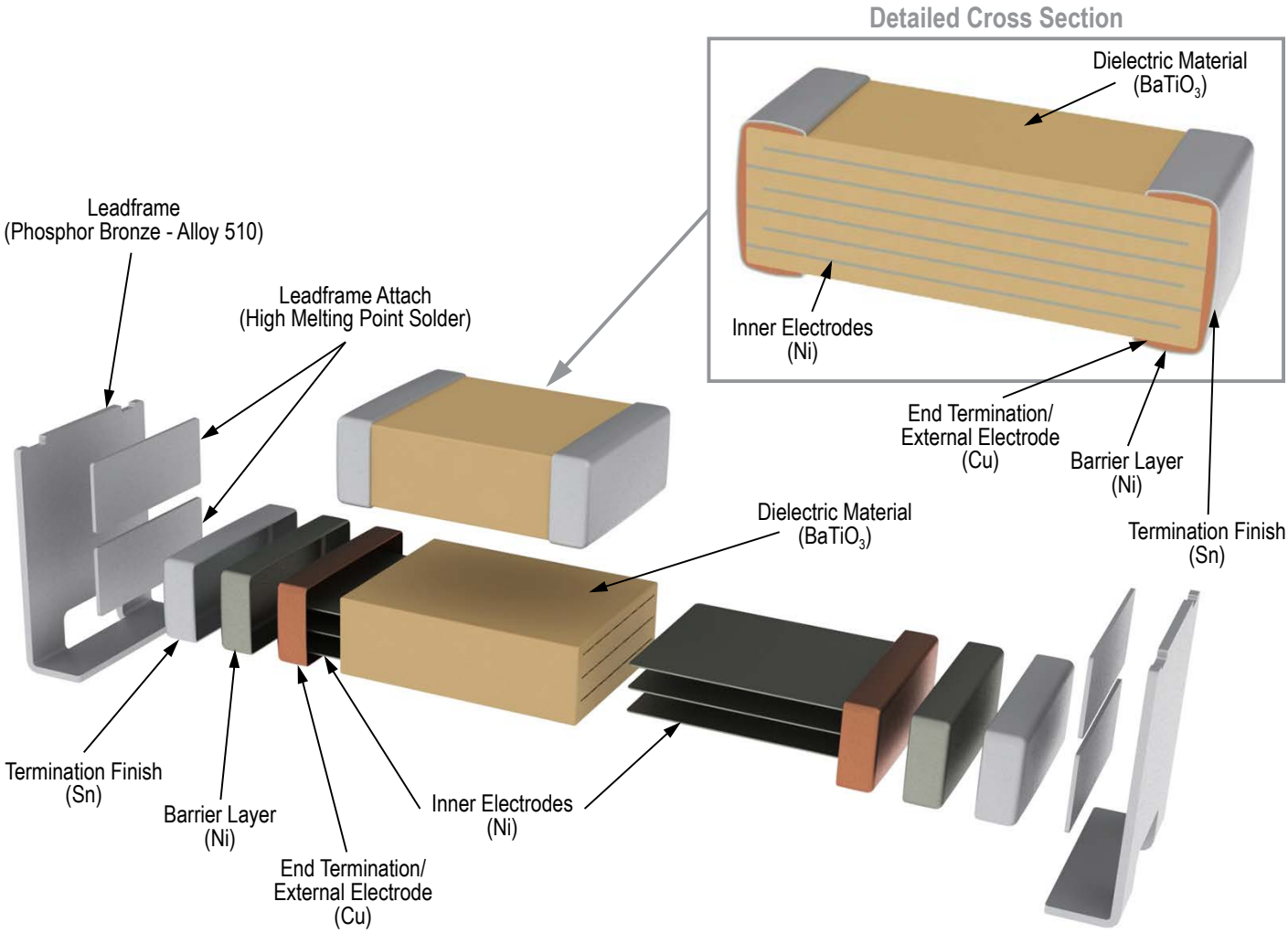
Mechanical Shock	MIL–STD–202 Method 213	Figure 1 of Method 213, Condition F.
Resistance to Solvents	MIL–STD–202 Method 215	Add aqueous wash chemical, OKEM Clean or equivalent.

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.

KPS MIL Series, SMPS Stacked Capacitors, MIL–PRF–49470, DSCC 87106, 25 – 1,000 VDC (Commercial, Military, & 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.

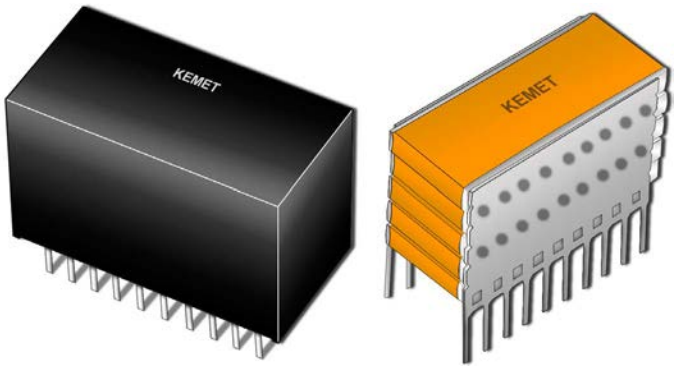
Available in BX, BR, BQ, and X7R dielectrics, these devices are available in encapsulated and unencapsulated styles in both surface mountable and through-hole configurations. Their low Equivalent Series Resistance (ESR) and Equivalent Series Inductance (ESL) make them ideally suited for input and output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

Applications

- Military
- Space
- Industrial
- Input and output filtering on power supplies – often found on “capacitor banks“
- Snubber circuits
- Radar filtering (28 V/microwave burst)



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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 02 = Encapsulated	Two significant digits + number of zeros	J = ±5% K = ±10% M = ±20%	A = 50 B = 100 C = 200 E = 500	N = Straight Pin L = Formed "L" M = Formed "L" J = Formed "J" K = 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 L2 = Encapsulated	Q = BQ R = BR X = BX W = X7R	N = Straight L = Formed "L" M = Formed "L" J = Formed "J" K = 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 + 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.

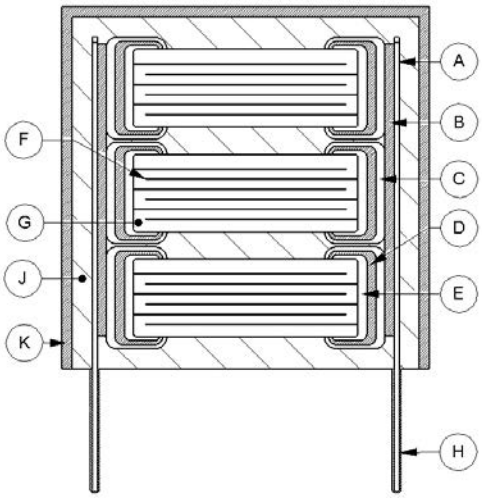
[4] DSCC Drawing 87106 was cancelled on 01/03/2005. MIL–PRF–49470 capacitors are preferred over DSCC Drawing 87106 capacitors.

[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.

Construction



Note: Image is exaggerated in order to clearly identify all components of construction

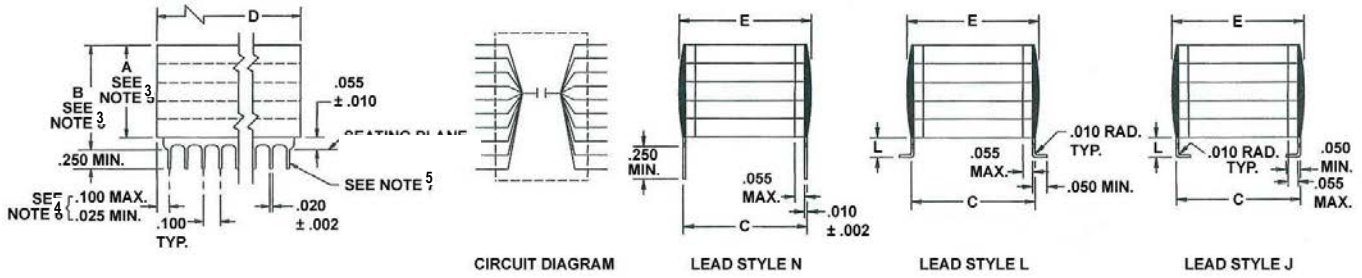
Reference	Item	Material	
A	Leadframe	Phosphor Bronze – Alloy 510	
B	Leadframe Attach Solder	Sn10, Pb88, Ag2	
C	Termination System[1]	SnPb (4% minimum)	Solderable Silver
D		Ni	
E		Ag	
F	Electrode	PdAg	
G	Dielectric	$BaTiO_3$	
H	Lead Solder	Sn60, Pb40	
J	Encapsulation[2]	Molding Compound	
K		Diallyl-Phthalate (DAP)	

[1] *KEMET reserves the right to construct these devices using either of the termination systems outlined.*
[2] *Encapsulated product only, i.e., MIL–PRF–49470/2 and L2 product families.*

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

Case Code	C Lead Spacing ±0.025 (0.635)	E Length ±0.010 (0.250)	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 & 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).*



1. Unless otherwise specified, tolerances are ±0.010" (0.25 mm).

2. Metric equivalents for C, D and E dimensions are provided for general information only.

3. For maximum B dimension, add 0.065" (1.65 mm) to the appropriate A dimension. For all lead styles, the number of chips is determined by the capacitance and voltage rating.

4. For case code 5, dimensions shall be 0.100" (2.54 mm) maximum and 0.012" (0.30 mm) minimum.

5. Lead alignment within pin rows shall be within ±0.005" (0.13 mm).

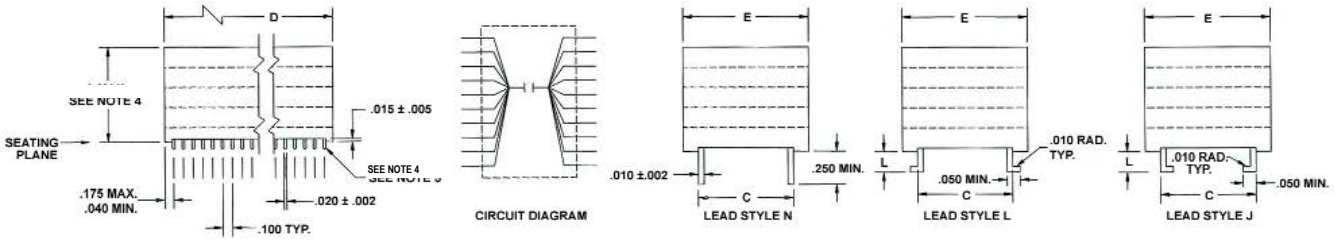
Unencapsulated & Encapsulated Lead Configurations – Inches (Millimeters)

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)
M		0.045 ± 0.010 (1.14 ±0.25)
J	(J) Formed	0.070 ± 0.010 (1.78 ±0.25)
K		0.045 ± 0.010 (1.14 ±0.25)

Additional lead configurations may be available. Contact KEMET for details.

Encapsulated (M49470/2 & L2) Product Dimensions – Inches (Millimeters)

Case Code	C Lead Spacing ±0.025 (0.635)	E Length Maximum	D Width ±0.635 (±0.025)	A Height	Number of Leads per Side	Mounting Technique
3	0.450 (11.43)	0.580 (14.73)	1.155 (29.34)	Refer to table 1B for specific maximum A dimension	10	Solder reflow only
4	0.400 (10.16)	0.485 (12.32)	0.485 (12.32)		4	
5	0.250 (6.35)	0.355 (9.02)	0.355 (9.02)		3	



1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified, tolerances are ±0.010" (0.25 mm).
4. Lead alignment within pin rows shall be within ±0.005" (0.13 mm).

Unencapsulated & Encapsulated 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)
M		0.045 ± 0.010 (1.14 ±0.25)
J	(J) Formed	0.070 ± 0.010 (1.78 ±0.25)
K		0.045 ± 0.010 (1.14 ±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 (open circuit voltage).
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 (open circuit voltage).
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 25ºC	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 (open circuit voltage).
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 voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA)
Dissipation Factor (DF) Maximum Limit at 25ºC	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.
20 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 Unencapsulated, 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, M, J, K	L1X(3)505105(2)(4)12
(1)49470X01125(2)A(3)	1.2	5	0.120 (3.05)	K, M	N, L, M, J, K	L1X(3)505125(2)(4)12
(1)49470X01155(2)A(3)	1.5	5	0.240 (6.10)	K, M	N, L, M, J, K	L1X(3)505155(2)(4)24
(1)49470X01185(2)A(3)	1.8	5	0.240 (6.10)	K, M	N, L, M, J, K	L1X(3)505185(2)(4)24
(1)49470X01225(2)A(3)	2.2	5	0.240 (6.10)	K, M	N, L, M, J, K	L1X(3)505225(2)(4)24
(1)49470X01275(2)A(3)	2.7	5	0.360 (9.14)	K, M	N, L, M, J, K	L1X(3)505275(2)(4)36
(1)49470X01335(2)A(3)	3.3	5	0.360 (9.14)	K, M	N, L, M, J, K	L1X(3)505335(2)(4)36
(1)49470X01475(2)A(3)	3.9	5	0.480 (12.19)	K, M	N, L, M, J, K	L1X(3)505475(2)(4)48
(1)49470X01395(2)A(3)	3.9	5	0.480 (12.19)	K, M	N, L, M, J, K	L1X(3)505395(2)(4)48
(1)49470X01565(2)A(3)	5.6	5	0.650 (16.51)	K, M	N, L, M, J, K	L1X(3)505565(2)(4)65
(1)49470X01685(2)A(3)	6.8	4	0.360 (9.14)	K, M	N, L, M, J, K	L1X(3)405685(2)(4)36
(1)49470X01825(2)A(3)	8.2	4	0.360 (9.14)	K, M	N, L, M, J, K	L1X(3)405825(2)(4)36
(1)49470X01106(2)A(3)	10	4	0.480 (12.19)	K, M	N, L, M, J, K	L1X(3)405106(2)(4)48
(1)49470X01126(2)A(3)	12	4	0.480 (12.19)	K, M	N, L, M, J, K	L1X(3)405126(2)(4)48
(1)49470X01156(2)A(3)	15	4	0.650 (16.51)	K, M	N, L, M, J, K	L1X(3)405156(2)(4)65
(1)49470X01186(2)A(3)	18	3	0.240 (6.10)	K, M	N, L, M, J, K	L1X(3)305186(2)(4)24
(1)49470X01226(2)A(3)	22	3	0.360 (9.14)	K, M	N, L, M, J, K	L1X(3)305226(2)(4)36
(1)49470X01276(2)A(3)	27	3	0.360 (9.14)	K, M	N, L, M, J, K	L1X(3)305276(2)(4)36
(1)49470X01336(2)A(3)	33	3	0.360 (9.14)	K, M	N, L, M, J, K	L1X(3)305336(2)(4)36
(1)49470X01396(2)A(3)	39	3	0.480 (12.19)	K, M	N, L, M, J, K	L1X(3)305396(2)(4)48
(1)49470X01476(2)A(3)	47	3	0.650 (16.51)	K, M	N, L, M, J, K	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, M, J, K	L1X(3)501684(2)(4)12
(1)49470X01824(2)B(3)	0.82	5	0.240 (6.10)	K, M	N, L, M, J, K	L1X(3)501824(2)(4)24
(1)49470X01105(2)B(3)	1	5	0.240 (6.10)	K, M	N, L, M, J, K	L1X(3)501105(2)(4)24
(1)49470X01125(2)B(3)	1.2	5	0.240 (6.10)	K, M	N, L, M, J, K	L1X(3)501125(2)(4)24
(1)49470X01155(2)B(3)	1.5	5	0.360 (9.14)	K, M	N, L, M, J, K	L1X(3)501155(2)(4)36
(1)49470X01185(2)B(3)	1.8	5	0.360 (9.14)	K, M	N, L, M, J, K	L1X(3)501185(2)(4)36
(1)49470X01225(2)B(3)	2.2	5	0.480 (12.19)	K, M	N, L, M, J, K	L1X(3)501225(2)(4)48
(1)49470X01275(2)B(3)	2.7	5	0.480 (12.19)	K, M	N, L, M, J, K	L1X(3)501275(2)(4)48
(1)49470X01335(2)B(3)	3.3	5	0.650 (16.51)	K, M	N, L, M, J, K	L1X(3)501335(2)(4)65
(1)49470X01395(2)B(3)	3.9	4	0.360 (9.14)	K, M	N, L, M, J, K	L1X(3)401395(2)(4)36
(1)49470X01475(2)B(3)	4.7	4	0.360 (9.14)	K, M	N, L, M, J, K	L1X(3)401475(2)(4)36
(1)49470X01565(2)B(3)	5.6	4	0.480 (12.19)	K, M	N, L, M, J, K	L1X(3)401565(2)(4)48
(1)49470X01685(2)B(3)	6.8	4	0.480 (12.19)	K, M	N, L, M, J, K	L1X(3)401685(2)(4)48
(1)49470X01825(2)B(3)	8.2	4	0.650 (16.51)	K, M	N, L, M, J, K	L1X(3)401825(2)(4)65
(1)49470X01106(2)B(3)	10	3	0.240 (6.10)	K, M	N, L, M, J, K	L1X(3)301106(2)(4)24
(1)49470X01126(2)B(3)	12	3	0.240 (6.10)	K, M	N, L, M, J, K	L1X(3)301126(2)(4)24
(1)49470X01156(2)B(3)	15	3	0.360 (9.14)	K, M	N, L, M, J, K	L1X(3)301156(2)(4)36
(1)49470X01186(2)B(3)	18	3	0.360 (9.14)	K, M	N, L, M, J, K	L1X(3)301186(2)(4)36
(1)49470X01226(2)B(3)	22	3	0.480 (12.19)	K, M	N, L, M, J, K	L1X(3)301226(2)(4)48
(1)49470X01276(2)B(3)	27	3	0.650 (16.51)	K, M	N, L, M, J, K	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, M, J, K	L1R(3)502474(2)(4)24
(1)49470R01564(2)C(3)	0.56	5	0.240 (6.10)	K, M	N, L, M, J, K	L1R(3)502564(2)(4)24
(1)49470R01684(2)C(3)	0.68	5	0.360 (9.14)	K, M	N, L, M, J, K	L1R(3)502684(2)(4)36
(1)49470R01824(2)C(3)	0.82	5	0.360 (9.14)	K, M	N, L, M, J, K	L1R(3)502824(2)(4)36
(1)49470R01105(2)C(3)	1	5	0.480 (12.19)	K, M	N, L, M, J, K	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", "M", "J" or "K".

(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'd

MIL–PRF–49470/1 Unencapsulated, 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, M, J, K	L1R(3)502125(2)(4)48
(1)49470R01155(2)C(3)	1.5	5	0.650 (16.51)	K, M	N, L, M, J, K	L1R(3)502155(2)(4)65
(1)49470R01185(2)C(3)	1.8	4	0.360 (9.14)	K, M	N, L, M, J, K	L1R(3)402185(2)(4)36
(1)49470R01225(2)C(3)	2.2	4	0.360 (9.14)	K, M	N, L, M, J, K	L1R(3)402225(2)(4)36
(1)49470R01275(2)C(3)	2.7	4	0.480 (12.19)	K, M	N, L, M, J, K	L1R(3)402275(2)(4)48
(1)49470R01335(2)C(3)	3.3	4	0.480 (12.19)	K, M	N, L, M, J, K	L1R(3)402335(2)(4)48
(1)49470R01395(2)C(3)	3.9	4	0.650 (16.51)	K, M	N, L, M, J, K	L1R(3)402395(2)(4)65
(1)49470R01475(2)C(3)	4.7	3	0.240 (6.10)	K, M	N, L, M, J, K	L1R(3)302475(2)(4)24
(1)49470R01565(2)C(3)	5.6	3	0.240 (6.10)	K, M	N, L, M, J, K	L1R(3)302565(2)(4)24
(1)49470R01685(2)C(3)	6.8	3	0.360 (9.14)	K, M	N, L, M, J, K	L1R(3)302685(2)(4)36
(1)49470R01825(2)C(3)	8.2	3	0.360 (9.14)	K, M	N, L, M, J, K	L1R(3)302825(2)(4)36
(1)49470R01106(2)C(3)	10	3	0.480 (12.19)	K, M	N, L, M, J, K	L1R(3)302106(2)(4)48
(1)49470R01126(2)C(3)	12	3	0.650 (16.51)	K, M	N, L, M, J, K	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, M, J, K	L1Q(3)50C154(2)(4)12
(1)49470Q01184(2)E(3)	0.18	5	0.240 (6.10)	K, M	N, L, M, J, K	L1Q(3)50C184(2)(4)24
(1)49470Q01224(2)E(3)	0.22	5	0.240 (6.10)	K, M	N, L, M, J, K	L1Q(3)50C224(2)(4)24
(1)49470Q01274(2)E(3)	0.27	5	0.240 (6.10)	K, M	N, L, M, J, K	L1Q(3)50C274(2)(4)24
(1)49470Q01334(2)E(3)	0.33	5	0.360 (9.14)	K, M	N, L, M, J, K	L1Q(3)50C334(2)(4)36
(1)49470Q01394(2)E(3)	0.39	5	0.360 (9.14)	K, M	N, L, M, J, K	L1Q(3)50C394(2)(4)36
(1)49470Q01474(2)E(3)	0.47	5	0.360 (9.14)	K, M	N, L, M, J, K	L1Q(3)50C474(2)(4)36
(1)49470Q01564(2)E(3)	0.56	5	0.480 (12.19)	K, M	N, L, M, J, K	L1Q(3)50C564(2)(4)48
(1)49470Q01684(2)E(3)	0.68	5	0.650 (16.51)	K, M	N, L, M, J, K	L1Q(3)50C684(2)(4)65
(1)49470Q01824(2)E(3)	0.82	4	0.360 (9.14)	K, M	N, L, M, J, K	L1Q(3)40C824(2)(4)36
(1)49470Q01105(2)E(3)	1	4	0.360 (9.14)	K, M	N, L, M, J, K	L1Q(3)40C105(2)(4)36
(1)49470Q01125(2)E(3)	1.2	4	0.360 (9.14)	K, M	N, L, M, J, K	L1Q(3)40C125(2)(4)36
(1)49470Q01155(2)E(3)	1.5	4	0.480 (12.19)	K, M	N, L, M, J, K	L1Q(3)40C155(2)(4)48
(1)49470Q01185(2)E(3)	1.8	4	0.650 (16.51)	K, M	N, L, M, J, K	L1Q(3)40C185(2)(4)65
(1)49470Q01225(2)E(3)	2.2	3	0.240 (6.10)	K, M	N, L, M, J, K	L1Q(3)30C225(2)(4)24
(1)49470Q01275(2)E(3)	2.7	3	0.360 (9.14)	K, M	N, L, M, J, K	L1Q(3)30C275(2)(4)36
(1)49470Q01335(2)E(3)	3.3	3	0.360 (9.14)	K, M	N, L, M, J, K	L1Q(3)30C335(2)(4)36
(1)49470Q01395(2)E(3)	3.9	3	0.360 (9.14)	K, M	N, L, M, J, K	L1Q(3)30C395(2)(4)36
(1)49470Q01475(2)E(3)	4.7	3	0.480 (12.19)	K, M	N, L, M, J, K	L1Q(3)30C475(2)(4)48
(1)49470Q01565(2)E(3)	5.6	3	0.650 (16.51)	K, M	N, L, M, J, K	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", "M", "J" or "K".

(4) Test level character "B" for B level, or "T" for T level (KEMET part number only).

Table 1B – MIL–PRF–49470/2, Product Selection 50 – 200 VDC

MIL–PRF–49470/2 Encapsulated, 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						
M49470X02125(1)A(2)	1.2	5	0.270 (6.86)	K, M	N, L, M, J, K	L2X(2)505125(1)B27
M49470X02155(1)A(2)	1.5	5	0.390 (9.91)	K, M	N, L, M, J, K	L2X(2)505155(1)B39
M49470X02185(1)A(2)	1.8	5	0.390 (9.91)	K, M	N, L, M, J, K	L2X(2)505185(1)B39
M49470X02225(1)A(2)	2.2	5	0.390 (9.91)	K, M	N, L, M, J, K	L2X(2)505225(1)B39
M49470X02275(1)A(2)	2.7	5	0.530 (13.46)	K, M	N, L, M, J, K	L2X(2)505275(1)B53
M49470X02335(1)A(2)	3.3	5	0.530 (13.46)	K, M	N, L, M, J, K	L2X(2)505335(1)B53
M49470X02475(1)A(2)	3.9	5	0.660 (16.76)	K, M	N, L, M, J, K	L2X(2)505475(1)B66
M49470X02395(1)A(2)	4.7	5	0.660 (16.76)	K, M	N, L, M, J, K	L2X(2)505395(1)B66
M49470X02565(1)A(2)	5.6	5	0.800 (20.32)	K, M	N, L, M, J, K	L2X(2)505565(1)B80
M49470X02685(1)A(2)	6.8	4	0.530 (13.46)	K, M	N, L, M, J, K	L2X(2)405685(1)B53
M49470X02825(1)A(2)	8.2	4	0.530 (13.46)	K, M	N, L, M, J, K	L2X(2)405825(1)B53
M49470X02106(1)A(2)	10	4	0.660 (16.76)	K, M	N, L, M, J, K	L2X(2)405106(1)B66
M49470X02126(1)A(2)	12	4	0.660 (16.76)	K, M	N, L, M, J, K	L2X(2)405126(1)B66
M49470X02156(1)A(2)	15	4	0.800 (20.32)	K, M	N, L, M, J, K	L2X(2)405156(1)B80
M49470X02186(1)A(2)	18	3	0.390 (9.91)	K, M	N, L, M, J, K	L2X(2)305186(1)B39
M49470X02226(1)A(2)	22	3	0.530 (13.46)	K, M	N, L, M, J, K	L2X(2)305226(1)B53
M49470X02276(1)A(2)	27	3	0.530 (13.46)	K, M	N, L, M, J, K	L2X(2)305276(1)B53
M49470X02336(1)A(2)	33	3	0.530 (13.46)	K, M	N, L, M, J, K	L2X(2)305336(1)B53
M49470X02396(1)A(2)	39	3	0.660 (16.76)	K, M	N, L, M, J, K	L2X(2)305396(1)B66
M49470X02476(1)A(2)	47	3	0.800 (20.32)	K, M	N, L, M, J, K	L2X(2)305476(1)B80
100 VDC – BX Dielectric						
M49470X02684(1)B(2)	0.68	5	0.270 (6.86)	K, M	N, L, M, J, K	L2X(2)501684(1)B27
M49470X02824(1)B(2)	0.82	5	0.390 (9.91)	K, M	N, L, M, J, K	L2X(2)501824(1)B39
M49470X02105(1)B(2)	1	5	0.390 (9.91)	K, M	N, L, M, J, K	L2X(2)501105(1)B39
M49470X02125(1)B(2)	1.2	5	0.390 (9.91)	K, M	N, L, M, J, K	L2X(2)501125(1)B39
M49470X02155(1)B(2)	1.5	5	0.530 (13.46)	K, M	N, L, M, J, K	L2X(2)501155(1)B53
M49470X02185(1)B(2)	1.8	5	0.530 (13.46)	K, M	N, L, M, J, K	L2X(2)501185(1)B53
M49470X02225(1)B(2)	2.2	5	0.660 (16.76)	K, M	N, L, M, J, K	L2X(2)501225(1)B66
M49470X02275(1)B(2)	2.7	5	0.660 (16.76)	K, M	N, L, M, J, K	L2X(2)501275(1)B66
M49470X02335(1)B(2)	3.3	5	0.800 (20.32)	K, M	N, L, M, J, K	L2X(2)501335(1)B80
M49470X02395(1)B(2)	3.9	4	0.530 (13.46)	K, M	N, L, M, J, K	L2X(2)401395(1)B53
M49470X02475(1)B(2)	4.7	4	0.530 (13.46)	K, M	N, L, M, J, K	L2X(2)401475(1)B53
M49470X02565(1)B(2)	5.6	4	0.660 (16.76)	K, M	N, L, M, J, K	L2X(2)401565(1)B66
M49470X02685(1)B(2)	6.8	4	0.660 (16.76)	K, M	N, L, M, J, K	L2X(2)401685(1)B66
M49470X02825(1)B(2)	8.2	4	0.800 (20.32)	K, M	N, L, M, J, K	L2X(2)401825(1)B80
M49470X02106(1)B(2)	10	3	0.390 (9.91)	K, M	N, L, M, J, K	L2X(2)301106(1)B39
M49470X02126(1)B(2)	12	3	0.390 (9.91)	K, M	N, L, M, J, K	L2X(2)301126(1)B39
M49470X02156(1)B(2)	15	3	0.530 (13.46)	K, M	N, L, M, J, K	L2X(2)301156(1)B53
M49470X02186(1)B(2)	18	3	0.530 (13.46)	K, M	N, L, M, J, K	L2X(2)301186(1)B53
M49470X02226(1)B(2)	22	3	0.660 (16.76)	K, M	N, L, M, J, K	L2X(2)301226(1)B66
M49470X02276(1)B(2)	27	3	0.800 (20.32)	K, M	N, L, M, J, K	L2X(2)301276(1)B80
200 VDC – BR Dielectric						
M49470R02474(1)C(2)	0.47	5	0.390 (9.91)	K, M	N, L, M, J, K	L2R(2)502474(1)B39
M49470R02564(1)C(2)	0.56	5	0.390 (9.91)	K, M	N, L, M, J, K	L2R(2)502564(1)B39
M49470R02684(1)C(2)	0.68	5	0.530 (13.46)	K, M	N, L, M, J, K	L2R(2)502684(1)B53
M49470R02824(1)C(2)	0.82	5	0.530 (13.46)	K, M	N, L, M, J, K	L2R(2)502824(1)B53
M49470R02105(1)C(2)	1	5	0.660 (16.76)	K, M	N, L, M, J, K	L2R(2)502105(1)B66
M49470R02125(1)C(2)	1.2	5	0.660 (16.76)	K, M	N, L, M, J, K	L2R(2)502125(1)B66
M49470R02155(1)C(2)	1.5	5	0.800 (20.32)	K, M	N, L, M, J, K	L2R(2)502155(1)B80
M49470R02185(1)C(2)	1.8	4	0.530 (13.46)	K, M	N, L, M, J, K	L2R(2)402185(1)B53
M49470R02225(1)C(2)	2.2	4	0.530 (13.46)	K, M	N, L, M, J, K	L2R(2)402225(1)B53
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 capacitance tolerance and lead configuration. For each numbered position, available options are as follows:

(1) Capacitance tolerance character " K" or " M".

(2) Lead style character " N", "L", "M", "J" or "K".

Table 1B – MIL–PRF–49470 /2, Product Selection 200 – 500 VDC cont'd

MIL–PRF–49470/2 Encapsulated, Horizontally Stacked						
MIL–PRF–49470 P/N [1]	Capacitance (µF)	Case Code	Height A inch (mm)	Capacitance Tolerance	Lead Configuration	KEMET P/N [1]
M49470R02275(1)C(2)	2.7	4	0.660 (16.76)	K, M	N, L, M, J, K	L2R(2)402275(1)B66
M49470R02335(1)C(2)	3.3	4	0.660 (16.76)	K, M	N, L, M, J, K	L2R(2)402335(1)B66
M49470R02395(1)C(2)	3.9	4	0.800 (20.32)	K, M	N, L, M, J, K	L2R(2)402395(1)B80
M49470R02475(1)C(2)	4.7	3	0.390 (9.91)	K, M	N, L, M, J, K	L2R(2)302475(1)B39
M49470R02565(1)C(2)	5.6	3	0.390 (9.91)	K, M	N, L, M, J, K	L2R(2)302565(1)B39
M49470R02685(1)C(2)	6.8	3	0.530 (13.46)	K, M	N, L, M, J, K	L2R(2)302685(1)B53
M49470R02825(1)C(2)	8.2	3	0.530 (13.46)	K, M	N, L, M, J, K	L2R(2)302825(1)B53
M49470R02106(1)C(2)	10	3	0.660 (16.76)	K, M	N, L, M, J, K	L2R(2)302106(1)B66
M49470R02126(1)C(2)	12	3	0.800 (20.32)	K, M	N, L, M, J, K	L2R(2)302126(1)B80
500 VDC – BQ Dielectric						
M49470Q02154(1)E(2)	0.15	5	0.270 (6.86)	K, M	N, L, M, J, K	L2Q(2)50C154(1)B27
M49470Q02184(1)E(2)	0.18	5	0.390 (9.91)	K, M	N, L, M, J, K	L2Q(2)50C184(1)B39
M49470Q02224(1)E(2)	0.22	5	0.390 (9.91)	K, M	N, L, M, J, K	L2Q(2)50C224(1)B39
M49470Q02274(1)E(2)	0.27	5	0.390 (9.91)	K, M	N, L, M, J, K	L2Q(2)50C274(1)B39
M49470Q02334(1)E(2)	0.33	5	0.530 (13.46)	K, M	N, L, M, J, K	L2Q(2)50C334(1)B53
M49470Q02394(1)E(2)	0.39	5	0.530 (13.46)	K, M	N, L, M, J, K	L2Q(2)50C394(1)B53
M49470Q02474(1)E(2)	0.47	5	0.530 (13.46)	K, M	N, L, M, J, K	L2Q(2)50C474(1)B53
M49470Q02564(1)E(2)	0.56	5	0.660 (16.76)	K, M	N, L, M, J, K	L2Q(2)50C564(1)B66
M49470Q02684(1)E(2)	0.68	5	0.800 (20.32)	K, M	N, L, M, J, K	L2Q(2)50C684(1)B80
M49470Q02824(1)E(2)	0.82	4	0.530 (13.46)	K, M	N, L, M, J, K	L2Q(2)40C824(1)B53
M49470Q02105(1)E(2)	1	4	0.530 (13.46)	K, M	N, L, M, J, K	L2Q(2)40C105(1)B53
M49470Q02125(1)E(2)	1.2	4	0.530 (13.46)	K, M	N, L, M, J, K	L2Q(2)40C125(1)B53
M49470Q02155(1)E(2)	1.5	4	0.660 (16.76)	K, M	N, L, M, J, K	L2Q(2)40C155(1)B66
M49470Q02185(1)E(2)	1.8	4	0.800 (20.32)	K, M	N, L, M, J, K	L2Q(2)40C185(1)B80
M49470Q02225(1)E(2)	2.2	3	0.390 (9.91)	K, M	N, L, M, J, K	L2Q(2)30C225(1)B39
M49470Q02275(1)E(2)	2.7	3	0.530 (13.46)	K, M	N, L, M, J, K	L2Q(2)30C275(1)B53
M49470Q02335(1)E(2)	3.3	3	0.530 (13.46)	K, M	N, L, M, J, K	L2Q(2)30C335(1)B53
M49470Q02395(1)E(2)	3.9	3	0.530 (13.46)	K, M	N, L, M, J, K	L2Q(2)30C395(1)B53
M49470Q02475(1)E(2)	4.7	3	0.660 (16.76)	K, M	N, L, M, J, K	L2Q(2)30C475(1)B66
M49470Q02565(1)E(2)	5.6	3	0.800 (20.32)	K, M	N, L, M, J, K	L2Q(2)30C565(1)B80
M49470Q02565(1)E(2)	5.6	3	0.800 (20.32)	K, M	N, L, M, J, K	L2Q(2)30C565(1)B65
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 capacitance tolerance and lead configuration. For each numbered position, available options are as follows:

(1) Capacitance tolerance character " K" or " M".

(2) Lead style character " N", "L", "M", "J" or "K".

Table 1C – 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, M, J, K
L1X(1)503105(2)(3)12	1	5	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)503125(2)(3)12	1.2	5	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)503155(2)(3)12	1.5	5	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)503185(2)(3)24	1.8	5	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)403225(2)(3)12	2.2	4	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)503225(2)(3)24	2.2	5	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)503255(2)(3)24	2.5	5	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)403275(2)(3)12	2.7	4	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)503275(2)(3)24	2.7	5	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)403335(2)(3)12	3.3	4	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)503335(2)(3)36	3.3	5	0.360 (9.14)	K, M	N, L, M, J, K
L1X(1)403395(2)(3)12	3.9	4	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)503395(2)(3)36	3.9	5	0.360 (9.14)	K, M	N, L, M, J, K
L1X(1)403475(2)(3)12	4.7	4	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)503475(2)(3)36	4.7	5	0.360 (9.14)	K, M	N, L, M, J, K
L1X(1)403565(2)(3)24	5.6	4	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)503565(2)(3)48	5.6	5	0.480 (12.19)	K, M	N, L, M, J, K
L1X(1)403605(2)(3)24	6	4	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)503605(2)(3)48	6	5	0.480 (12.19)	K, M	N, L, M, J, K
L1X(1)303685(2)(3)12	6.8	3	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)403685(2)(3)24	6.8	4	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)503685(2)(3)65	6.8	5	0.650 (16.51)	K, M	N, L, M, J, K
L1X(1)403755(2)(3)24	7.5	4	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)503755(2)(3)65	7.5	5	0.650 (16.51)	K, M	N, L, M, J, K
L1X(1)303825(2)(3)12	8.2	3	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)403825(2)(3)24	8.2	4	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)303106(2)(3)12	10	3	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)403106(2)(3)24	10	4	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)303116(2)(3)12	11	3	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)303126(2)(3)12	12	3	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)403126(2)(3)36	12	4	0.360 (9.14)	K, M	N, L, M, J, K
L1X(1)303156(2)(3)12	15	3	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)403156(2)(3)36	15	4	0.360 (9.14)	K, M	N, L, M, J, K
L1X(1)303166(2)(3)24	16	3	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)403166(2)(3)48	16	4	0.480 (12.19)	K, M	N, L, M, J, K
L1X(1)303186(2)(3)24	18	3	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)403186(2)(3)48	18	4	0.480 (12.19)	K, M	N, L, M, J, K
L1X(1)303206(2)(3)24	20	3	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)403206(2)(3)48	20	4	0.480 (12.19)	K, M	N, L, M, J, K
L1X(1)303226(2)(3)24	22	3	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)403226(2)(3)65	22	4	0.650 (16.51)	K, M	N, L, M, J, K
L1X(1)403246(2)(3)65	24	4	0.650 (16.51)	K, M	N, L, M, J, K
L1X(1)303276(2)(3)24	27	3	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)303306(2)(3)24	30	3	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)303306(2)(3)36	30	3	0.360 (9.14)	K, M	N, L, M, J, K
L1X(1)303336(2)(3)36	33	3	0.360 (9.14)	K, M	N, L, M, J, K
L1X(1)303396(2)(3)36	39	3	0.360 (9.14)	K, M	N, L, M, J, K
L1X(1)303456(2)(3)36	45	3	0.360 (9.14)	K, M	N, L, M, J, K
L1X(1)303506(2)(3)48	50	3	0.480 (12.19)	K, M	N, L, M, J, K
L1X(1)303546(2)(3)48	54	3	0.480 (12.19)	K, M	N, L, M, J, K
L1X(1)303606(2)(3)48	60	3	0.480 (12.19)	K, M	N, L, M, J, K
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 1C – Commercial/Non-Standard – Product Selection 25 – 50 VDC cont'd

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, M, J, K
L1X(1)303726(2)(3)65	72	3	0.650 (16.51)	K, M	N, L, M, J, K
L1X(1)303756(2)(3)65	75	3	0.650 (16.51)	K, M	N, L, M, J, K
50 VDC – BX Dielectric					
L1X(1)505824(2)(3)12	0.82	5	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)505105(2)(3)12	1	5	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)505125(2)(3)12	1.2	5	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)505155(2)(3)12	1.5	5	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)505185(2)(3)24	1.8	5	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)405225(2)(3)12	2.2	4	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)505225(2)(3)24	2.2	5	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)505255(2)(3)24	2.5	5	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)405275(2)(3)12	2.7	4	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)505275(2)(3)24	2.7	5	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)505275(2)(3)36	2.7	5	0.360 (9.14)	K, M	N, L, M, J, K
L1X(1)405335(2)(3)12	3.3	4	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)505335(2)(3)36	3.3	5	0.360 (9.14)	K, M	N, L, M, J, K
L1X(1)405395(2)(3)12	3.9	4	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)505395(2)(3)36	3.9	5	0.360 (9.14)	K, M	N, L, M, J, K
L1X(1)405475(2)(3)12	4.7	4	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)505475(2)(3)36	4.7	5	0.360 (9.14)	K, M	N, L, M, J, K
L1X(1)405565(2)(3)24	5.6	4	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)505565(2)(3)48	5.6	5	0.480 (12.19)	K, M	N, L, M, J, K
L1X(1)405605(2)(3)24	6	4	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)505605(2)(3)48	6	5	0.480 (12.19)	K, M	N, L, M, J, K
L1X(1)305685(2)(3)12	6.8	3	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)405685(2)(3)24	6.8	4	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)505685(2)(3)65	6.8	5	0.650 (16.51)	K, M	N, L, M, J, K
L1X(1)405755(2)(3)24	7.5	4	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)505755(2)(3)65	7.5	5	0.650 (16.51)	K, M	N, L, M, J, K
L1X(1)305825(2)(3)12	8.2	3	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)405825(2)(3)24	8.2	4	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)305106(2)(3)12	10	3	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)405106(2)(3)24	10	4	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)305116(2)(3)12	11	3	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)305126(2)(3)12	12	3	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)405126(2)(3)36	12	4	0.360 (9.14)	K, M	N, L, M, J, K
L1X(1)305156(2)(3)12	15	3	0.120 (3.05)	K, M	N, L, M, J, K
L1X(1)405156(2)(3)36	15	4	0.360 (9.14)	K, M	N, L, M, J, K
L1X(1)305166(2)(3)24	16	3	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)405166(2)(3)48	16	4	0.480 (12.19)	K, M	N, L, M, J, K
L1X(1)305186(2)(3)24	18	3	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)405186(2)(3)48	18	4	0.480 (12.19)	K, M	N, L, M, J, K
L1X(1)305206(2)(3)24	20	3	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)405206(2)(3)48	20	4	0.480 (12.19)	K, M	N, L, M, J, K
L1X(1)305226(2)(3)24	22	3	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)405226(2)(3)65	22	4	0.650 (16.51)	K, M	N, L, M, J, K
L1X(1)405246(2)(3)65	24	4	0.650 (16.51)	K, M	N, L, M, J, K
L1X(1)305276(2)(3)24	27	3	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)305306(2)(3)24	30	3	0.240 (6.10)	K, M	N, L, M, J, K
L1X(1)305336(2)(3)36	33	3	0.360 (9.14)	K, M	N, L, M, J, K
L1X(1)305396(2)(3)36	39	3	0.360 (9.14)	K, M	N, L, M, J, K
L1X(1)305456(2)(3)36	45	3	0.360 (9.14)	K, M	N, L, M, J, K
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 1C – Commercial/Non-Standard – Product Selection 50 – 100 VDC cont'd

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, M, J, K
L1X(1)305546(2)(3)48	54	3	0.480 (12.19)	K, M	N, L, M, J, K
L1X(1)305606(2)(3)48	60	3	0.480 (12.19)	K, M	N, L, M, J, K
L1X(1)305666(2)(3)65	66	3	0.650 (16.51)	K, M	N, L, M, J, K
L1X(1)305726(2)(3)65	72	3	0.650 (16.51)	K, M	N, L, M, J, K
L1X(1)305756(2)(3)65	75	3	0.650 (16.51)	K, M	N, L, M, J, K
100 VDC – BR Dielectric					
L1R(1)501564(2)(3)12	0.56	5	0.120 (3.05)	K, M	N, L, M, J, K
L1R(1)501684(2)(3)12	0.68	5	0.120 (3.05)	K, M	N, L, M, J, K
L1R(1)501754(2)(3)12	0.75	5	0.120 (3.05)	K, M	N, L, M, J, K
L1R(1)501824(2)(3)12	0.82	5	0.120 (3.05)	K, M	N, L, M, J, K
L1R(1)501105(2)(3)12	1	5	0.120 (3.05)	K, M	N, L, M, J, K
L1R(1)501125(2)(3)12	1.2	5	0.120 (3.05)	K, M	N, L, M, J, K
L1R(1)401155(2)(3)12	1.5	4	0.120 (3.05)	K, M	N, L, M, J, K
L1R(1)501155(2)(3)24	1.5	5	0.240 (6.10)	K, M	N, L, M, J, K
L1R(1)401185(2)(3)12	1.8	4	0.120 (3.05)	K, M	N, L, M, J, K
L1R(1)501185(2)(3)24	1.8	5	0.240 (6.10)	K, M	N, L, M, J, K
L1R(1)401225(2)(3)12	2.2	4	0.120 (3.05)	K, M	N, L, M, J, K
L1R(1)501225(2)(3)24	2.2	5	0.240 (6.10)	K, M	N, L, M, J, K
L1R(1)501255(2)(3)24	2.5	5	0.240 (6.10)	K, M	N, L, M, J, K
L1R(1)401275(2)(3)12	2.7	4	0.120 (3.05)	K, M	N, L, M, J, K
L1R(1)501275(2)(3)36	2.7	5	0.360 (9.14)	K, M	N, L, M, J, K
L1R(1)401335(2)(3)12	3.3	4	0.120 (3.05)	K, M	N, L, M, J, K
L1R(1)501335(2)(3)36	3.3	5	0.360 (9.14)	K, M	N, L, M, J, K
L1R(1)401395(2)(3)12	3.9	4	0.120 (3.05)	K, M	N, L, M, J, K
L1R(1)501395(2)(3)48	3.9	5	0.480 (12.19)	K, M	N, L, M, J, K
L1R(1)401475(2)(3)24	4.7	4	0.240 (6.10)	K, M	N, L, M, J, K
L1R(1)501475(2)(3)48	4.7	5	0.480 (12.19)	K, M	N, L, M, J, K
L1R(1)301565(2)(3)12	5.6	3	0.120 (3.05)	K, M	N, L, M, J, K
L1R(1)401565(2)(3)24	5.6	4	0.240 (6.10)	K, M	N, L, M, J, K
L1R(1)501565(2)(3)65	5.6	5	0.650 (16.51)	K, M	N, L, M, J, K
L1R(1)301605(2)(3)12	6	3	0.120 (3.05)	K, M	N, L, M, J, K
L1R(1)401605(2)(3)24	6	4	0.240 (6.10)	K, M	N, L, M, J, K
L1R(1)501605(2)(3)65	6	5	0.650 (16.51)	K, M	N, L, M, J, K
L1R(1)301685(2)(3)12	6.8	3	0.120 (3.05)	K, M	N, L, M, J, K
L1R(1)401685(2)(3)24	6.8	4	0.240 (6.10)	K, M	N, L, M, J, K
L1R(1)401755(2)(3)24	7.5	4	0.240 (6.10)	K, M	N, L, M, J, K
L1R(1)301825(2)(3)12	8.2	3	0.120 (3.05)	K, M	N, L, M, J, K
L1R(1)401825(2)(3)36	8.2	4	0.360 (9.14)	K, M	N, L, M, J, K
L1R(1)301106(2)(3)12	10	3	0.120 (3.05)	K, M	N, L, M, J, K
L1R(1)401106(2)(3)36	10	4	0.360 (9.14)	K, M	N, L, M, J, K
L1R(1)301116(2)(3)12	11	3	0.120 (3.05)	K, M	N, L, M, J, K
L1R(1)301126(2)(3)24	12	3	0.240 (6.10)	K, M	N, L, M, J, K
L1R(1)401126(2)(3)48	12	4	0.480 (12.19)	K, M	N, L, M, J, K
L1R(1)301156(2)(3)24	15	3	0.240 (6.10)	K, M	N, L, M, J, K
L1R(1)401156(2)(3)48	15	4	0.480 (12.19)	K, M	N, L, M, J, K
L1R(1)301166(2)(3)24	16	3	0.240 (6.10)	K, M	N, L, M, J, K
L1R(1)401166(2)(3)65	16	4	0.650 (16.51)	K, M	N, L, M, J, K
L1R(1)301186(2)(3)24	18	3	0.240 (6.10)	K, M	N, L, M, J, K
L1R(1)401186(2)(3)65	18	4	0.650 (16.51)	K, M	N, L, M, J, K
L1R(1)301206(2)(3)24	20	3	0.240 (6.10)	K, M	N, L, M, J, K
L1R(1)301226(2)(3)36	22	3	0.360 (9.14)	K, M	N, L, M, J, K
L1R(1)301276(2)(3)36	27	3	0.360 (9.14)	K, M	N, L, M, J, K
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 1C – Commercial/Non-Standard – Product Selection 100 – 200 VDC cont'd

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, M, J, K
L1R(1)301336(2)(3)48	33	3	0.480 (12.19)	K, M	N, L, M, J, K
L1R(1)301396(2)(3)48	39	3	0.480 (12.19)	K, M	N, L, M, J, K
L1R(1)301456(2)(3)65	45	3	0.650 (16.51)	K, M	N, L, M, J, K
L1R(1)301506(2)(3)65	50	3	0.650 (16.51)	K, M	N, L, M, J, K
200 VDC – BQ Dielectric					
L1Q(1)502334(2)(3)12	0.33	5	0.120 (3.05)	K, M	N, L, M, J, K
L1Q(1)502394(2)(3)12	0.39	5	0.120 (3.05)	K, M	N, L, M, J, K
L1Q(1)502474(2)(3)12	0.47	5	0.120 (3.05)	K, M	N, L, M, J, K
L1Q(1)502564(2)(3)12	0.56	5	0.120 (3.05)	K, M	N, L, M, J, K
L1Q(1)502684(2)(3)12	0.68	5	0.120 (3.05)	K, M	N, L, M, J, K
L1Q(1)502754(2)(3)12	0.75	5	0.120 (3.05)	K, M	N, L, M, J, K
L1Q(1)402824(2)(3)12	0.82	4	0.120 (3.05)	K, M	N, L, M, J, K
L1Q(1)502824(2)(3)24	0.82	5	0.240 (6.10)	K, M	N, L, M, J, K
L1Q(1)402105(2)(3)12	1	4	0.120 (3.05)	K, M	N, L, M, J, K
L1Q(1)502105(2)(3)24	1	5	0.240 (6.10)	K, M	N, L, M, J, K
L1Q(1)402125(2)(3)12	1.2	4	0.120 (3.05)	K, M	N, L, M, J, K
L1Q(1)502125(2)(3)24	1.2	5	0.240 (6.10)	K, M	N, L, M, J, K
L1Q(1)402155(2)(3)12	1.5	4	0.120 (3.05)	K, M	N, L, M, J, K
L1Q(1)502155(2)(3)36	1.5	5	0.360 (9.14)	K, M	N, L, M, J, K
L1Q(1)402185(2)(3)12	1.8	4	0.120 (3.05)	K, M	N, L, M, J, K
L1Q(1)502185(2)(3)36	1.8	5	0.360 (9.14)	K, M	N, L, M, J, K
L1Q(1)402225(2)(3)24	2.2	4	0.240 (6.10)	K, M	N, L, M, J, K
L1Q(1)502225(2)(3)48	2.2	5	0.480 (12.19)	K, M	N, L, M, J, K
L1Q(1)302245(2)(3)12	2.4	3	0.120 (3.05)	K, M	N, L, M, J, K
L1Q(1)502255(2)(3)48	2.5	5	0.480 (12.19)	K, M	N, L, M, J, K
L1Q(1)302275(2)(3)12	2.7	3	0.120 (3.05)	K, M	N, L, M, J, K
L1Q(1)402275(2)(3)24	2.7	4	0.240 (6.10)	K, M	N, L, M, J, K
L1Q(1)502275(2)(3)48	2.7	5	0.480 (12.19)	K, M	N, L, M, J, K
L1Q(1)302335(2)(3)12	3.3	3	0.120 (3.05)	K, M	N, L, M, J, K
L1Q(1)402335(2)(3)24	3.3	4	0.240 (6.10)	K, M	N, L, M, J, K
L1Q(1)502335(2)(3)65	3.3	5	0.650 (16.51)	K, M	N, L, M, J, K
L1Q(1)302365(2)(3)12	3.6	3	0.120 (3.05)	K, M	N, L, M, J, K
L1Q(1)302395(2)(3)12	3.9	3	0.120 (3.05)	K, M	N, L, M, J, K
L1Q(1)402395(2)(3)24	3.9	4	0.240 (6.10)	K, M	N, L, M, J, K
L1Q(1)302475(2)(3)12	4.7	3	0.120 (3.05)	K, M	N, L, M, J, K
L1Q(1)402475(2)(3)36	4.7	4	0.360 (9.14)	K, M	N, L, M, J, K
L1Q(1)302565(2)(3)12	5.6	3	0.120 (3.05)	K, M	N, L, M, J, K
L1Q(1)402565(2)(3)36	5.6	4	0.360 (9.14)	K, M	N, L, M, J, K
L1Q(1)302605(2)(3)12	6	3	0.120 (3.05)	K, M	N, L, M, J, K
L1Q(1)402605(2)(3)36	6	4	0.360 (9.14)	K, M	N, L, M, J, K
L1Q(1)302685(2)(3)24	6.8	3	0.240 (6.10)	K, M	N, L, M, J, K
L1Q(1)402685(2)(3)48	6.8	4	0.480 (12.19)	K, M	N, L, M, J, K
L1Q(1)402755(2)(3)48	7.5	4	0.480 (12.19)	K, M	N, L, M, J, K
L1Q(1)302825(2)(3)24	8.2	3	0.240 (6.10)	K, M	N, L, M, J, K
L1Q(1)402825(2)(3)65	8.2	4	0.650 (16.51)	K, M	N, L, M, J, K
L1Q(1)302106(2)(3)24	10	3	0.240 (6.10)	K, M	N, L, M, J, K
L1Q(1)402106(2)(3)65	10	4	0.650 (16.51)	K, M	N, L, M, J, K
L1Q(1)302116(2)(3)24	11	3	0.240 (6.10)	K, M	N, L, M, J, K
L1Q(1)302126(2)(3)36	12	3	0.360 (9.14)	K, M	N, L, M, J, K
L1Q(1)302156(2)(3)36	15	3	0.360 (9.14)	K, M	N, L, M, J, K
L1Q(1)302166(2)(3)36	16	3	0.360 (9.14)	K, M	N, L, M, J, K
L1Q(1)302186(2)(3)48	18	3	0.480 (12.19)	K, M	N, L, M, J, K
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 1C – Commercial/Non-Standard – Product Selection 200 – 630 VDC cont'd

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, M, J, K
L1Q(1)302226(2)(3)48	22	3	0.480 (12.19)	K, M	N, L, M, J, K
L1Q(1)302276(2)(3)65	27	3	0.650 (16.51)	K, M	N, L, M, J, K
500 VDC – X7R Dielectric					
L1W(1)50C124(2)(3)12	0.12	5	0.120 (3.05)	K, M	N, L, M, J, K
L1W(1)50C154(2)(3)12	0.15	5	0.120 (3.05)	K, M	N, L, M, J, K
L1W(1)50C184(2)(3)12	0.18	5	0.120 (3.05)	K, M	N, L, M, J, K
L1W(1)50C224(2)(3)12	0.22	5	0.120 (3.05)	K, M	N, L, M, J, K
L1W(1)50C274(2)(3)12	0.27	5	0.120 (3.05)	K, M	N, L, M, J, K
L1W(1)50C334(2)(3)24	0.33	5	0.240 (6.10)	K, M	N, L, M, J, K
L1W(1)40C394(2)(3)12	0.39	4	0.120 (3.05)	K, M	N, L, M, J, K
L1W(1)50C394(2)(3)24	0.39	5	0.240 (6.10)	K, M	N, L, M, J, K
L1W(1)40C474(2)(3)12	0.47	4	0.120 (3.05)	K, M	N, L, M, J, K
L1W(1)50C474(2)(3)24	0.47	5	0.240 (6.10)	K, M	N, L, M, J, K
L1W(1)50C564(2)(3)24	0.56	5	0.240 (6.10)	K, M	N, L, M, J, K
L1W(1)40C684(2)(3)12	0.68	4	0.120 (3.05)	K, M	N, L, M, J, K
L1W(1)50C684(2)(3)36	0.68	5	0.360 (9.14)	K, M	N, L, M, J, K
L1W(1)50C754(2)(3)36	0.75	5	0.360 (9.14)	K, M	N, L, M, J, K
L1W(1)40C824(2)(3)12	0.82	4	0.120 (3.05)	K, M	N, L, M, J, K
L1W(1)50C824(2)(3)36	0.82	5	0.360 (9.14)	K, M	N, L, M, J, K
L1W(1)30C105(2)(3)12	1	3	0.120 (3.05)	K, M	N, L, M, J, K
L1W(1)40C105(2)(3)24	1	4	0.240 (6.10)	K, M	N, L, M, J, K
L1W(1)50C105(2)(3)48	1	5	0.480 (12.19)	K, M	N, L, M, J, K
L1W(1)30C125(2)(3)12	1.2	3	0.120 (3.05)	K, M	N, L, M, J, K
L1W(1)40C125(2)(3)24	1.2	4	0.240 (6.10)	K, M	N, L, M, J, K
L1W(1)50C125(2)(3)65	1.2	5	0.650 (16.51)	K, M	N, L, M, J, K
L1W(1)30C155(2)(3)12	1.5	3	0.120 (3.05)	K, M	N, L, M, J, K
L1W(1)40C155(2)(3)24	1.5	4	0.240 (6.10)	K, M	N, L, M, J, K
L1W(1)50C155(2)(3)65	1.5	5	0.650 (16.51)	K, M	N, L, M, J, K
L1W(1)40C185(2)(3)36	1.8	4	0.360 (9.14)	K, M	N, L, M, J, K
L1W(1)30C225(2)(3)12	2.2	3	0.120 (3.05)	K, M	N, L, M, J, K
L1W(1)40C225(2)(3)36	2.2	4	0.360 (9.14)	K, M	N, L, M, J, K
L1W(1)30C245(2)(3)12	2.4	3	0.120 (3.05)	K, M	N, L, M, J, K
L1W(1)30C275(2)(3)12	2.7	3	0.120 (3.05)	K, M	N, L, M, J, K
L1W(1)40C275(2)(3)48	2.7	4	0.480 (12.19)	K, M	N, L, M, J, K
L1W(1)30C335(2)(3)24	3.3	3	0.240 (6.10)	K, M	N, L, M, J, K
L1W(1)40C335(2)(3)48	3.3	4	0.480 (12.19)	K, M	N, L, M, J, K
L1W(1)30C365(2)(3)24	3.6	3	0.240 (6.10)	K, M	N, L, M, J, K
L1W(1)30C395(2)(3)24	3.9	3	0.240 (6.10)	K, M	N, L, M, J, K
L1W(1)40C395(2)(3)65	3.9	4	0.650 (16.51)	K, M	N, L, M, J, K
L1W(1)30C475(2)(3)24	4.7	3	0.240 (6.10)	K, M	N, L, M, J, K
L1W(1)30C565(2)(3)24	5.6	3	0.240 (6.10)	K, M	N, L, M, J, K
L1W(1)30C605(2)(3)24	6	3	0.240 (6.10)	K, M	N, L, M, J, K
L1W(1)30C685(2)(3)36	6.8	3	0.360 (9.14)	K, M	N, L, M, J, K
L1W(1)30C825(2)(3)36	8.2	3	0.360 (9.14)	K, M	N, L, M, J, K
L1W(1)30C106(2)(3)48	10	3	0.480 (12.19)	K, M	N, L, M, J, K
L1W(1)30C116(2)(3)65	11	3	0.650 (16.51)	K, M	N, L, M, J, K
L1W(1)30C126(2)(3)65	12	3	0.650 (16.51)	K, M	N, L, M, J, K
630 VDC – X7R Dielectric					
L1W(1)50B683(2)(3)12	0.068	5	0.120 (3.05)	K, M	N, L, M, J, K
L1W(1)40B104(2)(3)12	0.1	4	0.120 (3.05)	K, M	N, L, M, J, K
L1W(1)50B104(2)(3)12	0.1	5	0.120 (3.05)	K, M	N, L, M, J, K
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 1C – Commercial/Non-Standard – Product Selection 630 – 1,000 VDC cont'd

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

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, M, J, K
L1W(1)50D394(2)(3)65	0.39	5	0.650 (16.51)	K, M	N, L, M, J, K
L1W(1)30D474(2)(3)12	0.47	3	0.120 (3.05)	K, M	N, L, M, J, K
L1W(1)40D474(2)(3)24	0.47	4	0.240 (6.10)	K, M	N, L, M, J, K
L1W(1)30D684(2)(3)12	0.68	3	0.120 (3.05)	K, M	N, L, M, J, K
L1W(1)40D684(2)(3)36	0.68	4	0.360 (9.14)	K, M	N, L, M, J, K
L1W(1)40D824(2)(3)48	0.82	4	0.480 (12.19)	K, M	N, L, M, J, K
L1W(1)30D105(2)(3)24	1	3	0.240 (6.10)	K, M	N, L, M, J, K
L1W(1)40D105(2)(3)65	1	4	0.650 (16.51)	K, M	N, L, M, J, K
L1W(1)30D125(2)(3)24	1.2	3	0.240 (6.10)	K, M	N, L, M, J, K
L1W(1)30D155(2)(3)36	1.5	3	0.360 (9.14)	K, M	N, L, M, J, K
L1W(1)30D225(2)(3)36	2.2	3	0.360 (9.14)	K, M	N, L, M, J, K
L1W(1)30D245(2)(3)48	2.4	3	0.480 (12.19)	K, M	N, L, M, J, K
L1W(1)30D275(2)(3)48	2.7	3	0.480 (12.19)	K, M	N, L, M, J, K
L1W(1)30D335(2)(3)65	3.3	3	0.650 (16.51)	K, M	N, L, M, J, K
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).

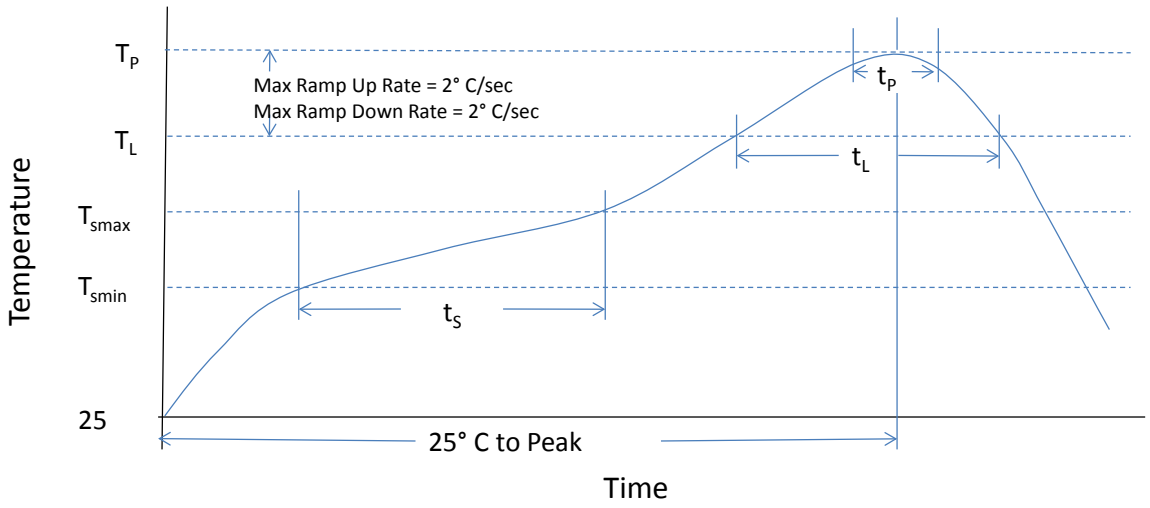
Soldering Process

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

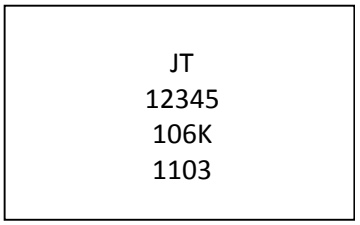
Inspection	Test Method	Test Level Option				
		MIL–PRF–49470 B Level (B)	MIL–PRF–49470 T Level (T)	DSSC Drawing 87106 (C)[1]	Commercial (S)	Non-Standard (X)[2]
In-Process Inspection						
Ultrasonic Scanning (C-SAM)	Meet EIA–469 Criteria	Not required	Yes (per lot)	Not required	Not required	Optional per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

[1] *As per discretionary statement outlined in cancelled DSCC Drawing 87106, KEMET will not perform Group B inspections on a per lot basis. KEMET 87106 orders may include a standard certificate of compliance stating compliance to the 87106 requirements, specifically conformance to Group B inspections. Please contact KEMET for additional details*

[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.*

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.



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	Small Box Quantity[1] (7.5” x 7.5”)	Large Box Quantity[1] (13.0” x 13.0”)
3	28	104
4	36	144
5	64	225

[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.

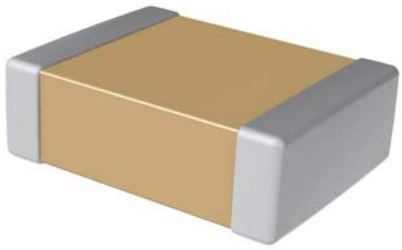
High Temperature 150°C, Ultra-Stable X8R Dielectric, 25 – 100 VDC (Commercial & Automotive Grade)

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 + number of zeros	F = ±1% G = ±2% J = ±5% K = ±10% M = ±20%	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" below

[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.*

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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 25 V, 50 V, and 100 V
- Capacitance offerings ranging from 100 pF to 0.22 µF
- Available capacitance tolerances of ±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's 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:

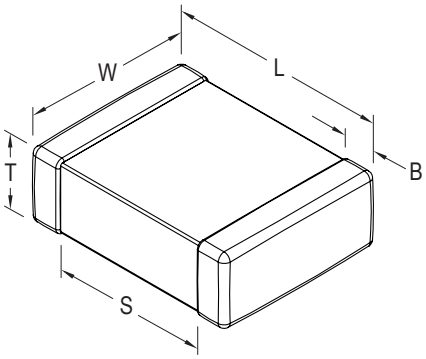
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design record and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

Qualification/Certification

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

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%
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 @ 25ºC	2.5%
Insulation Resistance (IR) Limit @ 25°C	1,000 megohm microfarads or 100 GΩ (Rated voltage applied for 120 ±5 seconds @ 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 Vrms if capacitance ≤ 1,000 pF.

1 kHz ±50 Hz and 1.0 ±0.2 Vrms 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					3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	5	1
		Rated Voltage (VDC)					25	50	100	25	50	100	25	50	100	25	50	100	25	50	100	50	100
		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														
110 pF	111	F	G	J	K	M	BB	BB	BB														
120 pF	121	F	G	J	K	M	BB	BB	BB														
130 pF	131	F	G	J	K	M	BB	BB	BB														
150 pF	151	F	G	J	K	M	BB	BB	BB														
160 pF	161	F	G	J	K	M	BB	BB	BB														
180 pF	181	F	G	J	K	M	BB	BB	BB														
200 pF	201	F	G	J	K	M	BB	BB	BB														
220 pF	221	F	G	J	K	M	BB	BB	BB														
240 pF	241	F	G	J	K	M	BB	BB	BB														
270 pF	271	F	G	J	K	M	BB	BB	BB														
300 pF	301	F	G	J	K	M	BB	BB	BB														
330 pF	331	F	G	J	K	M	BB	BB	BB														
360 pF	361	F	G	J	K	M	BB	BB	BB														
390 pF	391	F	G	J	K	M	BB	BB	BB														
430 pF	431	F	G	J	K	M	BB	BB	BB	CF	CF	CF											
470 pF	471	F	G	J	K	M	BB	BB	BB	CF	CF	CF											
510 pF	511	F	G	J	K	M	BB	BB	BB	CF	CF	CF											
560 pF	561	F	G	J	K	M	BB	BB	BB	CF	CF	CF											
620 pF	621	F	G	J	K	M	BB	BB	BB	CF	CF	CF											
680 pF	681	F	G	J	K	M	BB	BB	BB	CF	CF	CF											
750 pF	751	F	G	J	K	M	BB	BB	BB	CF	CF	CF											
820 pF	821	F	G	J	K	M	BB	BB	BB	CF	CF	CF											
910 pF	911	F	G	J	K	M	BB	BB	BB	CF	CF	CF											
1,000 pF	102	F	G	J	K	M	BB	BB	BB	CF	CF	CF											
1,100 pF	112	F	G	J	K	M	BB	BB		CF	CF	CF											
1,200 pF	122	F	G	J	K	M	BB	BB		CF	CF	CF											
1,300 pF	132	F	G	J	K	M	BB	BB		CF	CF	CF											
1,500 pF	152	F	G	J	K	M	BB	BB		CF	CF	CF											
1,600 pF	162	F	G	J	K	M				CF	CF	CF											
1,800 pF	182	F	G	J	K	M				CF	CF	CF											
2,000 pF	202	F	G	J	K	M				CF	CF	CF	DN	DN	DN								
2,200 pF	222	F	G	J	K	M				CF	CF	CF	DN	DN	DN								
2,400 pF	242	F	G	J	K	M				CF	CF	CF	DN	DN	DN								
2,700 pF	272	F	G	J	K	M				CF	CF	CF	DN	DN	DN								
3,000 pF	302	F	G	J	K	M				CF	CF	CF	DN	DN	DN								
3,300 pF	332	F	G	J	K	M				CF	CF	CF	DN	DN	DN								
3,600 pF	362	F	G	J	K	M				CF	CF	CF	DN	DN	DN								
3,900 pF	392	F	G	J	K	M				CF	CF	CF	DN	DN	DN								
4,300 pF	432	F	G	J	K	M				CF	CF	CF	DN	DN	DN								
4,700 pF	472	F	G	J	K	M				CF	CF	CF	DN	DN	DN								
5,100 pF	512	F	G	J	K	M				CF	CF		DN	DN	DN								
5,600 pF	562	F	G	J	K	M				CF	CF		DN	DN	DN								
6,200 pF	622	F	G	J	K	M				CF	CF		DN	DN	DN								
6,800 pF	682	F	G	J	K	M				CF	CF		DN	DN	DN	EB	EB	EB					
7,500 pF	752	F	G	J	K	M				CF			DN	DN	DN	EB	EB	EB					
8,200 pF	822	F	G	J	K	M				CF			DN	DN	DN	EB	EB	EB					
9,100 pF	912	F	G	J	K	M				CF			DN	DN	DN	EB	EB	EB					
10,000 pF	103	F	G	J	K	M				CF			DN	DN	DP	EB	EB	EB					
12,000 pF	123	F	G	J	K	M							DN	DN	DE	EB	EB	EB	FB	FB	FB		
15,000 pF	153	F	G	J	K	M							DN	DP	DG	EB	EB	EB	FB	FB	FB	GB	GB
18,000 pF	183	F	G	J	K	M							DN	DP		EB	EB	EB	FB	FB	FB	GB	GB
22,000 pF	223	F	G	J	K	M							DP	DF		EB	EB	EC	FB	FB	FB	GB	GB
27,000 pF	273	F	G	J	K	M							DF			EB	EB	EE	FB	FB	FB	GB	GB
33,000 pF	333	F	G	J	K	M							DG			EB	EB	EE	FB	FB	FB	GB	GB
Capacitance	Cap Code	Rated Voltage (VDC)					25	50	100	25	50	100	25	50	100	25	50	100	25	50	100	50	100
		Voltage Code					3	5	1	3	5	1	3	5	1	3	5	1	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'd

Capacitance	Cap Code	Case Size/ Series	C0402C			C0603C			C0805C			C1206C			C1210C			C1812C	
		Voltage Code	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	5	1
		Rated Voltage (VDC)	25	50	100	25	50	100	25	50	100	25	50	100	25	50	100	50	100
		Capacitance Tolerance	Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions																
47,000 pF	473	F G J K M										EC	EE	EH	FB	FB	FE	GB	GB
56,000 pF	563	F G J K M										ED	EF	EH	FB	FB	FF	GB	GB
68,000 pF	683	F G J K M										EF	EH		FB	FC	FG	GB	GB
82,000 pF	823	F G J K M										EH	EH		FC	FF	FH	GB	GB
100,000 pF	104	F G J K M										EH			FE	FG	FM	GB	GD
120,000 pF	124	F G J K M													FG	FH		GB	GH
150,000 pF	154	F G J K M													FH	FM		GD	GN
180,000 pF	184	F G J K M													FJ			GH	
220,000 pF	224	F G J K M																GK	
Capacitance	Cap Code	Rated Voltage (VDC)	25	50	100	25	50	100	25	50	100	25	50	100	25	50	100	50	100
		Voltage Code	3	5	1	3	5	1	3	5	1	3	5	1	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	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
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
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 out 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

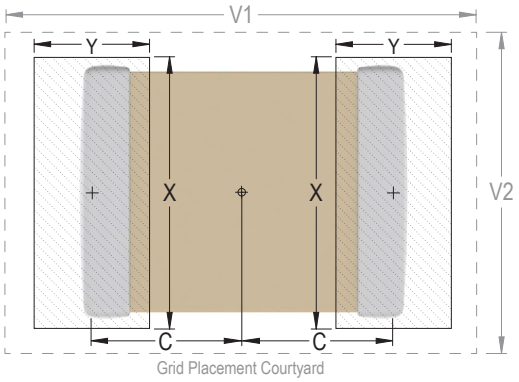
[1] *Only for capacitance values ≥ 22 µF*

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.

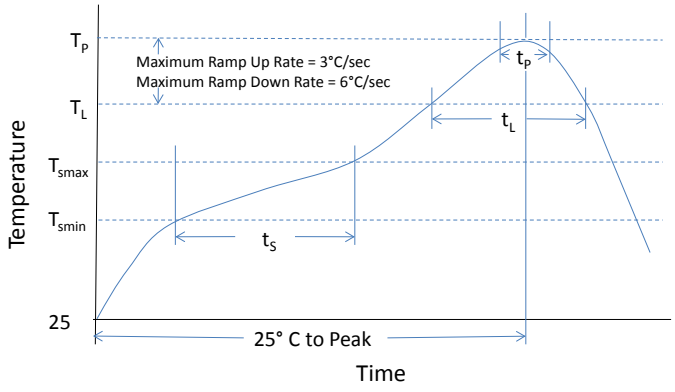


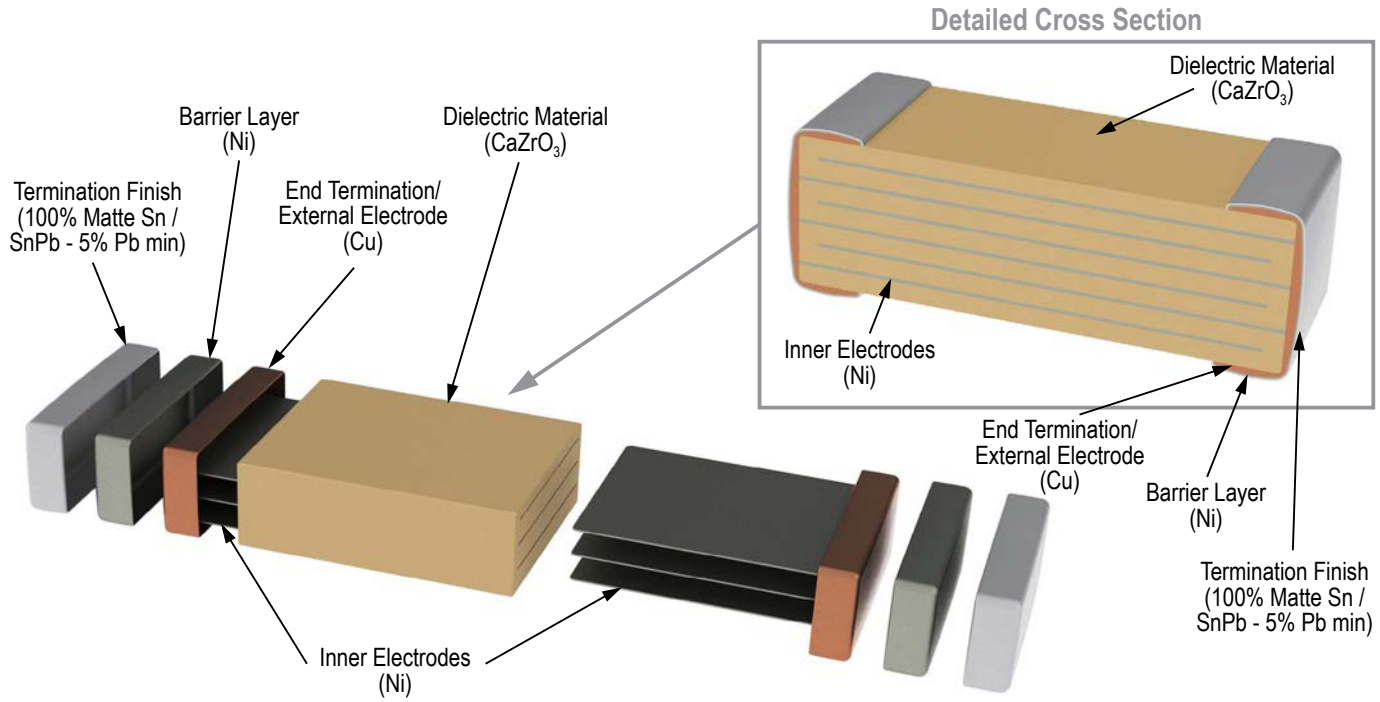
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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 +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



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.

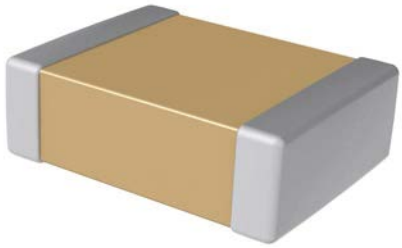
High Temperature 150°C, X8L Dielectric, 10 – 50 VDC (Commercial & Automotive Grade)

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 + number of zeros	J = ±5% K = ±10% M = ±20%	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" below

[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.*

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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 and smaller case sizes) 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 & 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's 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:

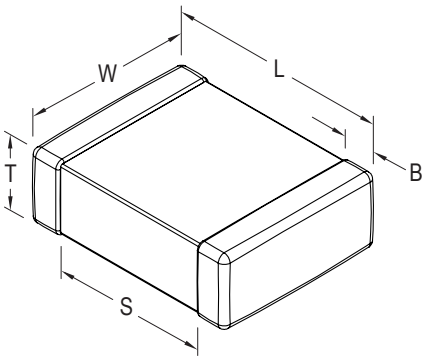
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design record and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

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)	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 (0.020) ±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

Qualification/Certification

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

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 @ 25°C	3.5% (≤ 16V) and 2.5% (≥ 25V)
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	500 megohm microfarads or 10 GΩ (Rated voltage applied for 120 ±5 seconds @ 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		

Insulation Resistance Limit Table (X8L Dielectric)

EIA Case Size	1,000 Megohm Microfarads or 100 GΩ	500 Megohm Microfarads or 10 GΩ
0201	N/A	ALL
0402	< .012 µF	≥ .012 µF
0603	< .047 µF	≥ .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 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																						
33,000 pF	333	J	K	M	BB	BB																						
39,000 pF	393	J	K	M	BB	BB																						
47,000 pF	473	J	K	M	BB	BB			CF	CF	CF	CF	CF															
56,000 pF	563	J	K	M																								
68,000 pF	683	J	K	M																								
82,000 pF	823	J	K	M																								
0.10 µF	104	J	K	M					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				DG	DG	DG	DG	DG										
0.22 µF	224	J	K	M					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 out 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.

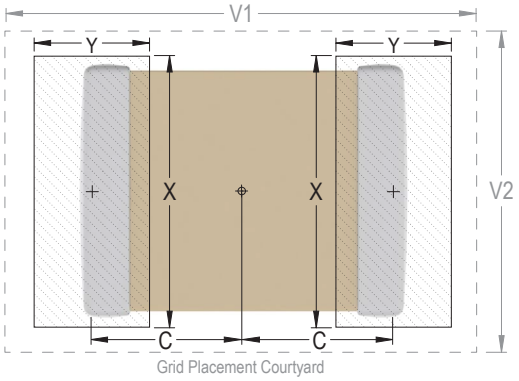
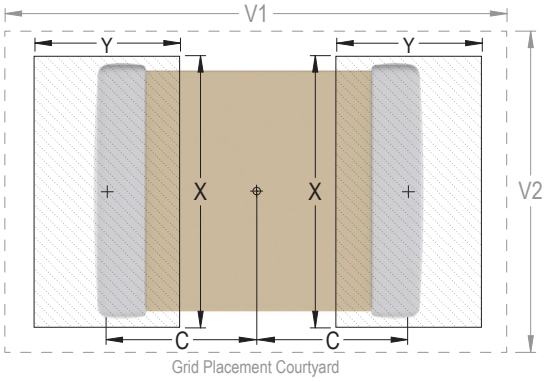


Table 3B – Land Pattern Design Recommendations per IPC–7351 – Flexible Termination

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.

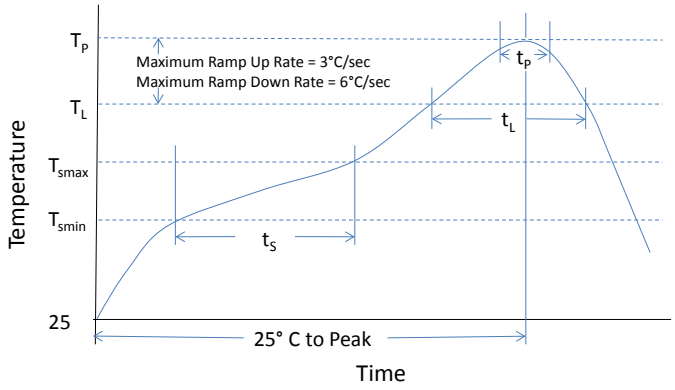


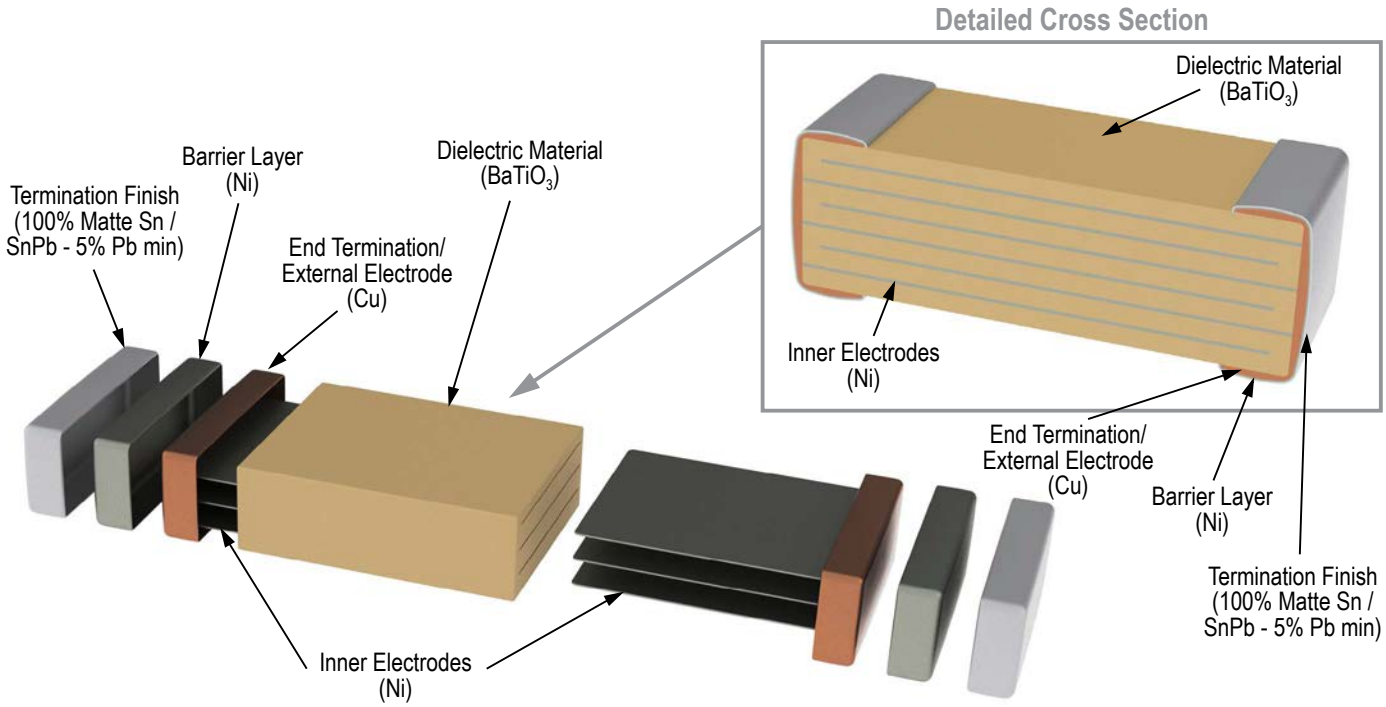
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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 +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.

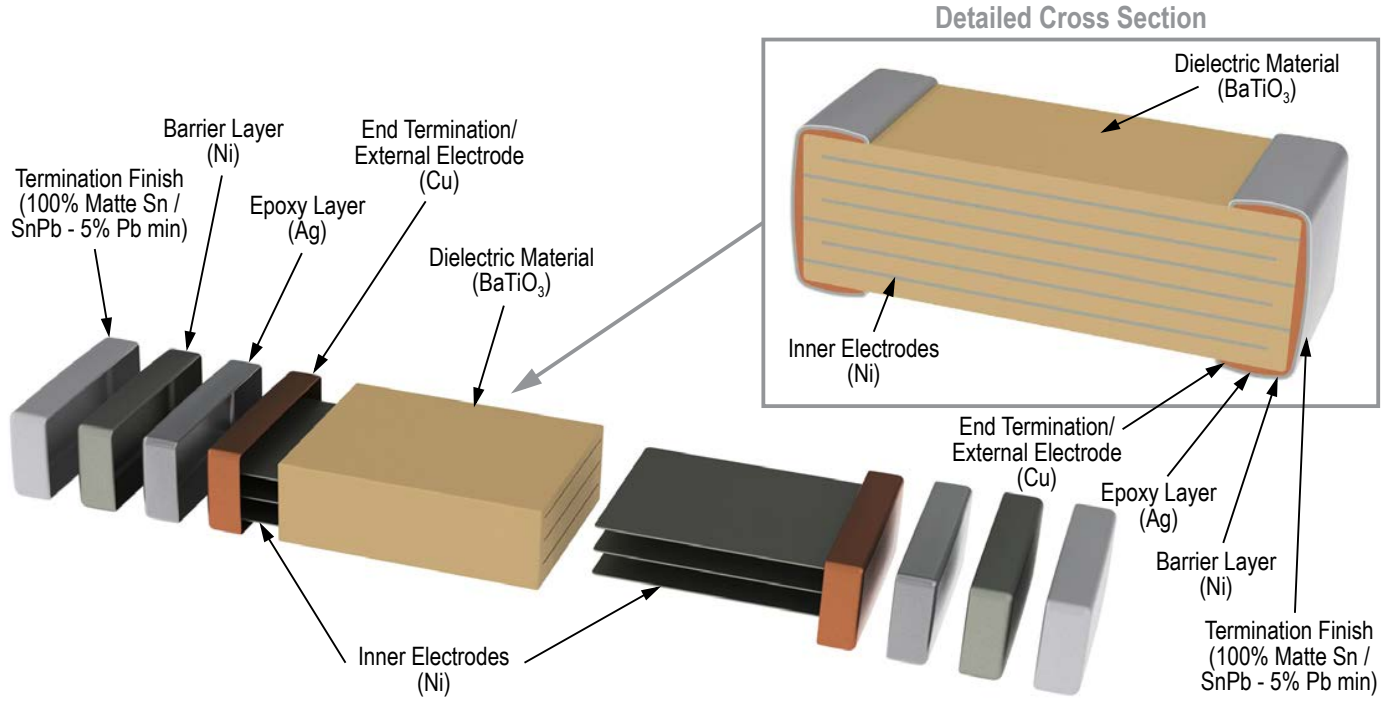
Storage and Handling

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



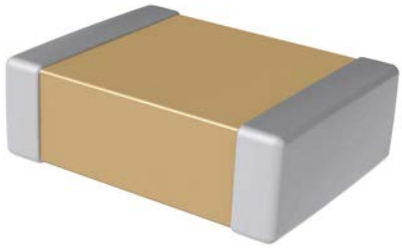
Construction – Flexible Termination



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

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.



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	Blank = Bulk 7292 = Waffle Pack/Tray TU = 7" Reel - Unmarked (full reel quantity) T050 = 50 pieces/7" Reel - Unmarked T100 = 100 pieces/7" Reel - Unmarked T250 = 250 pieces/7" Reel - Unmarked T500 = 500 pieces/7" Reel - Unmarked T1K0 = 1,000 pieces/Reel - Unmarked

[1] *Flexible termination option is only available in 0603 (1608 metric) and larger case sizes.*

[2] *Reeling quantities are dependent upon chip size and thickness dimension. When ordering using the "T1K0" packaging option, 1812 case size devices with chip thickness of ≥ 1.9 mm (nominal) may be shipped on multiple 7" reels or a single 13" reel. The term "Unmarked" pertains to laser marking of components. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. Additional reeling or packaging options may be available. Contact KEMET for details.*

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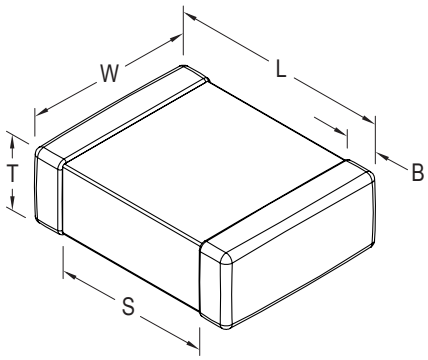
Dimensions – Millimeters (Inches) – Standard Termination



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

Overview cont'd

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.

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.

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 & 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
- Flexible termination option available upon request

Applications

Typical applications include decoupling, bypass, filtering and transient voltage suppression in extreme environments such as down-hole exploration, aerospace engine compartments and geophysical probes.

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.

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.

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 secs 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

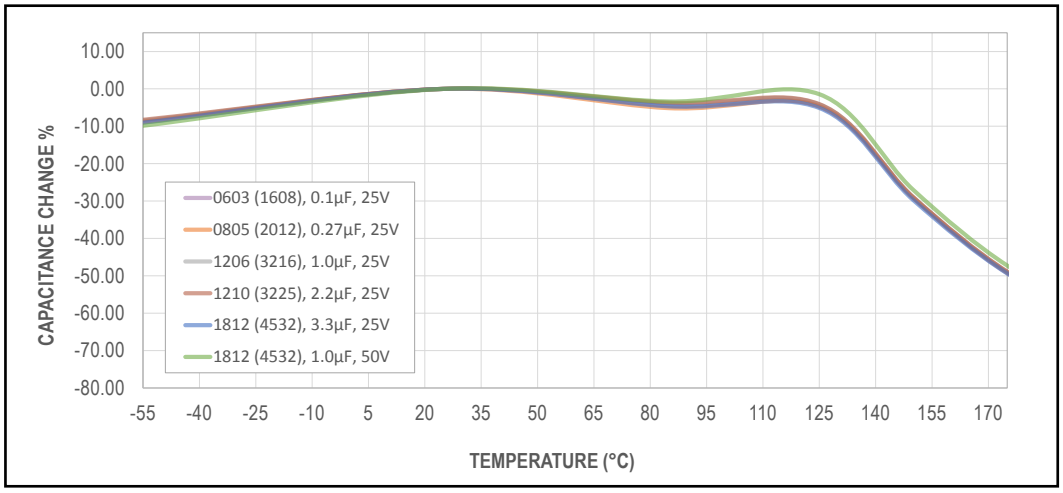
Rated DC Voltage	Dissipation Factor
16/25	3.5%
>25	2.5%

Post Environmental Limits

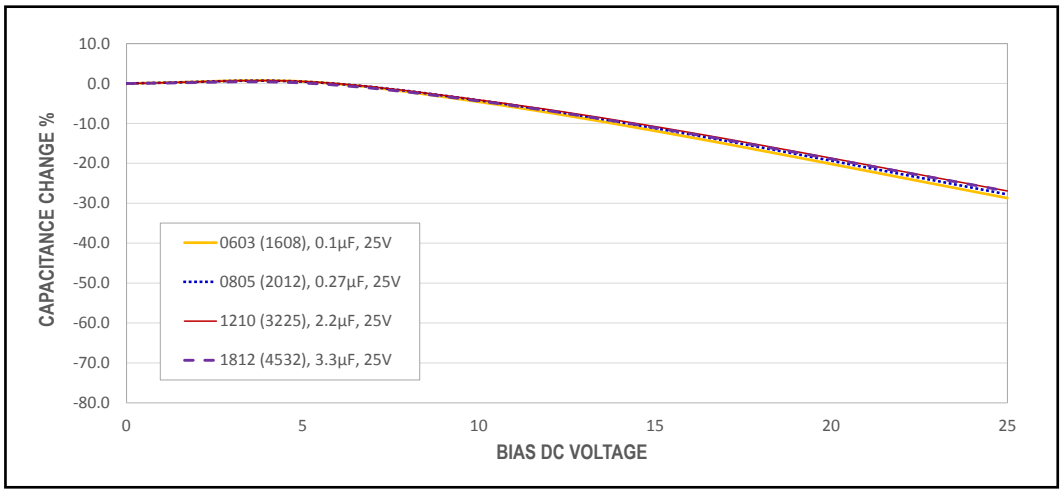
High Temperature Life, Biased Humidity, Moisture Resistance					
Dielectric	Rated DC Voltage	Capacitance Value	Dissipation Factor (Maximum %)	Capacitance Shift	Insulation Resistance
X7R	16/25	All	5.0	± 20%	10% of Initial Limit
	>25		3.0		

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)

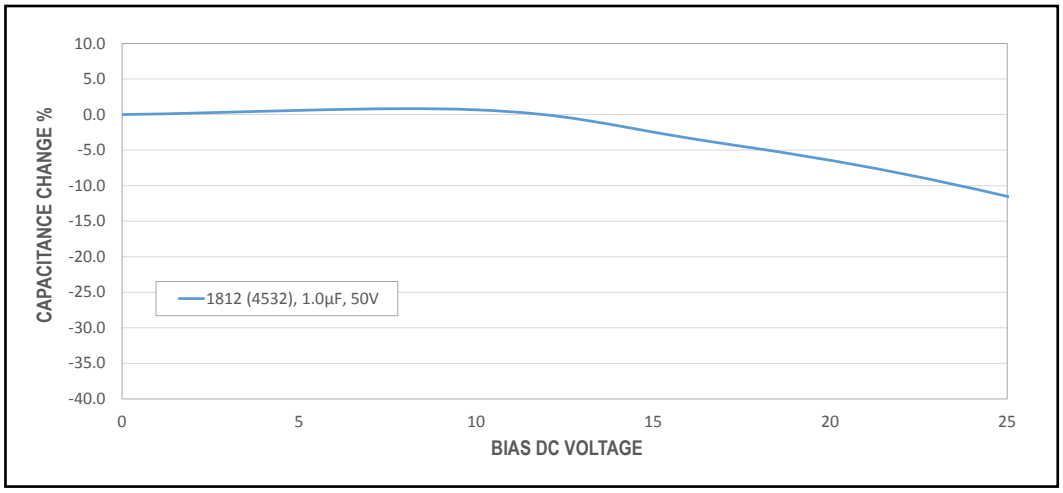


Table 1 – Capacitance Range/Selection Waterfall (0402 – 1812 Case Sizes)

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.

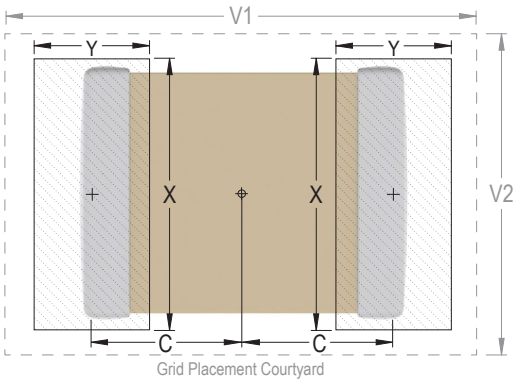
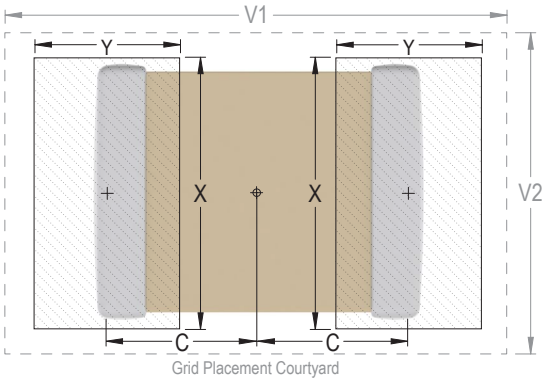


Table 3B – Land Pattern Design Recommendations per IPC–7351 – Flexible Termination

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

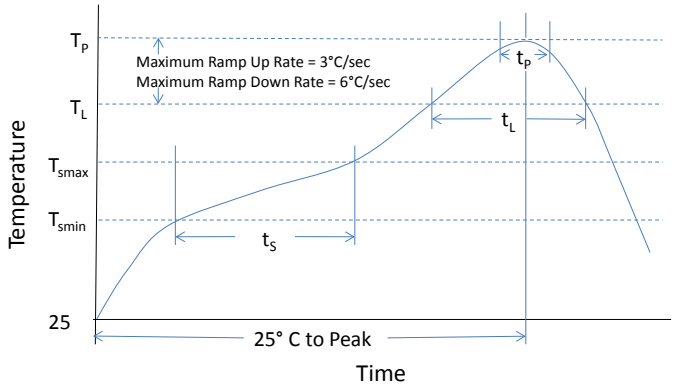


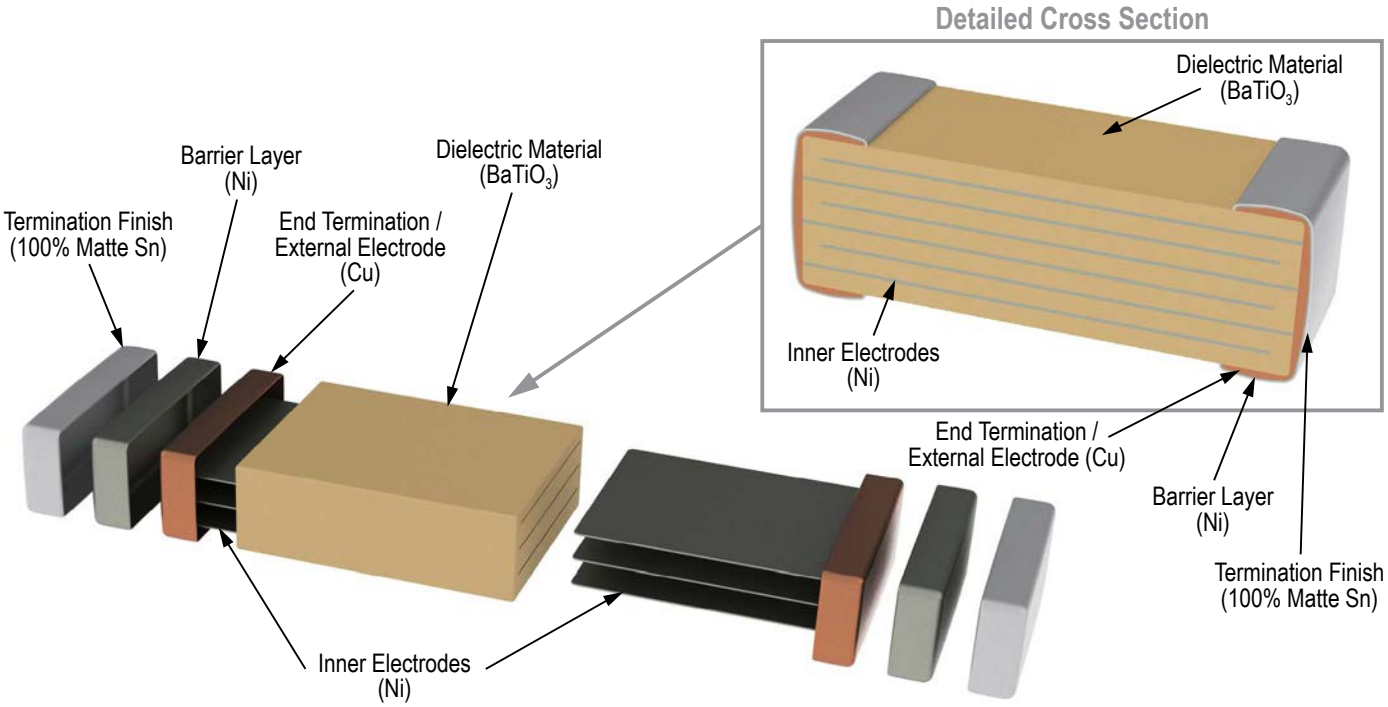
Table 4 – Performance & Reliability: Test Methods and Conditions

<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:
<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>

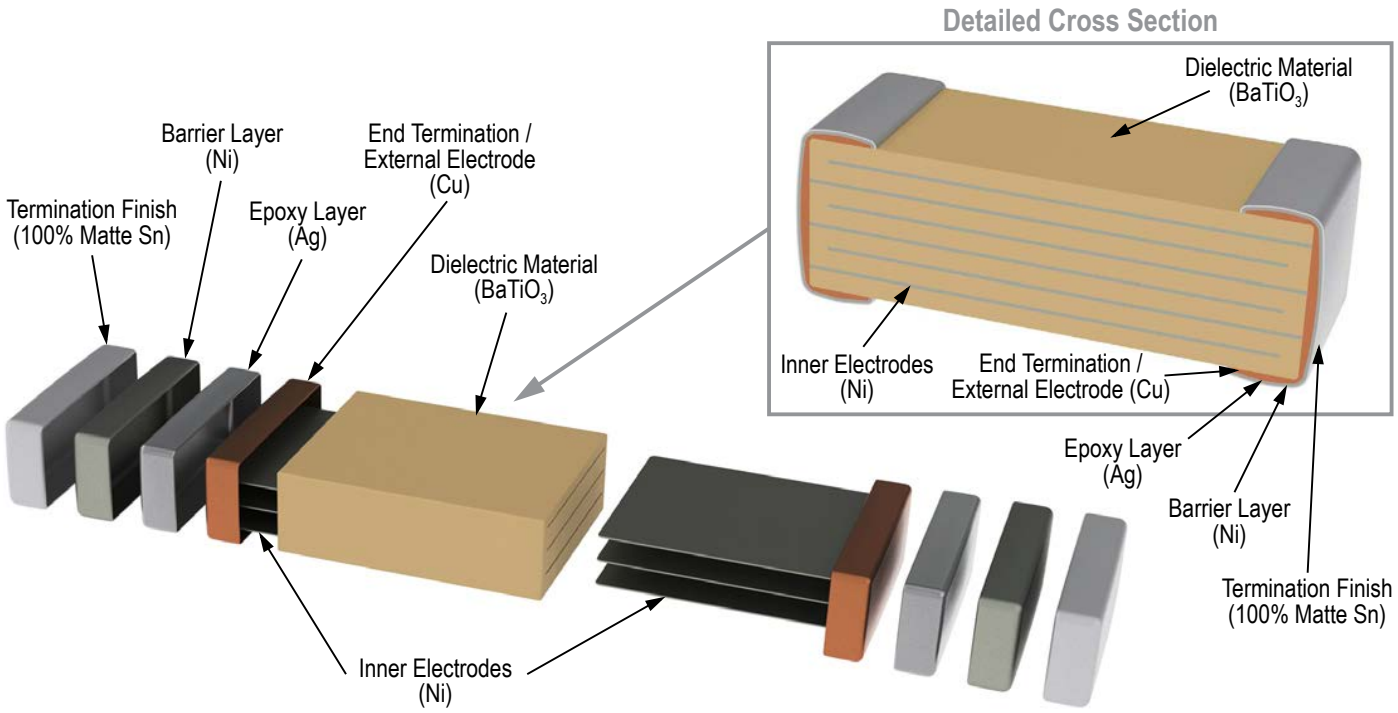
Storage and Handling

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



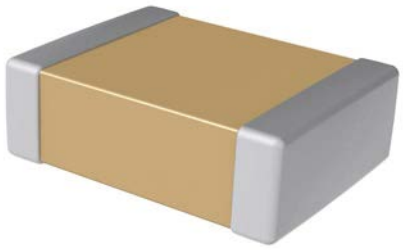
High Temperature 200°C, C0G Dielectric, 10 – 200 VDC (Industrial Grade)

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 – .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 – 50 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.

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Packaging C-Spec Ordering Options Table

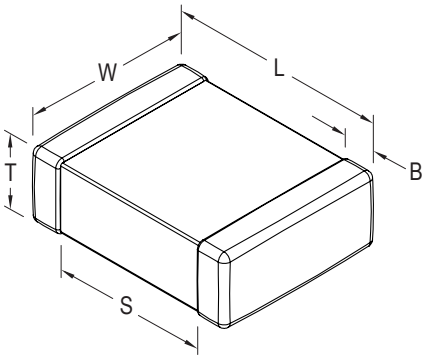
Termination Finish Options	Packaging Type/Options	Packaging Ordering Code (C-Spec)
Standard Packaging – Unmarked[3]		
C = 100% Matte Sn L = SnPb (5% Pb min.) F = Gold (Au) 30 – 50 µin G = Gold (Au) 100 µin minimum	Bulk Bag	Blank[1]
	Waffle Tray[2]	7292
	7" Tape & Reel	TU
	13" Reel	7411 (EIA 0603 and 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 – 50 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 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.
[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.

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

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	
1210	3225	3.20 (.126) ±0.20 (.008)	2.50 (.098) ±0.20 (.008)		0.50 (0.02) ±0.25 (.010)		Solder Reflow Only
1812	4532	4.50 (.177) ±0.30 (.012)	3.20 (.126) ±0.30 (.012)		0.60 (.024) ±0.35 (.014)		
2220	5650	5.70 (.224) ±0.40 (.016)	5.00 (.197) ±0.40 (.016)		0.60 (.024) ±0.35 (.014)		

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.

Qualification/Certification

High temperature (200ºC) Industrial grade products meet or exceed the requirements outlined in Table 4, Performance & Reliability. Qualification packages are available for review and download on our website at www.kemet.com/hightemp

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 (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 @ 25°C	0.1%
[3]Insulation Resistance (IR) Minimum Limit @ 25°C	1,000 megohm microfarads or 100 GΩ (Rated voltage applied for 120 ±5 seconds @ 25°C)

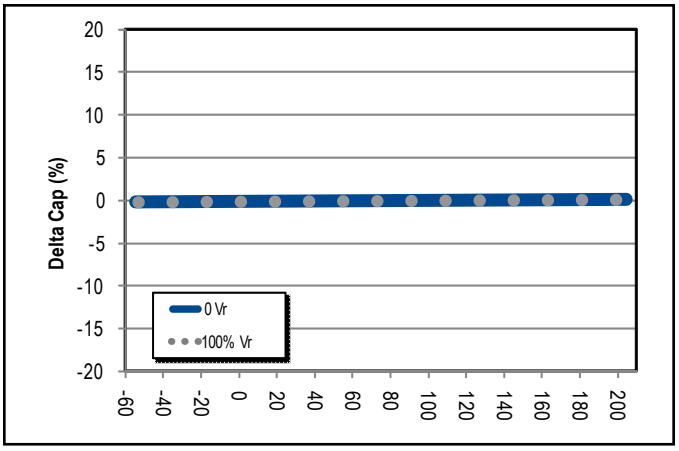
[1]DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.
[2]Capacitance and dissipation factor (DF) measured under the following conditions:
1 MHz ±100 kHz and 1.0 ±0.2 Vrms if capacitance ≤ 1,000 pF
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

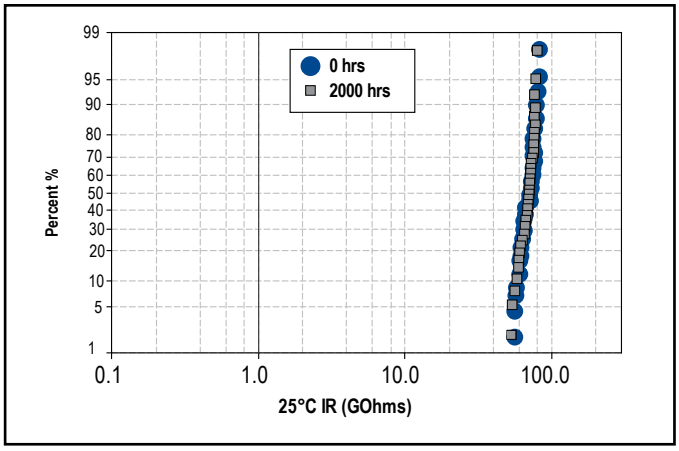
High Temperature Life, Biased Humidity, Moisture Resistance					
Dielectric	Rated DC Voltage	Capacitance Value	Dissipation Factor (Maximum %)	Capacitance Shift	Insulation Resistance
C0G	All	All	0.5	0.3% or ±0.25 pF	10% of Initial Limit

Electrical Characteristics

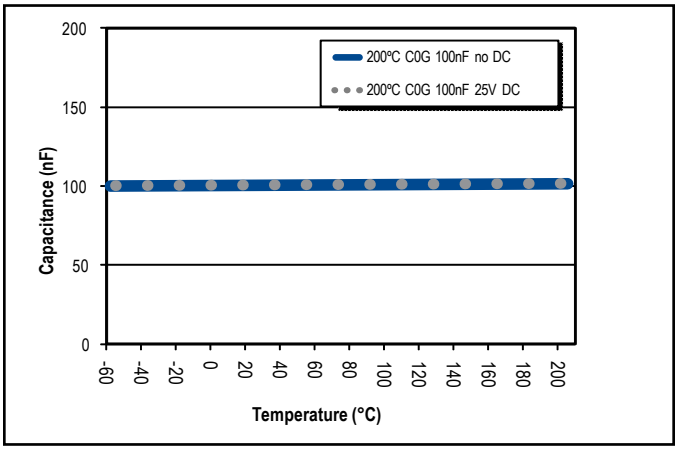
Delta Cap vs. Temperature (Typical)



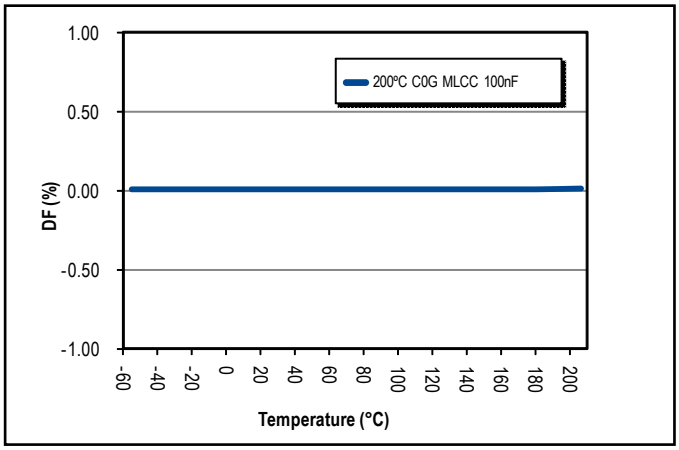
C1210H104J1GAC - Life Test IR Distribution (Lognormal)



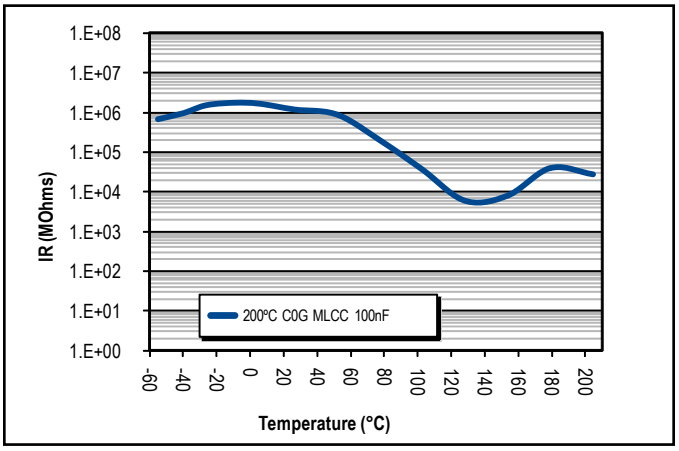
Capacitance vs. Temperature with 25 V DC Bias (Rated Voltage)



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)

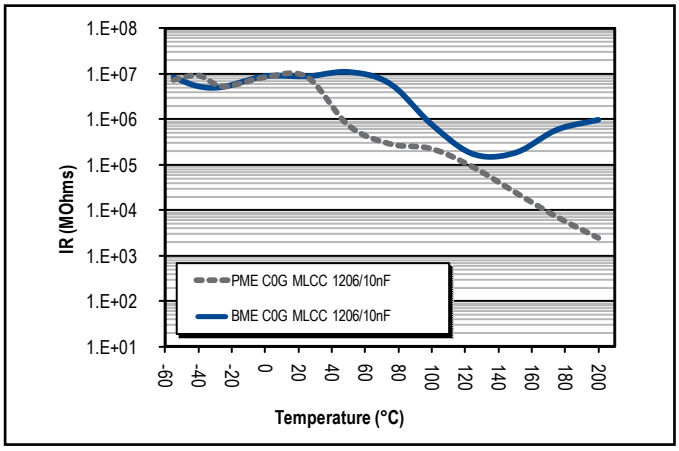


Table 1A – Capacitance Range/Selection Waterfall (0402 – 1206 Case Sizes)

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	FB	FB	FB	FB	FB	FB												
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					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 out 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

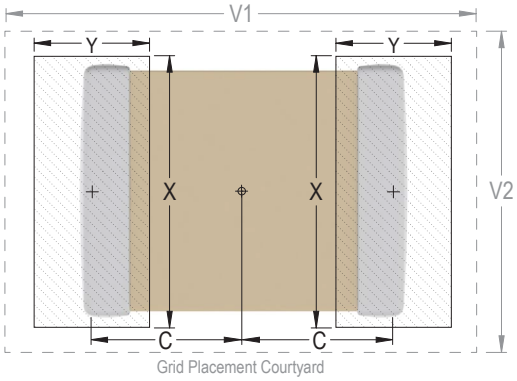
[1] *Only for capacitance values ≥ 22 µF*

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.

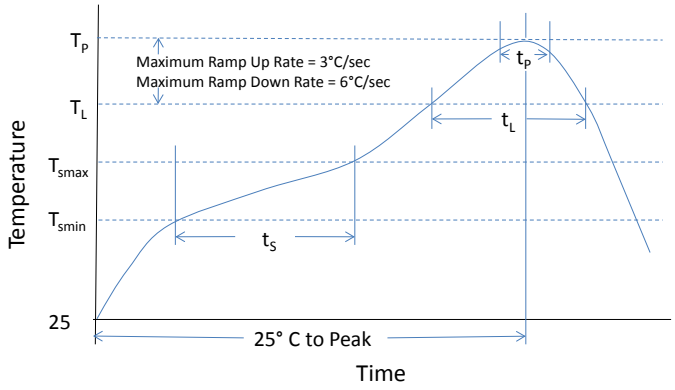


Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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

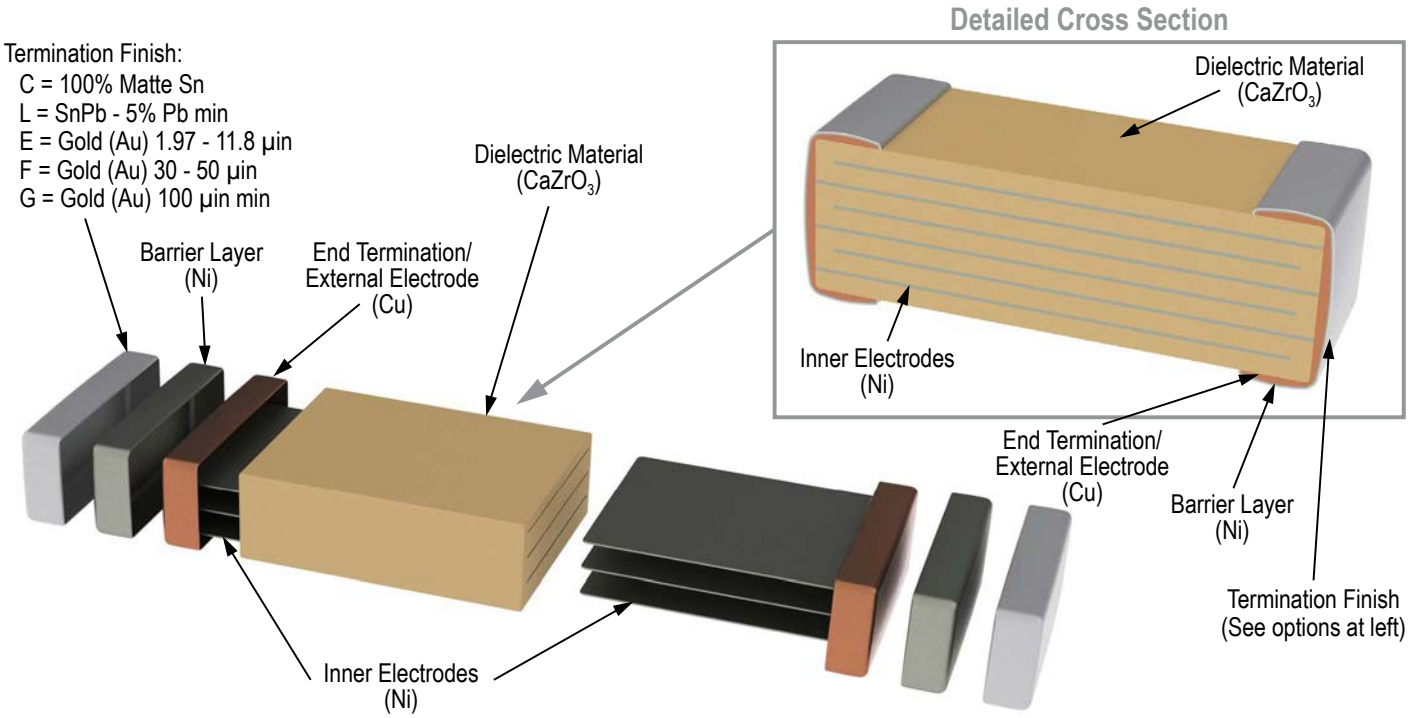
Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will 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 – 50 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.

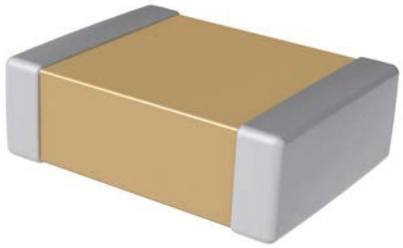
HV-HT Series, High Voltage, High Temperature 200°C, C0G Dielectric, 500 – 2,000 VDC (Industrial Grade)

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 + 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 min.) E = Gold (Au) 1.97 – 11.8 µin F = Gold (Au) 30 – 50 µin G = Gold (Au) 100 µin min.	See "Packaging C-Spec Ordering Options Table" below

[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.*

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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 – 50 µin G = Gold (Au) 100 µin min.	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 – 50 µin G = Gold (Au) 100 µin min.	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 thru 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 – 11.8 µin)

[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 & 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.

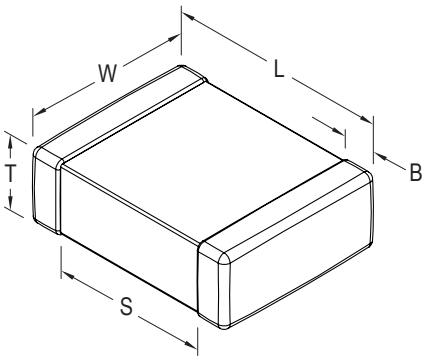
Qualification/Certification

High temperature (200ºC) Industrial grade products meet or exceed the requirements outlined in Table 4, Performance & Reliability. Qualification packages are available for review and download on our website at www.kemet.com/hightemp

Environmental Compliance

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

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 (.079) ± 0.20 (.008)	1.25 (.049) ± 0.20 (.008)	See Table 2 for Thickness	0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	"Solder Wave or Solder Reflow"
1206	3216	3.20 (.126) ± 0.20 (.008)	1.60 (.063) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)	N/A	
1210	3225	3.20 (.126) ± 0.20 (.008)	2.50 (.098) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)		Solder Reflow Only
1808	4520	4.70 (.185) ± 0.50 (.020)	2.00 (.079) ± 0.20 (.008)		0.60 (.024) ± 0.35 (.014)		
1812	4532	4.50 (.177) ± 0.30 (.012)	3.20 (.126) ± 0.30 (.012)		0.60 (.024) ± 0.35 (.014)		
1825	4564	4.50 (.177) ± 0.30 (.012)	6.40 (.252) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2220	5650	5.70 (.224) ± 0.40 (.016)	5.00 (.197) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2225	5664	5.60 (.220) ± 0.40 (.016)	6.40 (.248) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2824	7260	7.10 (.280) ± 0.40 (.016)	6.10 (.240) ± 0.40 (.016)		1.27 (.050) ± 0.40 (.016)		
3040	7610	7.60 (.300) ± 0.40 (.016)	10.20 (.402) ± 0.40 (.016)		1.27 (.050) ± 0.40 (.016)		
3640	9210	9.10 (.358) ± 0.40 (.016)	10.20 (.402) ± 0.40 (.016)		1.27 (.050) ± 0.40 (.016)		
4540	-	11.40 (.449) ± 0.40 (.016)	10.20 (.402) ± 0.40 (.016)		1.27 (.050) ± 0.40 (.016)		

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)	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)
[2]Dissipation Factor (DF) Maximum Limit @ 25°C	0.1%
[3]Insulation Resistance (IR) Minimum Limit @ 25°C	1000 megohm microfarads or 100 GΩ (500 VDC applied for 120 ±5 secs @ 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

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

**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.

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 F G J K M	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	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	LA	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				

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

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

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)*
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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)*
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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	1,550
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 out standard "bulk bag" packaging.

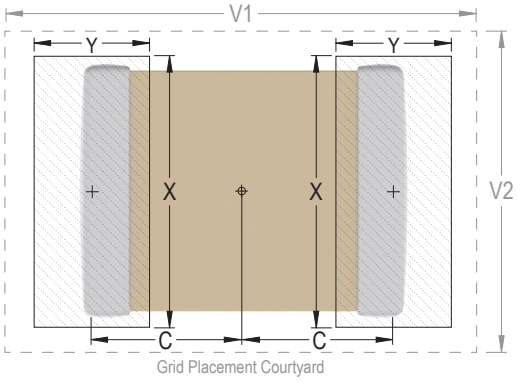
[3] Also commonly referred to as “Chip Carrier” or “Molded Tray”. All tray packaging options offer static protection.

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.

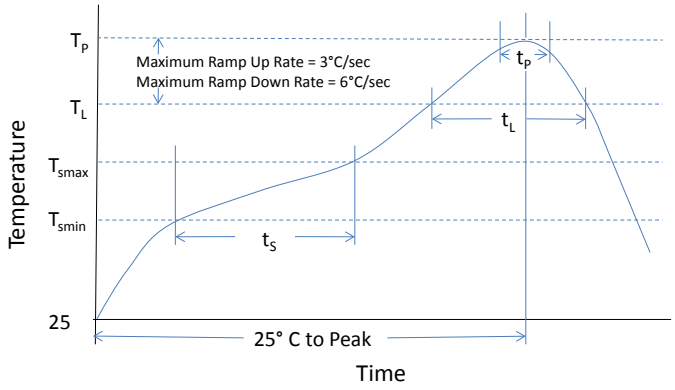


Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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

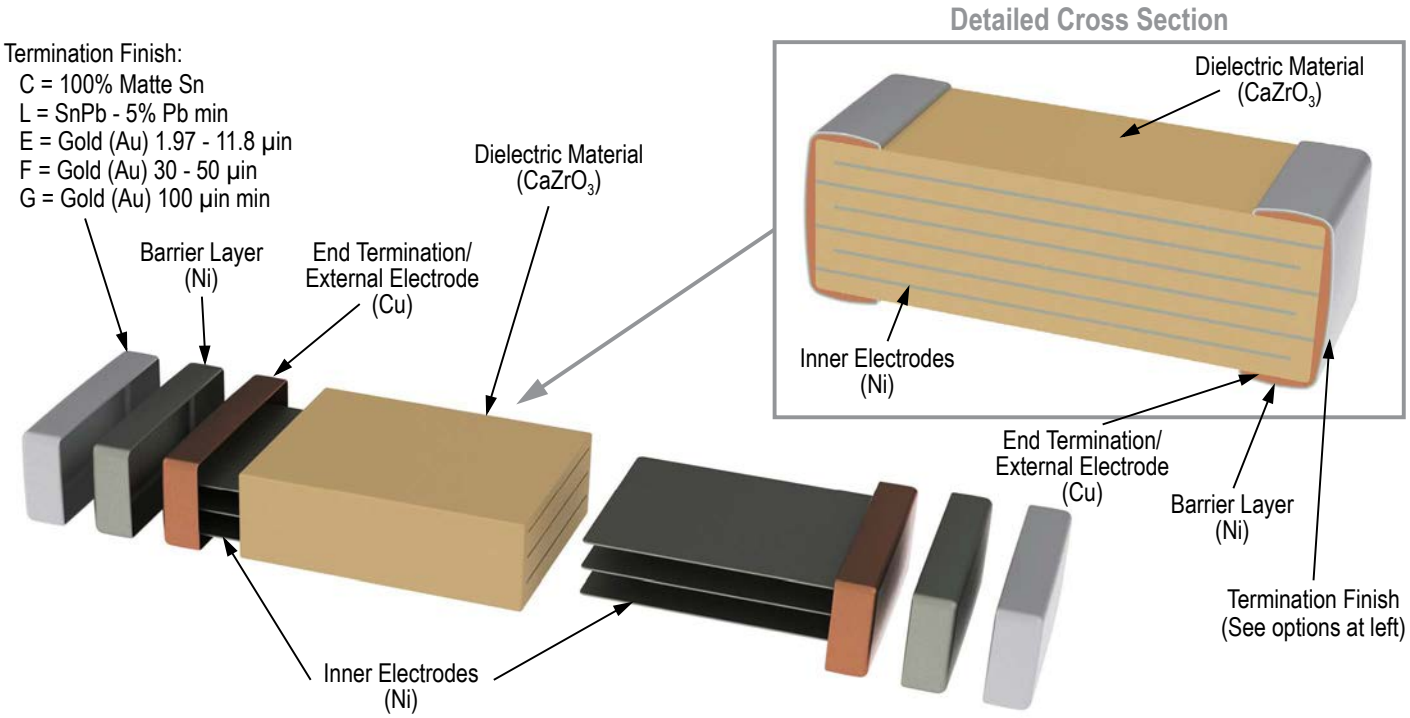
Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will 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 – 50 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.

Flexible Termination System (FT-CAP), Ultra-Stable X8R Dielectric, 25 – 100 VDC (Commercial & Automotive Grade)

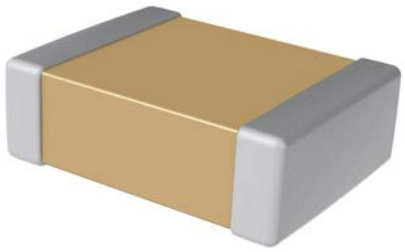
Overview

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 + number of zeros.	F = ±1% G = ±2% J = ±5% K = ±10% M = ±20%	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" below

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

[1] SnPb termination finish option is not available on Automotive Grade product.

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Packaging C-Spec Ordering Options Table

Packaging Type	Packaging/Grade Ordering Code (C-Spec)
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 25 V, 50 V, and 100 V
- Capacitance offerings ranging from 430 pF to 0.22 µF
- Available capacitance tolerances of ±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 & 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's 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:

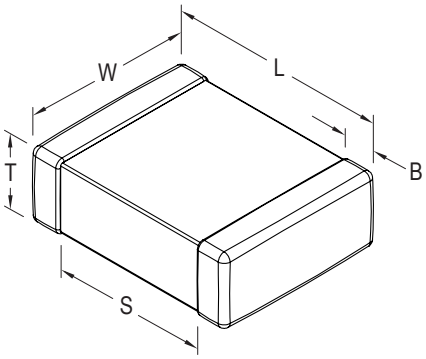
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design record and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

Qualification/Certification

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

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%
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 @ 25°C	2.5%
[3]Insulation Resistance (IR) Minimum Limit @ 25°C	1,000 megohm microfarads or 100 GΩ (Rated voltage applied for 120 ±5 seconds @ 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
Ultra-Stable X8R	All	All	3.0	0.3% or ±0.25 pF	10% of Initial Limit

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

Capacitance	Capacitance Code	Case Size/Series					C0603X			C0805X			C1206X			C1210X			C1812X	
		Voltage Code					3	5	1	3	5	1	3	5	1	3	5	1	5	1
		Rated Voltage (VDC)					25	50	100	25	50	100	25	50	100	25	50	100	50	100
		Capacitance Tolerance					Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions													
430 pF	431	F	G	J	K	M	CJ	CJ	CJ											
470 pF	471	F	G	J	K	M	CJ	CJ	CJ											
510 pF	511	F	G	J	K	M	CJ	CJ	CJ											
560 pF	561	F	G	J	K	M	CJ	CJ	CJ											
620 pF	621	F	G	J	K	M	CJ	CJ	CJ											
680 pF	681	F	G	J	K	M	CJ	CJ	CJ											
750 pF	751	F	G	J	K	M	CJ	CJ	CJ											
820 pF	821	F	G	J	K	M	CJ	CJ	CJ											
910 pF	911	F	G	J	K	M	CJ	CJ	CJ											
1,000 pF	102	F	G	J	K	M	CJ	CJ	CJ											
1,100 pF	112	F	G	J	K	M	CJ	CJ	CJ											
1,200 pF	122	F	G	J	K	M	CJ	CJ	CJ											
1,300 pF	132	F	G	J	K	M	CJ	CJ	CJ											
1,500 pF	152	F	G	J	K	M	CJ	CJ	CJ											
1,600 pF	162	F	G	J	K	M	CJ	CJ	CJ											
1,800 pF	182	F	G	J	K	M	CJ	CJ	CJ											
2,000 pF	202	F	G	J	K	M	CJ	CJ	CJ	DR	DR	DR								
2,200 pF	222	F	G	J	K	M	CJ	CJ	CJ	DR	DR	DR								
2,400 pF	242	F	G	J	K	M	CJ	CJ	CJ	DR	DR	DR								
2,700 pF	272	F	G	J	K	M	CJ	CJ	CJ	DR	DR	DR								
3,000 pF	302	F	G	J	K	M	CJ	CJ	CJ	DR	DR	DR								
3,300 pF	332	F	G	J	K	M	CJ	CJ	CJ	DR	DR	DR								
3,600 pF	362	F	G	J	K	M	CJ	CJ	CJ	DR	DR	DR								
3,900 pF	392	F	G	J	K	M	CJ	CJ	CJ	DR	DR	DR								
4,300 pF	432	F	G	J	K	M	CJ	CJ	CJ	DR	DR	DR								
4,700 pF	472	F	G	J	K	M	CJ	CJ	CJ	DR	DR	DR								
5,100 pF	512	F	G	J	K	M	CJ	CJ		DR	DR	DR								
5,600 pF	562	F	G	J	K	M	CJ	CJ		DR	DR	DR								
6,200 pF	622	F	G	J	K	M	CJ	CJ		DR	DR	DR								
6,800 pF	682	F	G	J	K	M	CJ	CJ		DR	DR	DR	EQ	EQ	EQ					
7,500 pF	752	F	G	J	K	M	CJ			DR	DR	DR	EQ	EQ	EQ					
8,200 pF	822	F	G	J	K	M	CJ			DR	DR	DR	EQ	EQ	EQ					
9,100 pF	912	F	G	J	K	M	CJ			DR	DR	DR	EQ	EQ	EQ					
10,000 pF	103	F	G	J	K	M	CJ			DR	DR	DD	EQ	EQ	EQ					
12,000 pF	123	F	G	J	K	M				DR	DR	DS	EQ	EQ	EQ	FN	FN	FN		
15,000 pF	153	F	G	J	K	M				DR	DD	DG	EQ	EQ	EQ	FN	FN	FN	GB	GB
18,000 pF	183	F	G	J	K	M				DR	DD		EQ	EQ	EQ	FN	FN	FN	GB	GB
22,000 pF	223	F	G	J	K	M				DD	DF		EQ	EQ	ER	FN	FN	FN	GB	GB
27,000 pF	273	F	G	J	K	M				DF			EQ	EQ	ET	FN	FN	FN	GB	GB
33,000 pF	333	F	G	J	K	M				DG			EQ	EQ	ET	FN	FN	FN	GB	GB
47,000 pF	473	F	G	J	K	M							ER	ET	EH	FN	FN	FE	GB	GB
56,000 pF	563	F	G	J	K	M							ES	EF	EH	FN	FN	FA	GB	GB
68,000 pF	683	F	G	J	K	M							EF	EH		FN	FQ	FZ	GB	GB
82,000 pF	823	F	G	J	K	M							EH	EH		FQ	FA	FU	GB	GB
100,000 pF	104	F	G	J	K	M							EH			FE	FZ	FM	GB	GD
120,000 pF	124	F	G	J	K	M										FZ	FU		GB	GH
150,000 pF	154	F	G	J	K	M										FU	FM		GD	GN
180,000 pF	184	F	G	J	K	M										FJ			GH	
220,000 pF	224	F	G	J	K	M													GK	
Capacitance	Capacitance Code	Rated Voltage (VDC)					25	50	100	25	50	100	25	50	100	25	50	100	50	100
		Voltage Code					3	5	1	3	5	1	3	5	1	3	5	1	5	1
		Case Size/Series					C0603X			C0805X			C1206X			C1210X			C1812X	

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	4,000	10,000	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
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 out 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.

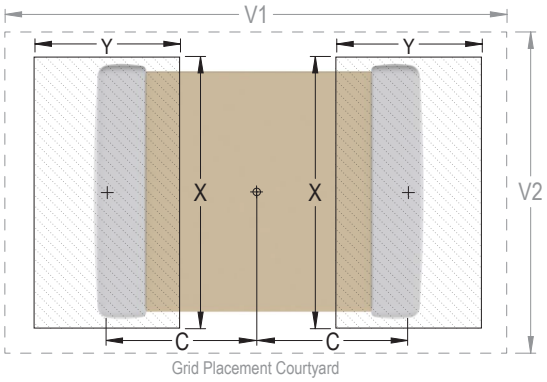


Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC–7351

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

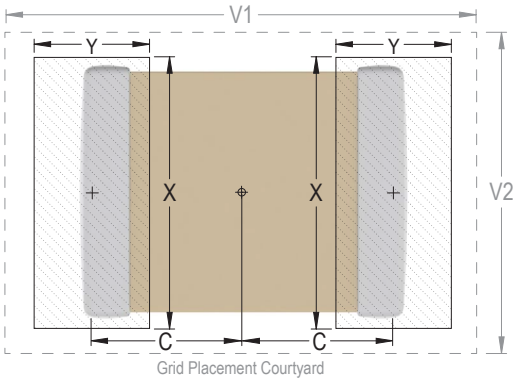
[1] *Only for capacitance values ≥ 22 µF*

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.

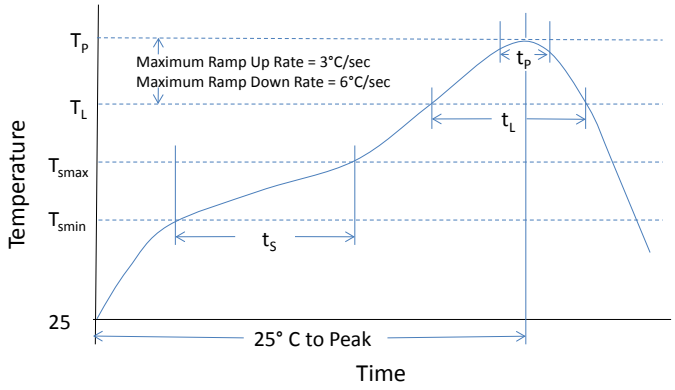


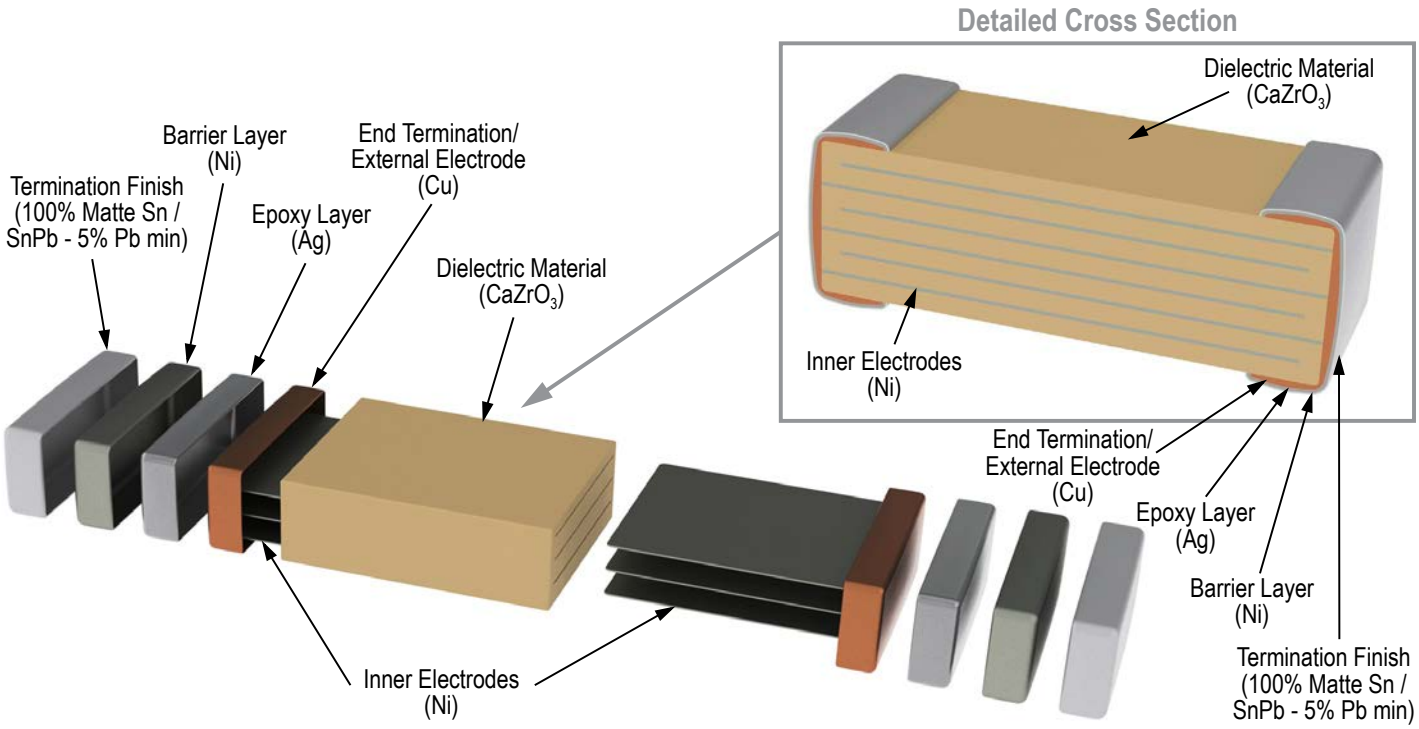
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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 +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



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.

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	Failure Rate/ Design	Leadframe Finish[2]	Packaging/Grade (C-Spec)
	1210 2220	C = Standard	Two significant digits + 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" below

[1] Double chip stacks ("2" in the 13th character position of the ordering code) are only available in M (±20%) capacitance tolerance. Single chip stacks ("1" in the 13th character position of the ordering code) are available in K (±10%) or M (±20%) tolerances.

[2] Additional leadframe finish options may be available. Contact KEMET for details.

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Packaging C-Spec Ordering Options Table

Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)[2]
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

- 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 & 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.

Qualification/Certification

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

Environmental Compliance

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

Automotive C-Spec Information

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

Automotive products offered through our distribution channel have been assigned an inclusive ordering code C-Spec, "AUTO". This C-Spec was developed in order to better serve small and medium sized companies that prefer an automotive grade component without the requirement to submit a customer Source Controlled Drawing (SCD) or specification for review by a KEMET engineering specialist. This C-Spec is therefore not intended for use by KEMET's 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 record 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

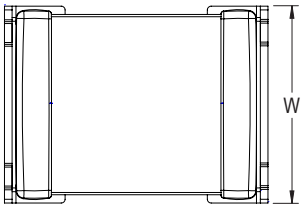
KEMET Automotive C-Spec	PPAP (Product Part Approval Process) Level				
	1	2	3	4	5
KEMET assigned[1]	●	●	●	●	●
AUTO	○		○		

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

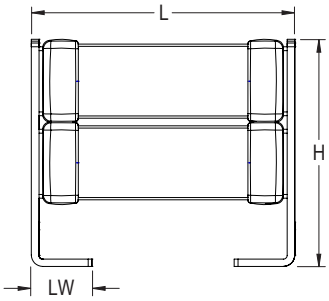
● Part Number specific PPAP available
○ Product family PPAP only

Dimensions – Millimeters (Inches)

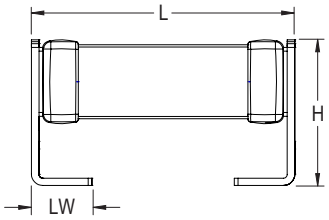
Single or Double Chip Stack



Double Chip Stack



Single Chip Stack



Chip Stack	EIA Size Code	Metric Size Code	L Length	W Width	H Height	LW Lead Width	Mounting Technique
Single	1210	3225	3.50 (.138) ±0.30 (.012)	2.60 (.102) ±0.30 (.012)	3.35 (.132) ±0.10 (.004)	0.80 (.032) ±0.15 (.006)	Solder Reflow Only
	2220	5650	6.00 (.236) ±0.50 (.020)	5.00 (.197) ±0.50 (.020)	3.50 (.138) ±0.30 (.012)	1.60 (.063) ±0.30 (.012)	
Double	1210	3225	3.50 (.138) ±0.30 (.012)	2.60 (.102) ±0.30 (.012)	6.15 (.242) ±0.15 (.006)	0.80 (.031) ±0.15 (.006)	
	2220	5650	6.00 (.236) ±0.50 (.020)	5.00 (.197) ±0.50 (.020)	5.00 (.197) ±0.50 (.020)	1.60 (.063) ±0.30 (.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 @ 25°C	3.5% (≤ 16V) and 2.5% (≥ 25V)
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	500 megohm microfarads or 10 GΩ (Rated voltage applied for 120 ±5 seconds @ 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						C2220C					
		Voltage Code			8	4	3	5	1	A	8	4	3	5	1	A
		Rated Voltage (VDC)			10	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				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	10	16	25	50	100	250
		Voltage Code			8	4	3	5	1	A	8	4	3	5	1	A
		Case Size/Series			C1210C						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

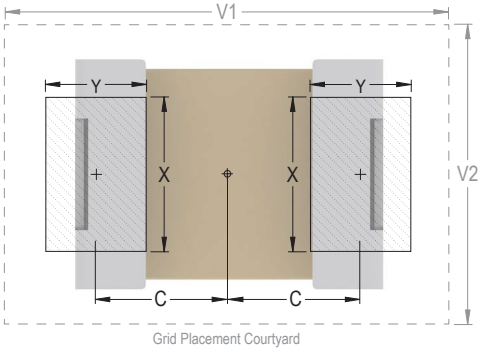
Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
FV	1210	3.35 ± 0.10	0	0	600	2,000
FW	1210	6.15 ± 0.15	0	0	300	1,000
JP	2220	3.50 ± 0.30	0	0	300	1,300
JR	2220	5.00 ± 0.50	0	0	200	800

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.



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.

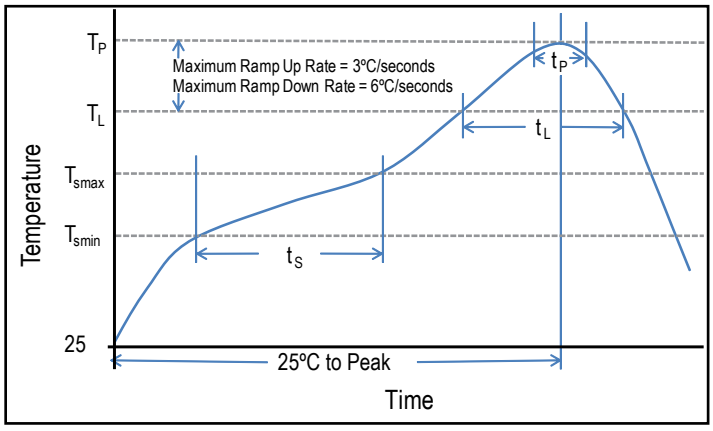


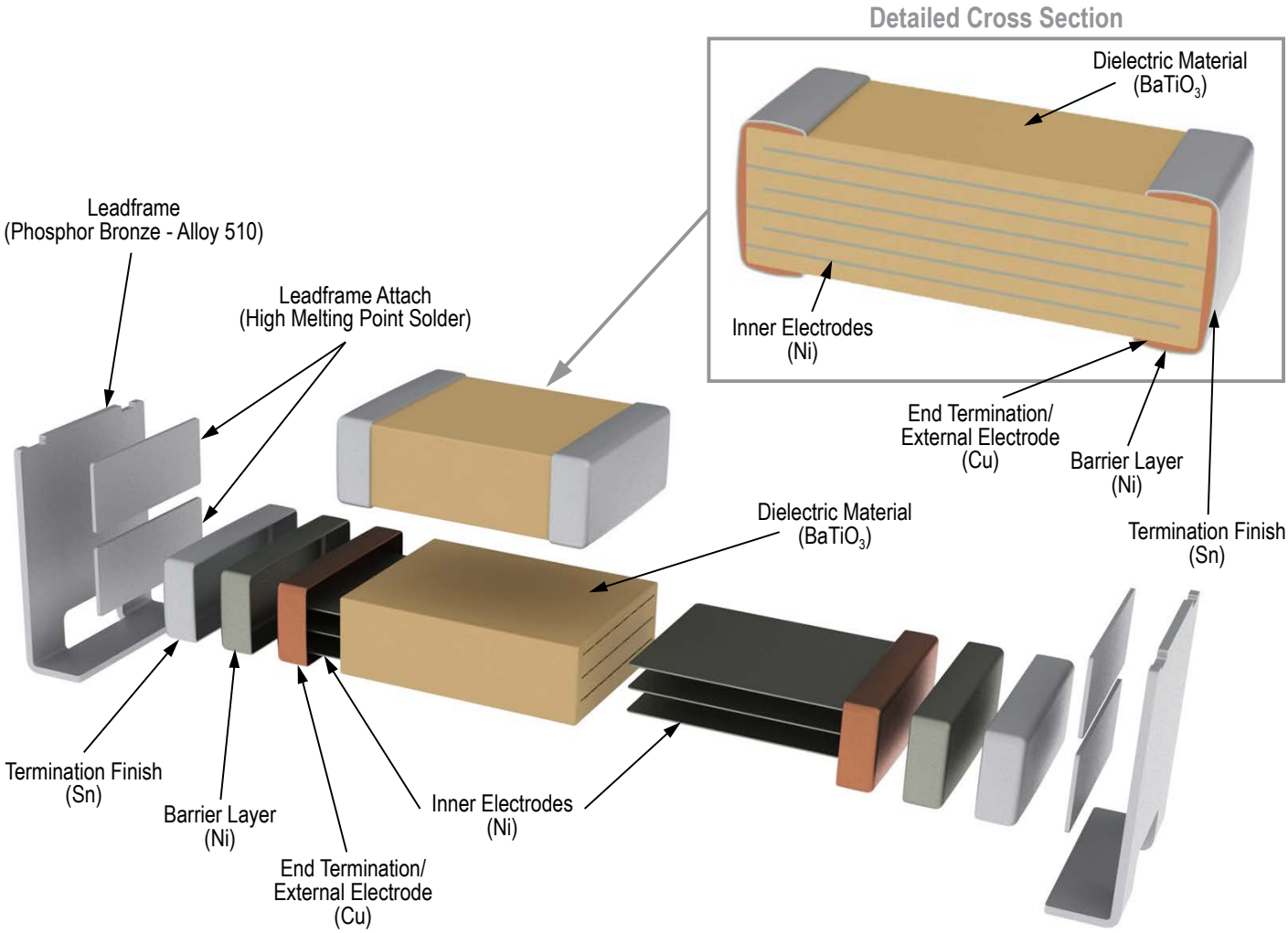
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 155°C, dry heat @ 235°C
		b) Method B @ 215°C category 3
		c) Method D, category 3 @ 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.

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 Temp (200°C)	Two significant digits + 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 min.)	See "Packaging C-Spec Ordering Options Table" below

[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.

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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.

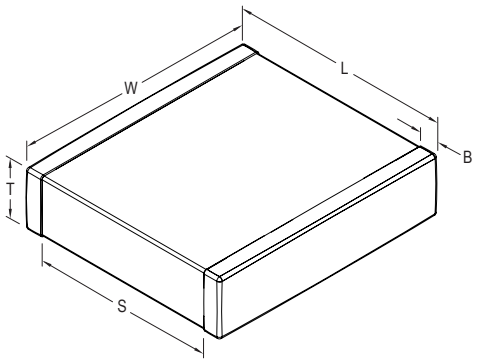
Benefits

- 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 @ 25°C	0.1%
[3]Insulation Resistance (IR) Minimum Limit @ 25°C	1,000 megohm microfarads or 100 GΩ (500 VDC applied for 120 ±5 seconds @ 25°C)

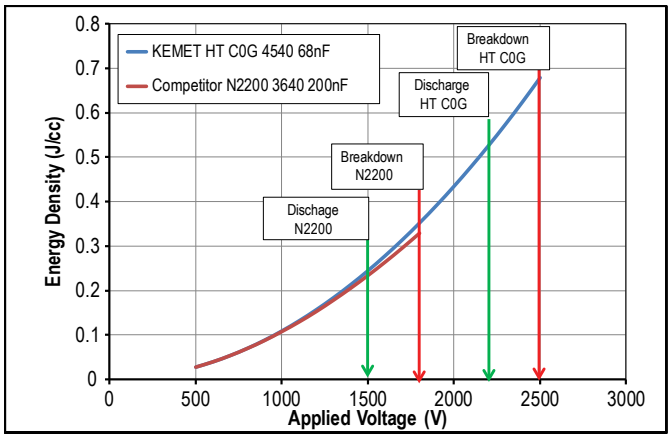
[1]DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.
[2]Capacitance and dissipation factor (DF) measured under the following conditions:
1 MHz ±100 kHz and 1.0 Vrms ±0.2 V if capacitance ≤ 1,000 pF
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

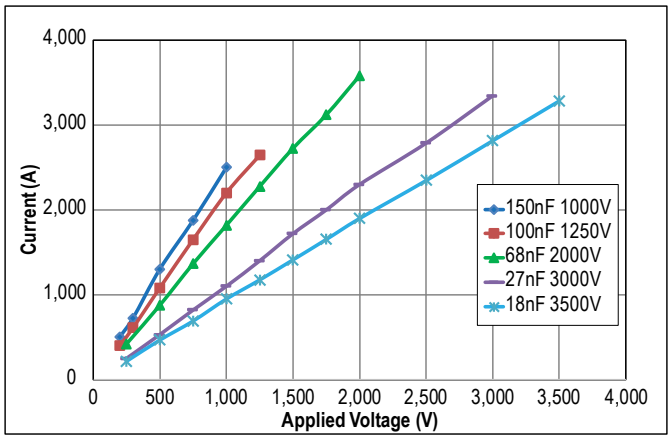


Table 1 – Pulse Discharge Series, Capacitance Range Waterfall

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	1,550
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**	

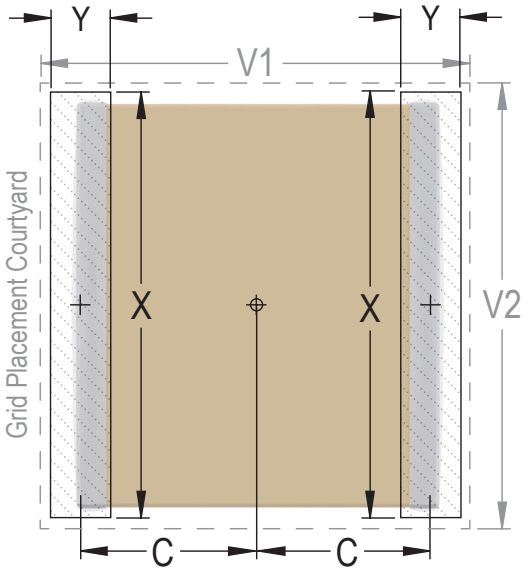
Package quantity based on finished chip thickness specifications.

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})	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.

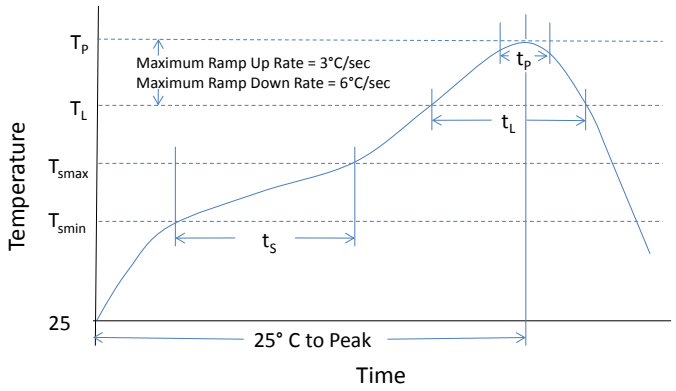


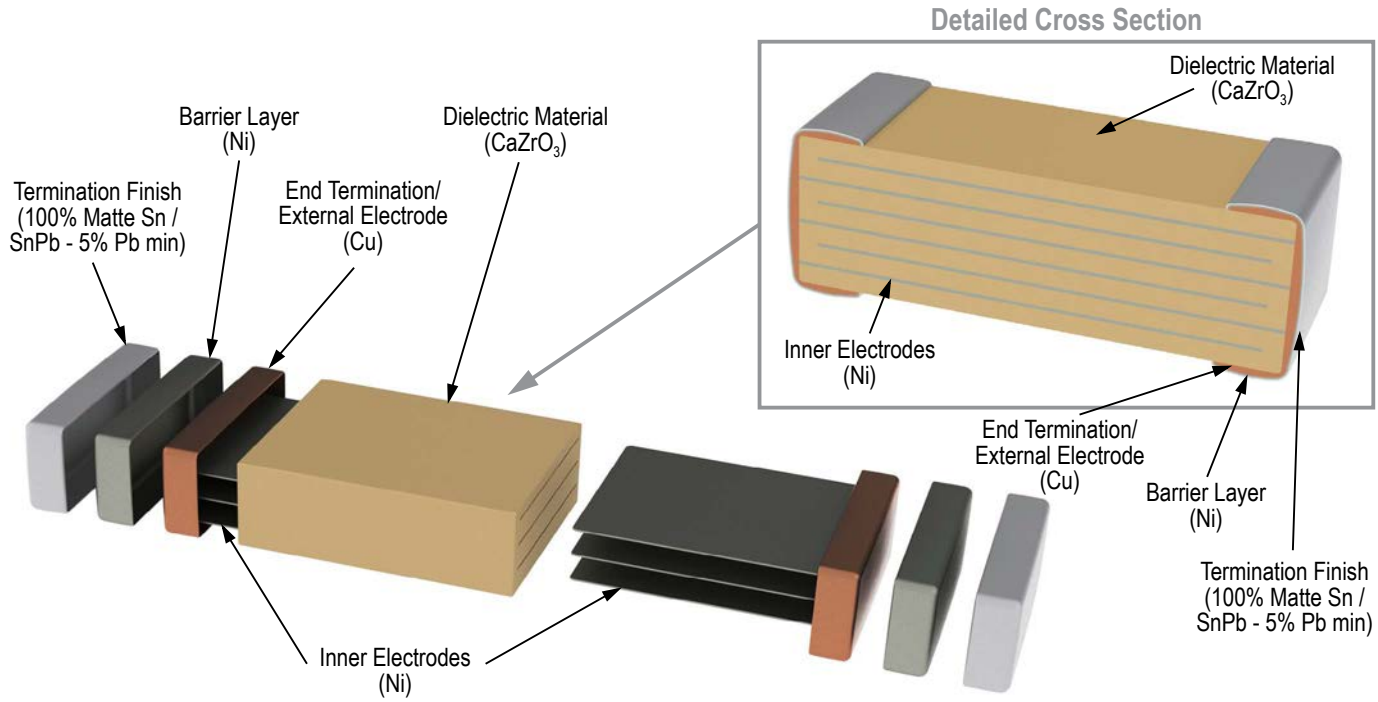
Table 4 – Performance & Reliability: Test Methods and Conditions

Product Qualification Test Plan	
Reliability/Environmental Tests per MIL–STD–202//JESD22	
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 @ 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.

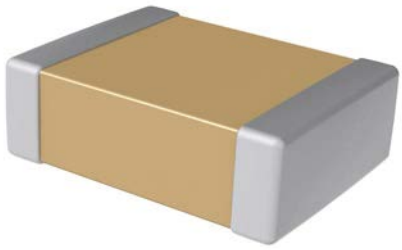
High Voltage C0G Dielectric, 500 – 3,000 VDC (Commercial Grade)

Overview

KEMET's High Voltage surface mount MLCCs in C0G dielectric feature a 125°C maximum operating temperature and are 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 ±30ppm/ºC 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 high voltage MLCC's 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.

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	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)
	0805 1206 1210 1808 1812 1825 2220 2225 2824 3040 3640 4540	C = Standard	Two significant digits + 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 min.)	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.*

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Packaging C-Spec Ordering Options Table

Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)
Bulk Bag/Unmarked	Not required (Blank)
7" Reel/Unmarked	TU
13" Reel/Unmarked	7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes)
7" Reel/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".

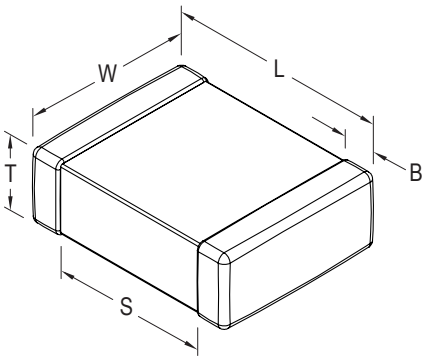
Benefits

- Operating temperature range of −55°C to +125°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, 2 KV, 2.5 KV, and 3 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
- Preferred capacitance solution at line frequencies & 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
- 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, snubbed 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.

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 (.079) ± 0.20 (.008)	1.25 (.049) ± 0.20 (.008)	See Table 2 for Thickness	0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	"Solder Wave or Solder Reflow"
1206	3216	3.20 (.126) ± 0.20 (.008)	1.60 (.063) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)	N/A	
1210	3225	3.20 (.126) ± 0.20 (.008)	2.50 (.098) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)		Solder Reflow Only
1808	4520	4.70 (.185) ± 0.50 (.020)	2.00 (.079) ± 0.20 (.008)		0.60 (.024) ± 0.35 (.014)		
1812	4532	4.50 (.177) ± 0.30 (.012)	3.20 (.126) ± 0.30 (.012)		0.60 (.024) ± 0.35 (.014)		
1825	4564	4.50 (.177) ± 0.30 (.012)	6.40 (.252) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2220	5650	5.70 (.224) ± 0.40 (.016)	5.00 (.197) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2225	5664	5.60 (.220) ± 0.40 (.016)	6.40 (.248) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2824	7260	7.10 (.280) ± 0.40 (.016)	6.10 (.240) ± 0.40 (.016)		1.27 (.050) ± 0.40 (.016)		
3040	7610	7.60 (.300) ± 0.40 (.016)	10.20 (.402) ± 0.40 (.016)		1.27 (.050) ± 0.40 (.016)		
3640	9210	9.10 (.358) ± 0.40 (.016)	10.20 (.402) ± 0.40 (.016)		1.27 (.050) ± 0.40 (.016)		
4540	-	11.40 (.449) ± 0.40 (.016)	10.20 (.402) ± 0.40 (.016)		1.27 (.050) ± 0.40 (.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).

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)	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)
[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 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

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

Capacitance	Cap Code	Case Size/Series	C0805C			C1206C					C1210C					C1808C						
		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	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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	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	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	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	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	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	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	LC	
390 pF	391	F G J K M	DG	DG		ED	ED	EF	EG		FG	FG	FG	FK	FS	LA	LA	LA	LB	LA	LC	
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			
Capacitance	Cap Code	Rated Voltage (VDC)	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	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		Case Size/Series	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 (0805 – 1808 Case Sizes) cont'd

Capacitance	Cap Code	Case Size/Series	C0805C			C1206C					C1210C					C1808C						
		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	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																			
1,200 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	EB				FK	FL	FS			LC	LA	LB				
2,200 pF	222	F G J K M				EG	EB				FK	FL	FS			LC	LA	LB				
2,400 pF	242	F G J K M				EG	EB				FS	FL	FS			LC	LA	LB				
2,700 pF	272	F G J K M				EG	EB				FS	FL	FS			LC	LA	LC				
3,000 pF	302	F G J K M				EB	EB				FS	FL				LA	LA					
3,300 pF	332	F G J K M				EB	EB				FS	FM				LA	LA					
3,600 pF	362	F G J K M				EC	EC				FL	FM				LA	LB					
3,900 pF	392	F G J K M				EC	EC				FL	FY				LA	LB					
4,300 pF	432	F G J K M				ED	ED				FM	FY				LA	LC					
4,700 pF	472	F G J K M				ED	ED				FM	FY				LA	LC					
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	FE				LC						
6,800pF	682	F G J K M									FY	FE				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	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	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	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
11 pF	110	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
12 pF	120	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
13 pF	130	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
15 pF	150	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
16 pF	160	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
18 pF	180	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
20 pF	200	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
22 pF	220	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
24 pF	240	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
27 pF	270	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
30 pF	300	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
33 pF	330	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
36 pF	360	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
39 pF	390	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
43 pF	430	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
47 pF	470	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
51 pF	510	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
56 pF	560	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
62 pF	620	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
68 pF	680	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
75 pF	750	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
82 pF	820	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
91 pF	910	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
100 pF	101	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
110 pF	111	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
120 pF	121	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
130 pF	131	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
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	GH	GH	GH	GH	GH	GK	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	GH	GH	GH	GH	GH	GK	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	GH	GH	GH	GH	GH	GK	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	GH	GH	GH	GH	GH	GK	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	GH	GH	GH	GH	GH	GK	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	GH	GH	GH	GH	GH	GK	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	GK	GK	GK	GK	GH	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	GK	GK	GK	GK	GK	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	GK	GK	GK	GK	GK	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	GK	GK	GK	GK	GK	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	GH	GH	GH	GK	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	GH	GH	GH	GK	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	GH	GH	GH	GK	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	GH	GH	GH	GK	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	GH	GH	GH	GK	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	GH	GH	GH	GK	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	GH	GH	GH	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
		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'd

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																											
1,000 pF	102	F G J K M	GH	GH	GH	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	GH	GK	GK	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	GH	GK	GK	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	GH	GK	GK	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	GK	GK	GK	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	GK	GK	GK	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	GK	GK	GK	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	GK	GK	GK	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	GK	GK	GK	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	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			
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	F G J K M	GM	GO						HE	HG	HK					JE	JE	JL					KF	KE	KH				
10,000 pF	103	F G J K M	GM	GO						HE	HG	HK					JE	JE	JL					KF	KE	KH				
12,000 pF	123	F G J K M	GO							HE	HG						JE	JK	JN					KE	KE	KH				
15,000 pF	153	F G J K M	GO							HE	HJ						JE	JL						KE	KF	KJ				
18,000 pF	183	F G J K M								HG	HK						JE	JL						KE	KH					
22,000 pF	223	F G J K M								HJ							JK	JN						KF	KJ					
27,000 pF	273	F G J K M								HJ							JL	JN						KF	KJ					
33,000 pF	333	F G J K M								HK							JN							KH						
39,000 pF	393	F G 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	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																			
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	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).
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	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
EB	1206	0.78 ± 0.10	4000	10000	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
EF	1206	1.20 ± 0.15	0	0	2,500	10,000
EG	1206	1.60 ± 0.15	0	0	2,000	8,000
FE	1210	1.00 ± 0.10	0	0	2,500	10,000
FG	1210	1.25 ± 0.15	0	0	2,500	10,000
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	1,550
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	
		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		

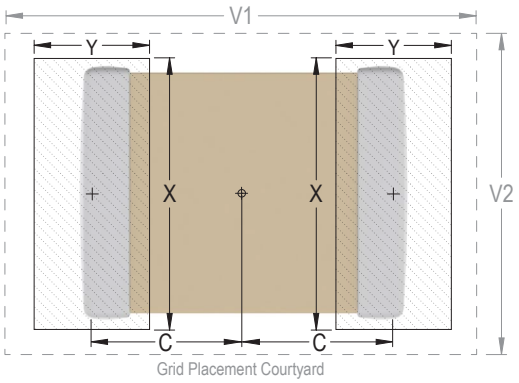
[1] The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial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

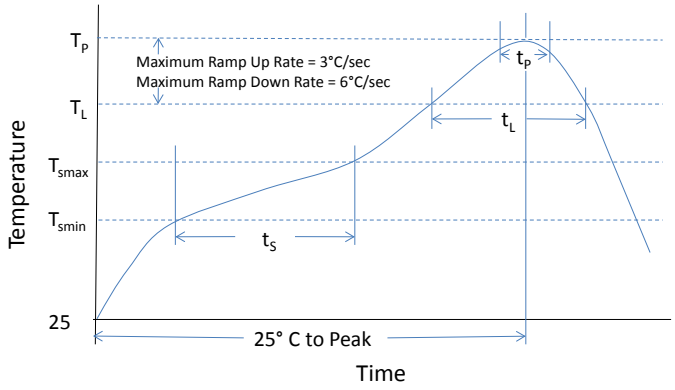


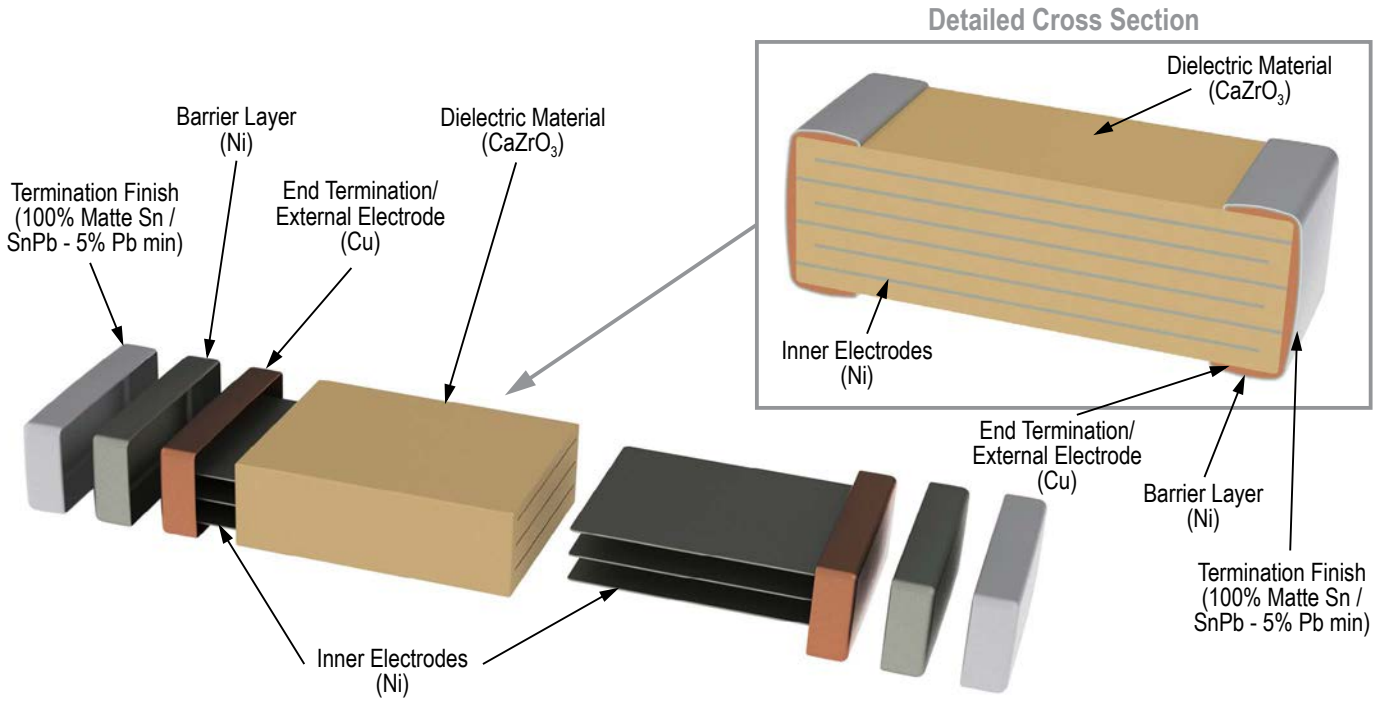
Table 4 – Performance & Reliability: Test Methods and Conditions

Stress	Reference	Test 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 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 (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 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.

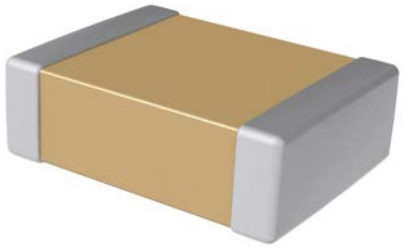
High Voltage X7R Dielectric, 500 – 3,000 VDC (Commercial Grade)

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.

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. 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 MLCC's 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.

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	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)
	0603 0805 1206 1210 1808 1812 1825 2220 2225	C = Standard	Two significant digits + 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" below

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

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Packaging C-Spec Ordering Options Table

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

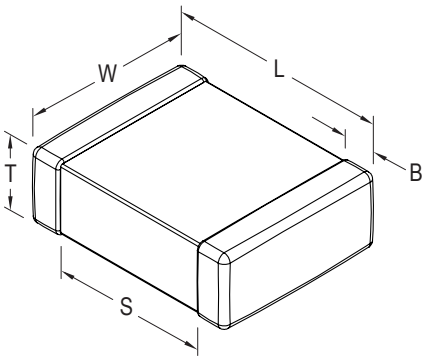
Applications

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
0603	1608	1.60 (.063) ± 0.15 (.006)	0.80 (.032) ± 0.15 (.006)	See Table 2 for Thickness	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	
1210	3225	3.20 (.126) ± 0.20 (.008)	2.50 (.098) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)		Solder Reflow Only
1808	4520	4.70 (.185) ± 0.50 (.020)	2.00 (.079) ± 0.20 (.008)		0.60 (.024) ± 0.35 (.014)		
1812	4532	4.50 (.177) ± 0.30 (.012)	3.20 (.126) ± 0.30 (.012)		0.60 (.024) ± 0.35 (.014)		
1825	4564	4.50 (.177) ± 0.30 (.012)	6.40 (.252) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2220	5650	5.70 (.224) ± 0.40 (.016)	5.00 (.197) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2225	5664	5.60 (.220) ± 0.40 (.016)	6.40 (.248) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.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)	±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 @ 25°C	2.5%
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (500VDC applied for 120 ± 5 secs @ 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	100 Megohm Microfarads or 10 GΩ
0603	N/A	All
0805	< 0.0039 µF	≥ 0.0039 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	All	N/A

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

Cap	Cap Code	Case Size/ Series	C0603C			C0805C			C1206C					C1210C					C1808C							C1812C						
		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	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	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	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	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	GK	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	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				GH	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	C0603C			C0805C			C1206C					C1210C					C1808C							C1812C						

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'd

Cap	Cap Code	Case Size/ Series	C0603C			C0805C			C1206C					C1210C					C1808C							C1812C						
		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			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				
62,000 pF	623	J K M							EJ					FG	FK	FS			LA	LA	LC					GK	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	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	C0603C			C0805C			C1206C					C1210C					C1808C							C1812C						

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).

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

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																				
		J K M																					
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			
62,000 pF	623	J K M	HG	HG	HG	HK				JE	JE	JE	JL				KE	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	C1825C							C2220C							C2225C						

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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
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		

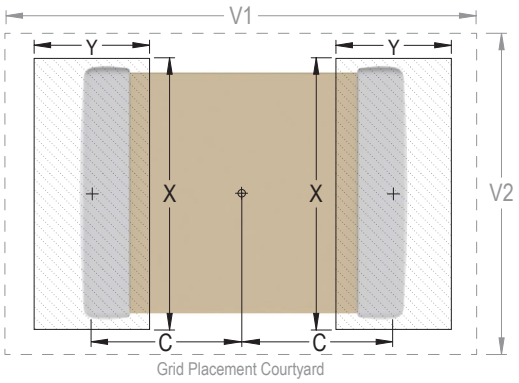
[1] The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial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

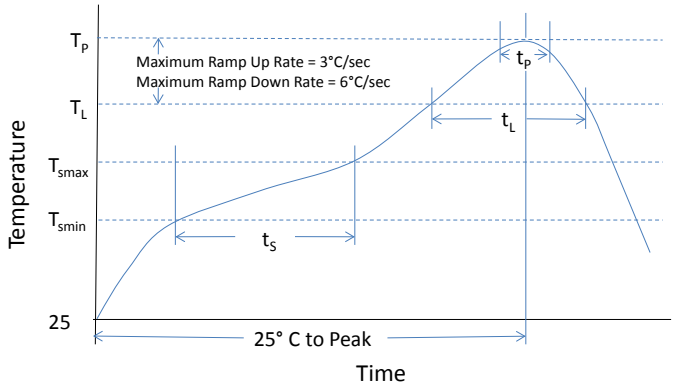


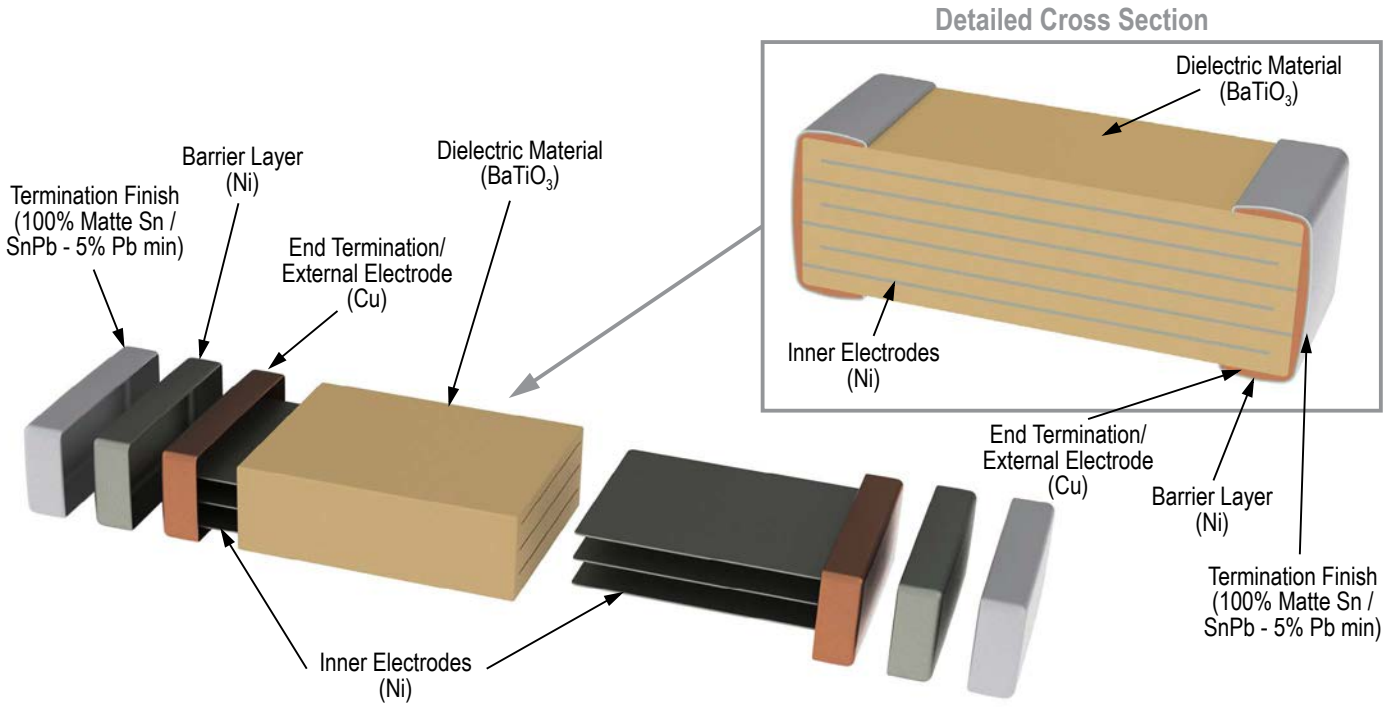
Table 4 – Performance & Reliability: Test Methods and Conditions

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 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 (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 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



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

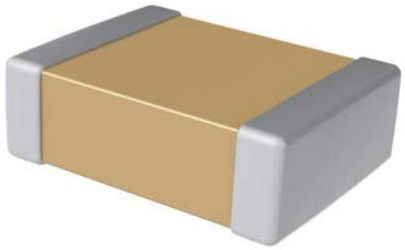
Overview

KEMET's High Voltage with Flexible Termination (HV FT-CAP) surface mount MLCCs in X7R dielectric address the primary failure mode of MLCCs– flex cracks, which are typically the result of excessive tensile and shear stresses produced during board flexure and thermal cycling. Featuring several of the highest CV (capacitance/voltage) values available in the industry, these devices utilize a pliable and conductive silver epoxy between the base metal and nickel barrier layers of the termination system. The addition of this epoxy layer inhibits the transfer of board stress to the rigid ceramic body, therefore mitigating flex cracks which can result in low IR or short circuit failures. Although flexible termination technology does not eliminate the potential for mechanical damage that may propagate during extreme environmental and handling conditions, it does provide superior flex performance over standard termination systems.

The HV FT-CAP offers low leakage current, exhibits low ESR at high frequencies and finds conventional use as snubbers or filters in applications such as switching power supplies and lighting ballasts. Their exceptional performance at high frequencies has made them a preferred 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.

Combined with the stability of an X7R dielectric and designed to accommodate all capacitance requirements, these flex-robust devices are RoHS-compliant, offer up to 5 mm of flex-bend capability and exhibits a predictable change in capacitance with respect to time and voltage. Capacitance change with reference to ambient temperature is limited to ±15% from −55°C to +125°C.

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



Ordering Information

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 + 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" below

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

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Packaging C-Spec Ordering Options Table

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

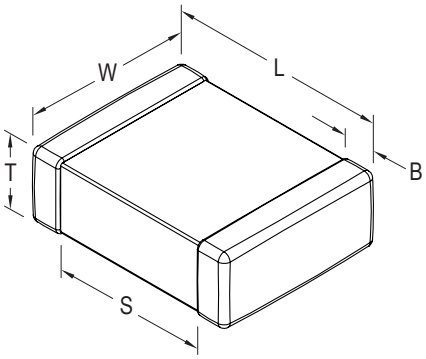
Applications

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
0603	1608	1.60 (.063) ± 0.17 (.007)	0.80 (.032) ± 0.15 (.006)	See Table 2 for Thickness	0.45 (.018) ± 0.15 (.006)	0.58 (.023)	Solder Wave or Solder Reflow
0805	2012	2.00 (.079) ± 0.30 (.012)	1.25 (.049) ± 0.30 (.012)		0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	
1206	3216	3.30 (.130) ± 0.40 (.016)	1.60 (.063) ± 0.35 (.013)		0.60 (.024) ± 0.25 (.010)	N/A	
1210	3225	3.30 (.130) ± 0.40 (.016)	2.60 (.102) ± 0.30 (.012)		0.60 (.024) ± 0.25 (.010)		Solder Reflow Only
1808	4520	4.70 (.185) ± 0.50 (.020)	2.00 (.079) ± 0.20 (.008)		0.70 (.028) ± 0.35 (.014)		
1812	4532	4.50 (.178) ± 0.40 (.016)	3.20 (.126) ± 0.30 (.012)		0.70 (.028) ± 0.35 (.014)		
1825	4564	4.60 (.181) ± 0.40 (.016)	6.40 (.252) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		
2220	5650	5.90 (.232) ± 0.75 (.030)	5.00 (.197) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		
2225	5664	5.90 (.232) ± 0.75 (.030)	6.40 (.248) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.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)	±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 @ 25°C	2.5%
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (500VDC applied for 120 ± 5 secs @ 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 (%)	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
0603	N/A	All
0805	< 0.0039 µF	≥ 0.0039 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	All	N/A

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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GG	GG	GG	GG	GG	GG	GK
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	GK	GK	GK	GK	GK	GK	GK
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	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	LB	LB	LB	LB	LB	LB	LB	GK	GK	GK	GK	GK	GK	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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GK	GK	GK	GK	GK	GK	GK
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	GH	GH	GH	GH	GH	GK	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	GH	GH	GH	GH	GH	GK	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	GH	GH	GH	GH	GH	GK	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	GH	GH	GH	GH	GH	GK	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		GH	GH	GH	GH	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		GH	GH	GH	GH	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		GH	GH	GH	GH	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		GH	GH	GH	GH	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			GH	GH	GH	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			GH	GH	GH	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			GH	GH	GH	GH	GK	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	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				GH	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'd

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				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	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				
62,000 pF	623	J K M							EJ					FZ	FK	FS			LA	LA	LC					GK	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		

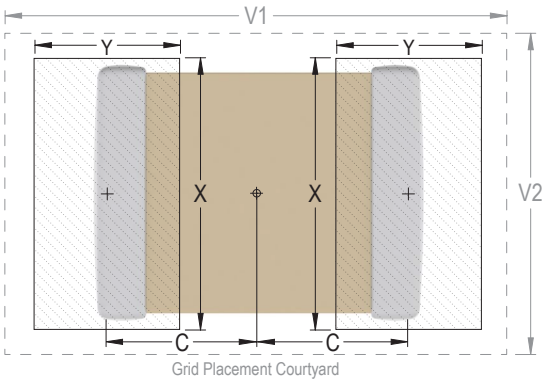
[1] The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial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

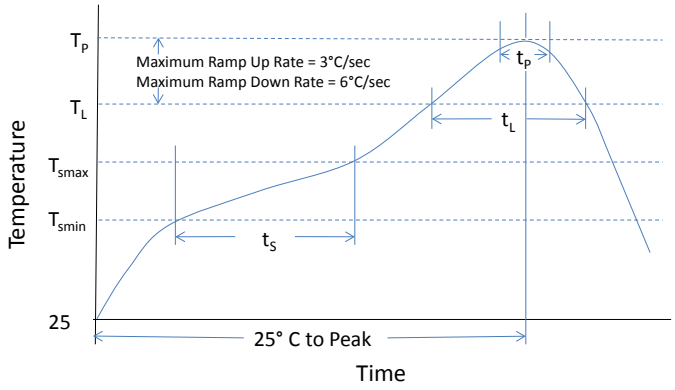


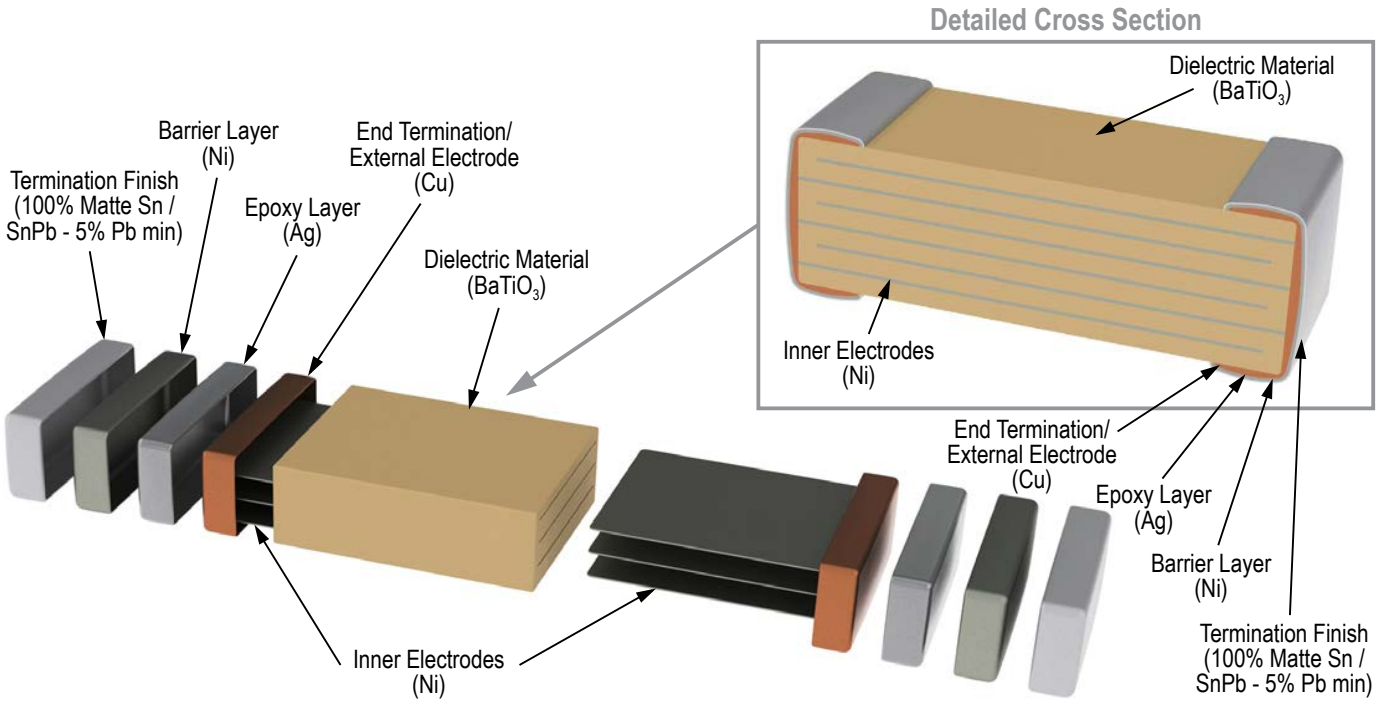
Table 4 – Performance & Reliability: Test Methods and Conditions

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 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 (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 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



High Voltage with Flexible Termination System (HV FT-CAP), C0G Dielectric, 500 – 3,000 VDC (Commercial Grade)

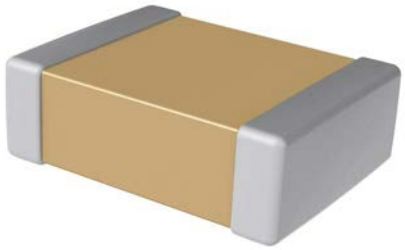
Overview

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, 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.

KEMET's high voltage surface mount MLCCs in C0G dielectric feature a 125°C maximum operating temperature and offer the most stable voltage and temperature performance of all ceramic dielectric materials. 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/ºC 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 high voltage MLCC's 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.

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	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)
	0805 1206 1210 1808 1812 1825 2220 2225	X= Flexible Termination	Two significant digits + 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" 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.

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Packaging C-Spec Ordering Options Table

Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)
Bulk Bag/Unmarked	Not required (Blank)
7" Reel/Unmarked	TU
13" Reel/Unmarked	7411 (EIA 0603 and smaller case sizes) 7210 (EIA 0805 and larger case sizes)
7" Reel/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".

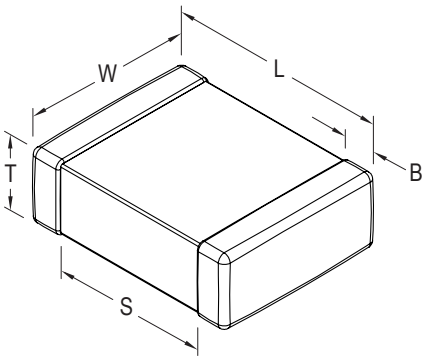
Benefits

- −55°C to +125°C operating temperature range
- Superior flex performance (up to 5 mm)
- 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 1 pF to 39 nF
- 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 & ESL
- High thermal stability
- High ripple current capability
- Preferred capacitance solution at line frequencies & 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
- 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, snubbed 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.

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 (.079) ± 0.30 (.012)	1.25 (.049) ± 0.30 (.012)	See Table 2 for Thickness	0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	Solder Wave or Solder Reflow
1206	3216	3.30 (.130) ± 0.40 (.016)	1.60 (.063) ± 0.35 (.013)		0.60 (.024) ± 0.25 (.010)	N/A	
1210	3225	3.30 (.130) ± 0.40 (.016)	2.60 (.102) ± 0.30 (.012)		0.60 (.024) ± 0.25 (.010)		Solder Reflow Only
1808	4520	4.70 (.185) ± 0.50 (.020)	2.00 (.079) ± 0.20 (.008)		0.70 (.028) ± 0.35 (.014)		
1812	4532	4.50 (.178) ± 0.40 (.016)	3.20 (.126) ± 0.30 (.012)		0.70 (.028) ± 0.35 (.014)		
1825	4564	4.60 (.181) ± 0.40 (.016)	6.40 (.252) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		
2220	5650	5.90 (.232) ± 0.75 (.030)	5.00 (.197) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		
2225	5664	5.90 (.232) ± 0.75 (.030)	6.40 (.248) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		

Qualification/Certification

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

Environmental Compliance

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

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)	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)
[2]Dissipation Factor (DF) Maximum Limit at 25ºC	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 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

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

Capacitance	Cap Code	Case Size/Series							C0805X			C1206X					C1210X					C1808X						
		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	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	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	EF	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	FM	FM	LA	LA	LA	LB	LC	LC	
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	DG	DG		ES	ES	EF	EU		FZ	FZ	FZ	FK	FK	LA	LA	LA	LB	LC	LC	
330 pF	331				F	G	J	K	M	DG	DG		ES	ES	EF	EU		FZ	FZ	FZ	FK	FK	LA	LA	LA	LB	LC	LC	
360 pF	361				F	G	J	K	M	DG	DG		ES	ES	EF	EU		FZ	FZ	FZ	FK	FS	LA	LA	LA	LB	LA	LC	
390 pF	391				F	G	J	K	M	DG	DG		ES	ES	EF	EU		FZ	FZ	FZ	FK	FS	LA	LA	LA	LB	LA	LC	
430 pF	431				F	G	J	K	M	DG	DG		ES	ES	EF	EU		FZ	FM	FM	FS	FS	LA	LB	LB	LC	LA		
470 pF	471				F	G	J	K	M	DG	DG		ES	ES	EU	EU		FZ	FM	FM	FS	FS	LA	LB	LB	LC	LA		
510 pF	511				F	G	J	K	M	DG	DG		ES	ES	EU	EU		FZ	FM	FM	FS	FS	LA	LB	LB	LC	LB		
560 pF	561				F	G	J	K	M	DG	DG		ES	ES	EU	EU		FZ	FM	FM	FS	FS	LA	LB	LB	LC	LB		
620 pF	621				F	G	J	K	M	DG			ES	ES	EU			FZ	FM	FM	FS	FS	LA	LB	LB	LA	LC		
680 pF	681				F	G	J	K	M	DG			ES	ES	EU			FZ	FM	FM	FS	FS	LB	LB	LB	LA	LC		
750 pF	751				F	G	J	K	M	DG			ES	EF	EU			FZ	FM	FM	FM		LB	LB	LB	LA			
820 pF	821				F	G	J	K	M	DG			ES	EF	EU			FZ	FM	FM	FM		LB	LB	LB	LA			
910 pF	911				F	G	J	K	M				ES	EF	EU			FM	FM	FM	FY		LB	LB	LB	LA			
1,000 pF	102				F	G	J	K	M				ES	EF	EU			FM	FM	FM	FY		LB	LB	LB	LB			
Capacitance	Cap Code	Rated Voltage (VDC)							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	F	G	C	B	D	F	G	C	B	D	F	G	Z	H
		Case Size/Series							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 (0805 – 1808 Case Sizes) cont'd

Capacitance	Cap Code	Case Size/Series	C0805X			C1206X					C1210X					C1808X						
		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	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				EF	EU				FM	FK	FK	FS		LC	LC	LC	LB			
1,200 pF	122	F G J K M				EF	EU				FM	FK	FK	FS		LC	LC	LC	LC			
1,300 pF	132	F G J K M				EF	EU				FM	FS	FS			LC	LC	LC	LC			
1,500 pF	152	F G J K M				EF	EU				FK	FS	FS			LC	LC	LC	LC			
1,600 pF	162	F G J K M				EF	EU				FK	FS	FS			LC	LC	LC				
1,800 pF	182	F G J K M				EF	EU				FK	FS	FS			LC	LC	LC				
2,000 pF	202	F G J K M				EU	EQ				FK	FL	FS			LC	LA	LB				
2,200 pF	222	F G J K M				EU	EQ				FK	FL	FS			LC	LA	LB				
2,400 pF	242	F G J K M				EU	EQ				FS	FL	FS			LC	LA	LB				
2,700 pF	272	F G J K M				EU	EQ				FS	FL	FS			LC	LA	LC				
3,000 pF	302	F G J K M				EQ	EQ				FS	FL				LA	LA					
3,300 pF	332	F G J K M				EQ	EQ				FS	FM				LA	LA					
3,600 pF	362	F G J K M				ER	ER				FL	FM				LA	LB					
3,900 pF	392	F G J K M				ER	ER				FL	FY				LA	LB					
4,300 pF	432	F G J K M				ES	ES				FM	FY				LA	LC					
4,700 pF	472	F G J K M				ES	ES				FM	FY				LA	LC					
5,100 pF	512	F G J K M									FY	FS				LA						
5,200 pF	562	F G J K M									FY	FS				LB						
6,200pF	622	F G J K M									FY	FE				LC						
6,800pF	682	F G J K M									FY	FE				LC						
7,500pF	752	F G J K M									FS											
8,200pF	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	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	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).
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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	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
11 pF	110	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
12 pF	120	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
13 pF	130	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
15 pF	150	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
16 pF	160	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
18 pF	180	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
20 pF	200	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
22 pF	220	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
24 pF	240	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
27 pF	270	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
30 pF	300	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
33 pF	330	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
36 pF	360	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
39 pF	390	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
43 pF	430	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
47 pF	470	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
51 pF	510	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
56 pF	560	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
62 pF	620	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
68 pF	680	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
75 pF	750	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
82 pF	820	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
91 pF	910	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
100 pF	101	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
110 pF	111	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
120 pF	121	F G J K M	GK	GK	GK	GK	GK	GK	GK								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
130 pF	131	F G J K M	GK	GK	GK	GK	GK	GK	GK								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								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								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								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
200 pF	201	F G J K M	GH	GH	GH	GH	GH	GK	GM								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
220 pF	221	F G J K M	GH	GH	GH	GH	GH	GK	GM								JK	JK	JK	JK	JK	JK	JK	KF	KF	KF	KF	KF	KF	KF
240 pF	241	F G J K M	GH	GH	GH	GH	GH	GK	GM								JK	JK	JK	JK	JK	JK	JK	KE	KE	KE	KE	KE	KE	KF
270 pF	271	F G J K M	GH	GH	GH	GH	GH	GK	GM								JK	JK	JK	JK	JK	JK	JK	KE	KE	KE	KE	KE	KE	KF
300 pF	301	F G J K M	GH	GH	GH	GH	GH	GK	GM								JK	JK	JK	JK	JK	JK	JK	KE	KE	KE	KE	KE	KE	KF
330 pF	331	F G J K M	GH	GH	GH	GH	GH	GK	GO								JE	JE	JE	JE	JE	JK	JK	KE	KE	KE	KE	KE	KE	KF
360 pF	361	F G J K M	GK	GK	GK	GK	GH	GK	GO								JE	JE	JE	JE	JE	JK	JK	KE	KE	KE	KE	KE	KE	KF
390 pF	391	F G J K M	GK	GK	GK	GK	GK	GK	GO								JE	JE	JE	JE	JE	JK	JK	KE	KE	KE	KE	KE	KE	KF
430 pF	431	F G J K M	GK	GK	GK	GK	GK	GK								HJ	JE	JE	JE	JE	JE	JK	JE	KE	KE	KE	KE	KE	KE	KF
470 pF	471	F G J K M	GK	GK	GK	GK	GK	GK								HJ	JE	JE	JE	JE	JE	JK	JK	KF	KF	KF	KF	KE	KE	KF
510 pF	511	F G J K M	GH	GH	GH	GK	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	GH	GH	GH	GK	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	GH	GH	GH	GK	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	GH	GH	GH	GK	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	GH	GH	GH	GK	GK										JE	JE	JE	JK	JK	JK	JL	KE	KE	KE	KF	KE	KF	KH
820 pF	821	F G J K M	GH	GH	GH	GK	GK										JE	JE	JE	JK	JK	JK	JN	KE	KE	KE	KF	KE	KF	KJ
910 pF	911	F G J K M	GH	GH	GH	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	GH	GH	GH	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	GH	GK	GK	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
		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)*
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Table 1B – Capacitance Range/Selection Waterfall (1812 – 2225 Case Sizes) cont'd

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	GH	GK	GK	GH	GO								HJ		JE	JK	JK	JK	JK	JL		KE	KE	KE	KF	KF	KF	
1,300 pF	132	F G J K M	GH	GK	GK	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	GK	GK	GK	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	GK	GK	GK	GK								HG	HK		JE	JK	JK	JK	JE	JL		KE	KE	KE	KF	KE	KH	
1,800 pF	182	F G J K M	GK	GK	GK	GM								HG			JE	JK	JK	JK	JE	JN		KE	KE	KE	KF	KE	KH	
2,000 pF	202	F G J K M	GK	GK	GK	GM							HE	HJ			JE	JK	JK	JE	JK			KE	KE	KE	KF	KE	KJ	
2,200 pF	222	F G J K M	GK	GK	GK	GO							HE	HJ			JE	JK	JK	JE	JK			KE	KE	KE	KF	KF	KJ	
2,400 pF	242	F G J K M	GK	GH	GK	GO							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	HK			JK	JK	JK	JE	JL			KE	KE	KE	KE	KH		
3,000 pF	302	F G J K M	GK	GH	GK								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				JK	JK	JK	JK	JN			KE	KE	KE	KE	KJ		
3,600 pF	362	F G J K M	GK	GH	GM								HG				JK	JK	JK	JK	JN			KE	KF	KF	KF	KJ		
3,900 pF	392	F G J K M	GK	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							HE	HG					JK	JE	JE	JN				KE	KF	KF	KJ			
6,800 pF	682	F G J K M	GH	GM							HE	HJ					JK	JE	JK	JN				KE	KF	KF	KJ			
7,500 pF	752	F G J K M	GH	GM							HE	HJ					JK	JE	JK					KF	KE	KF				
8,200 pF	822	F G J K M	GK	GO							HE	HJ					JK	JE	JL					KF	KE	KF				
9,100 pF	912	F G J K M	GM	GO						HE	HG	HK					JE	JE	JL					KF	KE	KH				
10,000 pF	103	F G J K M	GM	GO						HE	HG	HK					JE	JE	JL					KF	KE	KH				
12,000 pF	123	F G J K M	GO							HE	HG						JE	JK	JN					KE	KE	KH				
15,000 pF	153	F G J K M	GO							HE	HJ						JE	JL						KE	KF	KJ				
18,000 pF	183	F G J K M								HG	HK						JE	JL						KE	KH					
22,000 pF	223	F G J K M								HJ							JK	JN						KF	KJ					
27,000 pF	273	F G J K M								HJ							JL	JN						KF	KJ					
33,000 pF	333	F G J K M								HK							JN							KH						
39,000 pF	393	F G J K M																						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 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
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
EQ	1206	0.78 ± 0.20	4000	10000	4,000	10,000
ER	1206	0.90 ± 0.20	0	0	4,000	10,000
FE	1210	1.00 ± 0.10	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
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
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.*

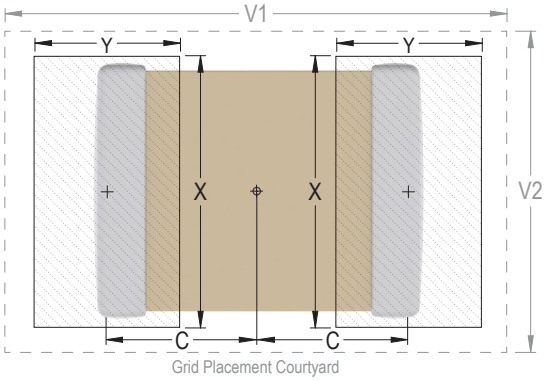
[2] *A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding Anti-Static Bulk Bag and Automotive Grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to out standard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

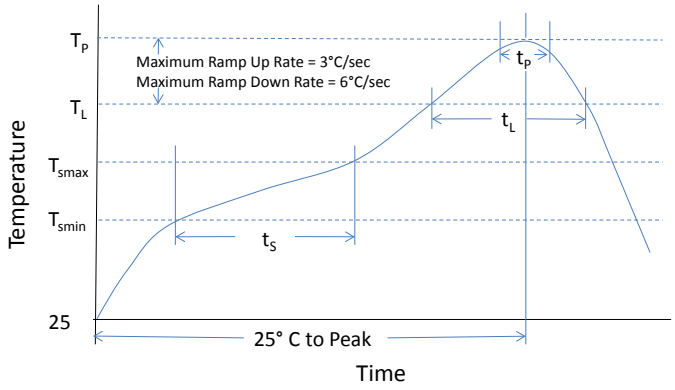


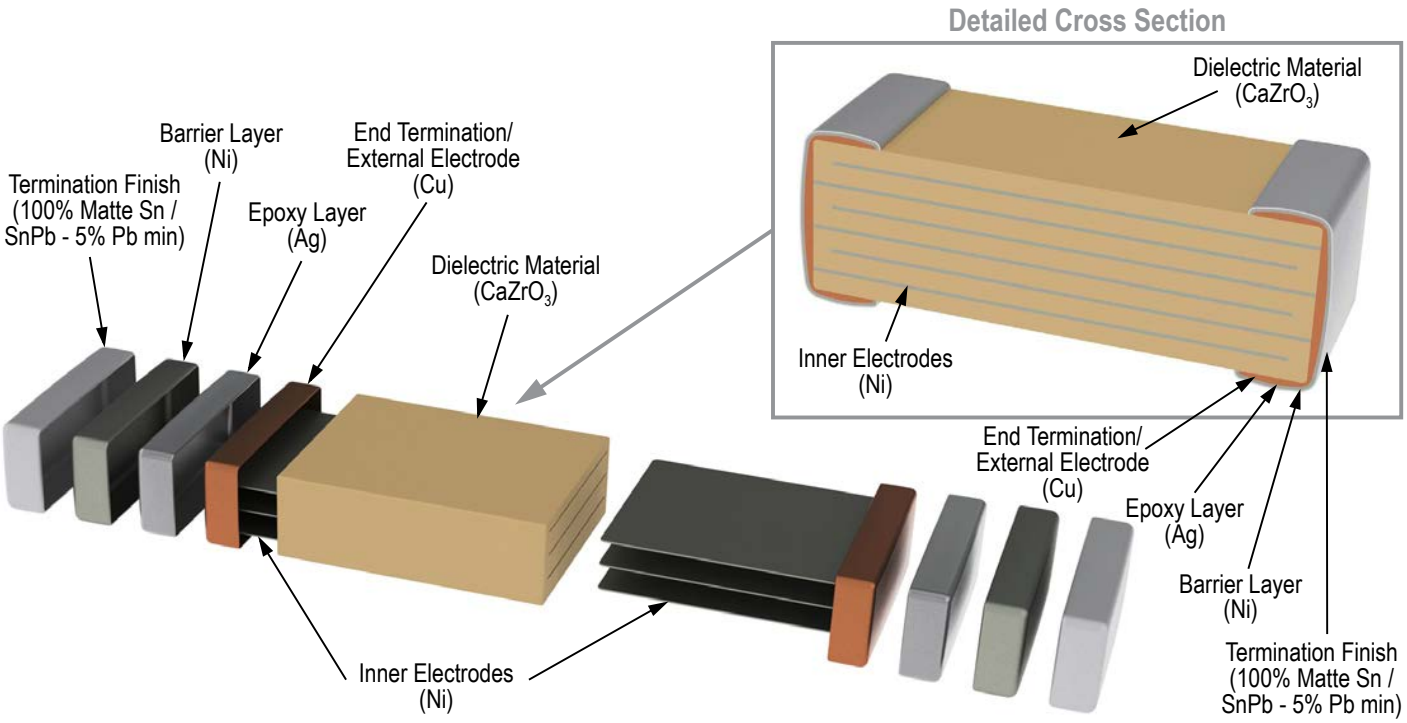
Table 4 – Performance & Reliability: Test Methods and Conditions

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 +/- 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 (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 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.

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

Overview

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.

KEMET's ArcShield high voltage surface mount MLCCs are available in Automotive Grade, which undergo stricter testing protocol and inspection criteria. Whether under-hood 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 + 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" below

[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.

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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 and smaller case sizes) 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 & ESL
- Non-polar device, minimizing installation concerns
- Commercial & 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's 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 record 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.

Qualification/Certification

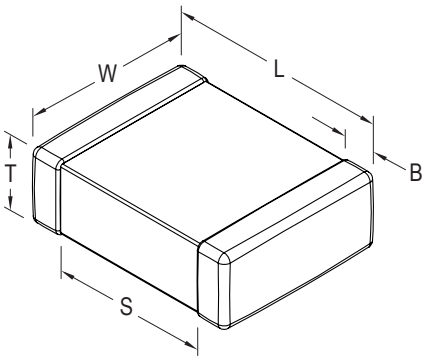
Commercial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4, Performance & Reliability.

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.

Environmental Compliance

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

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 (.063) ± 0.15 (.006)	0.80 (.032) ± 0.15 (.006)	See Table 2 for Thickness	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	
1210	3225	3.20 (.126) ± 0.20 (.008)	2.50 (.098) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)		Solder Reflow Only
1808	4520	4.70 (.185) ± 0.50 (.020)	2.00 (.079) ± 0.20 (.008)		0.60 (.024) ± 0.35 (.014)		
1812	4532	4.50 (.177) ± 0.30 (.012)	3.20 (.126) ± 0.30 (.012)		0.60 (.024) ± 0.35 (.014)		
1825	4564	4.50 (.177) ± 0.30 (.012)	6.40 (.252) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2220	5650	5.70 (.224) ± 0.40 (.016)	5.00 (.197) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2225	5664	5.60 (.220) ± 0.40 (.016)	6.40 (.248) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.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 (.064) ± 0.17 (.007)	0.80 (.032) ± 0.15 (.006)	See Table 2 for Thickness	0.45 (.018) ± 0.15 (.006)	0.58 (.023)	Solder Wave or Solder Reflow
0805	2012	2.00 (.079) ± 0.30 (.012)	1.25 (.049) ± 0.30 (.012)		0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	
1206	3216	3.30 (.130) ± 0.40 (.016)	1.60 (.063) ± 0.35 (.013)		0.60 (.024) ± 0.25 (.010)	N/A	
1210	3225	3.30 (.130) ± 0.40 (.016)	2.60 (.102) ± 0.30 (.012)		0.60 (.024) ± 0.25 (.010)		Solder Reflow Only
1808	4520	4.70 (.185) ± 0.50 (.020)	2.00 (.079) ± 0.20 (.008)		0.70 (.028) ± 0.35 (.014)		
1812	4532	4.50 (.178) ± 0.40 (.016)	3.20 (.126) ± 0.30 (.012)		0.70 (.028) ± 0.35 (.014)		
1825	4564	4.60 (.181) ± 0.40 (.016)	6.40 (.252) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		
2220	5650	5.90 (.232) ± 0.75 (.030)	5.00 (.197) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.014)		
2225	5664	5.90 (.232) ± 0.75 (.030)	6.40 (.248) ± 0.40 (.016)		0.70 (.028) ± 0.35 (.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 @ 25°C	2.5%
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	100 megohm microfarads or 10GΩ (500VDC applied for 120 ± 5 secs @ 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	KF	KE
0.22 µF	224	J K M																GJ			HE	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 Patent 8,885,319 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	0603	0.80 ± 0.10	4,000	15,000	0	0
DG	0805	1.25 ± 0.15	0	0	2,500	10,000
EJ	1206	1.70 ± 0.20	0	0	2,000	8,000
FZ	1210	1.25 ± 0.20	0	0	2,500	10,000
FU	1210	1.55 ± 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
GE	1812	1.30 ± 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
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
GS	1812	2.10 ± 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 out 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.

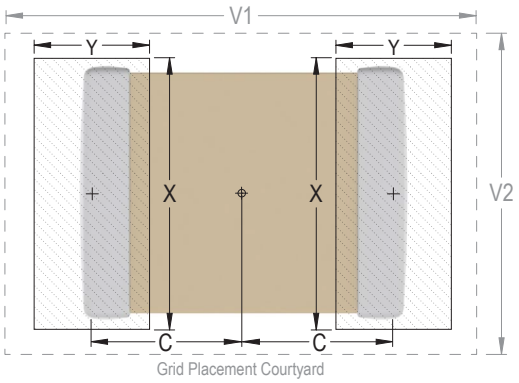
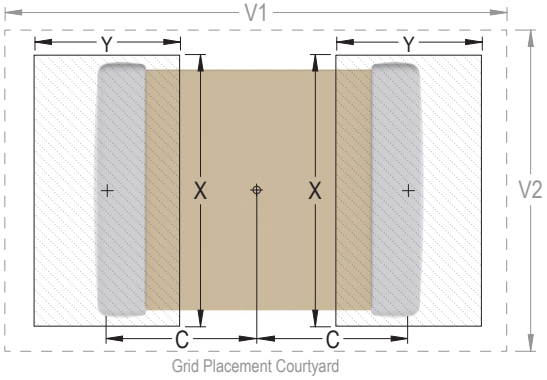


Table 3B – Land Pattern Design Recommendations per IPC–7351 – Flexible Termination

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:

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.

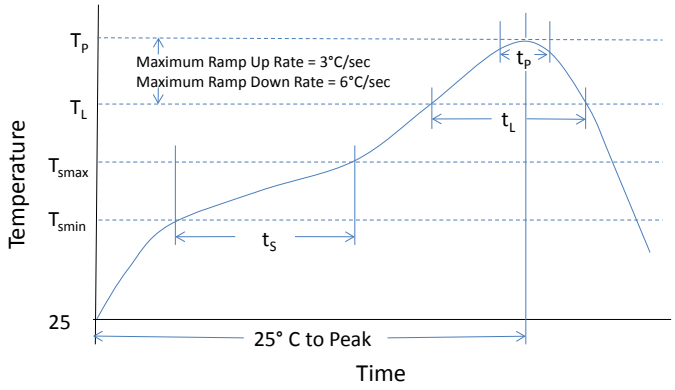


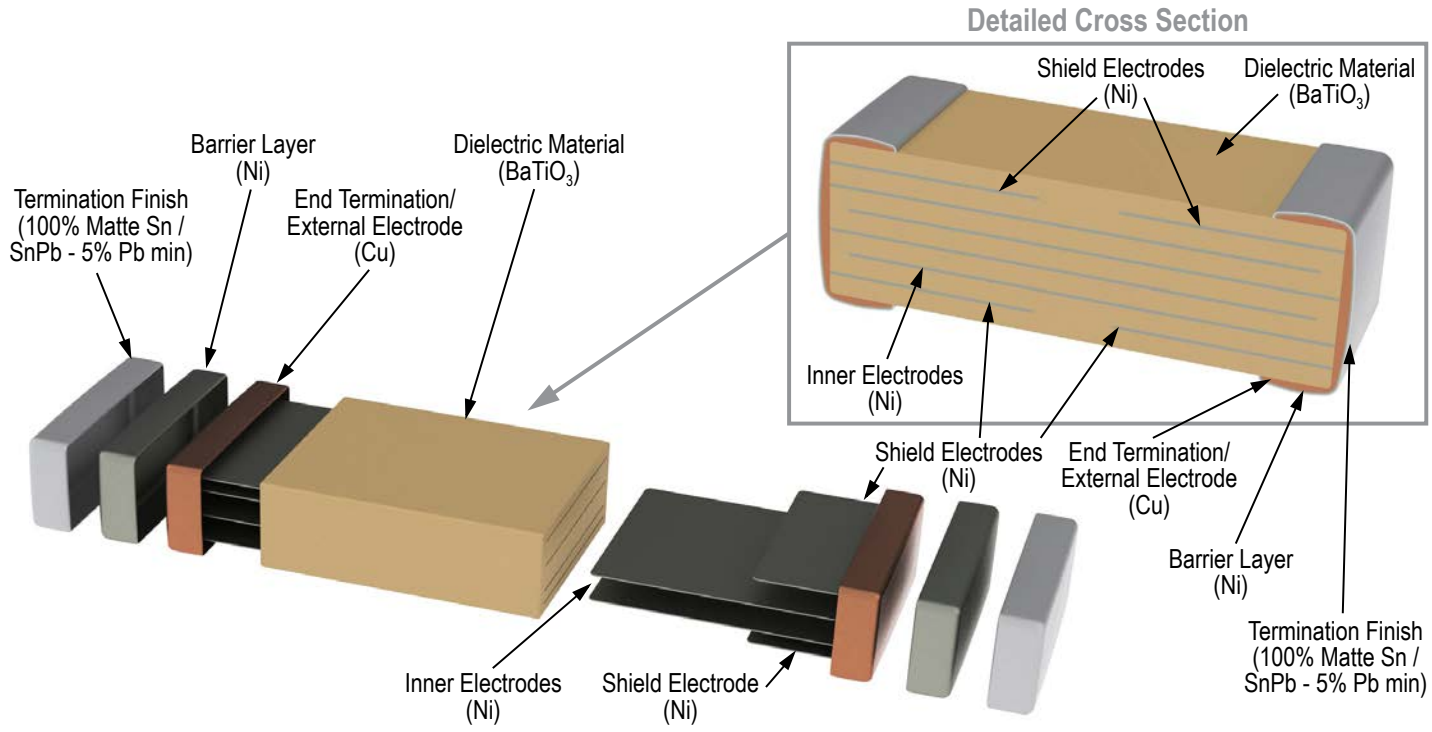
Table 4 – Performance & Reliability: Test Methods and Conditions

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 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 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.

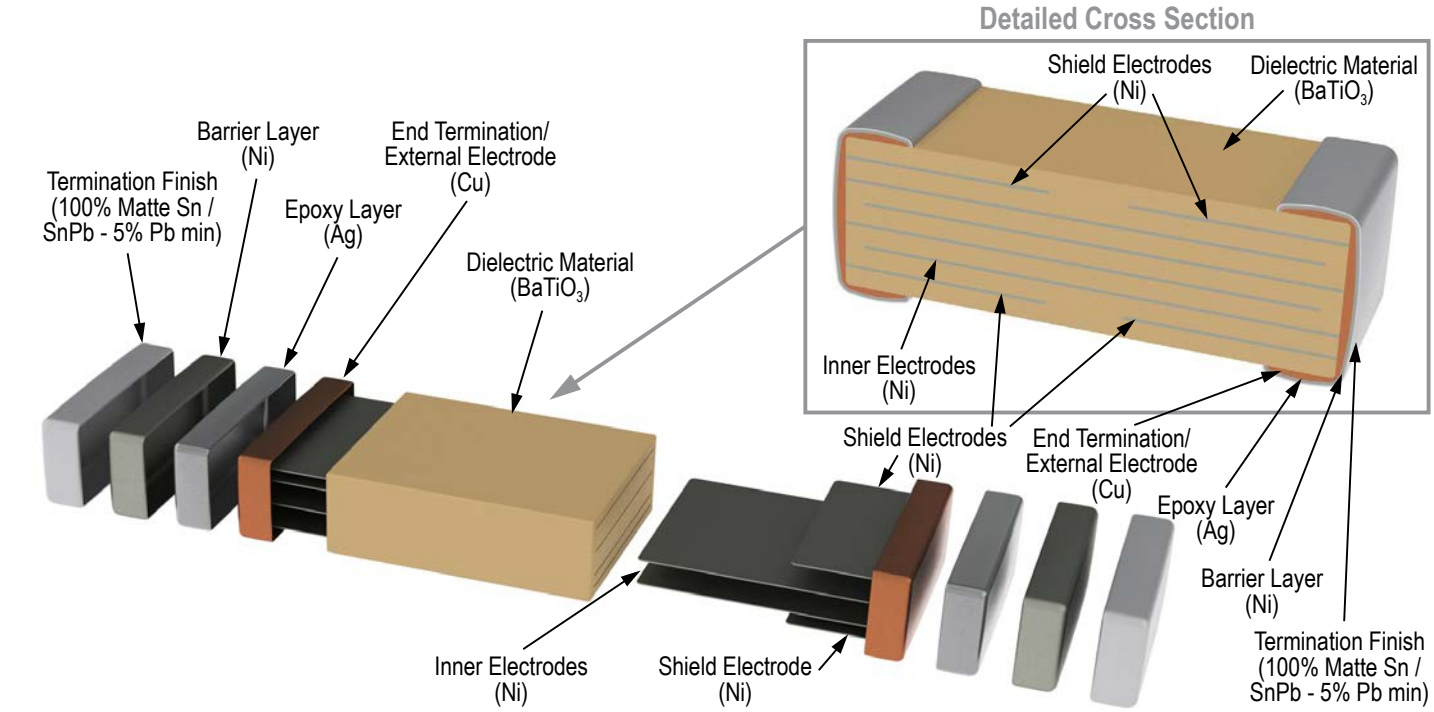
Storage & Handling

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 – Standard Termination



Construction – Flexible Termination



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 + 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" below

[1] Double chip stacks ("2" in the 13th character position of the ordering code) are only available in M (±20%) capacitance tolerance. Single chip stacks ("1" in the 13th character position of the ordering code) are available in K (±10%) or M (±20%) tolerances.

[2] Additional leadframe finish options may be available. Contact KEMET for details.

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Packaging C-Spec Ordering Options Table

Packaging Type[1]	Packaging/Grade Ordering Code (C-Spec)[2]
7" Reel (Embossed Plastic Tape)/Unmarked	7186
13" Reel (Embossed Plastic Tape)/Unmarked	7289

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

Benefits cont'd

- 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

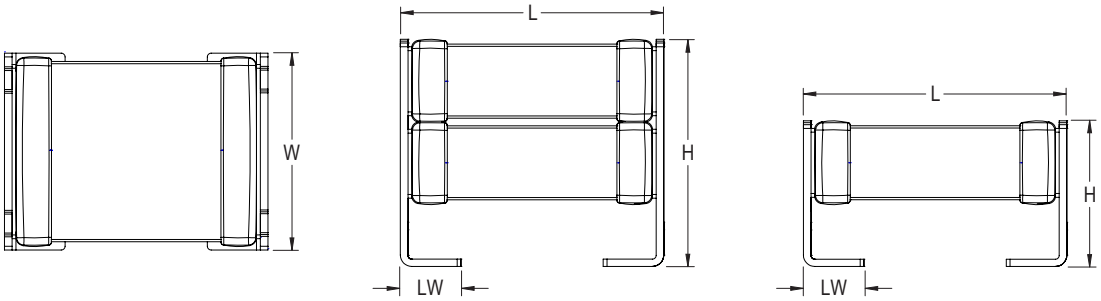
Commercial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 4 , Performance and Reliability.

Environmental Compliance

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

Dimensions – Millimeters (Inches)

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 (.197) ±0.50 (.020)	3.50 (.138) ±0.30 (.012)	1.60 (.063) ±0.30 (.012)	Solder Reflow Only
Double	2220	5650	6.00 (0.236) ±0.50 (0.020)	5.00 (.197) ±0.50 (.020)	5.00 (.197) ±0.50 (.020)	1.60 (.063) ±0.30 (.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 @ 25°C	2.5%
[4]Insulation Resistance (IR) Minimum Limit @ 25°C	See Insulation Resistance Limit Table (500VDC applied for 120 ± 5 secs @ 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	100 Megohm Microfarads or 10 GΩ
0805	< 0.0039 µF	≥ 0.0039 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	All	N/A

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.

Table 2 – Chip Thickness/Tape & Reel Packaging Quantities

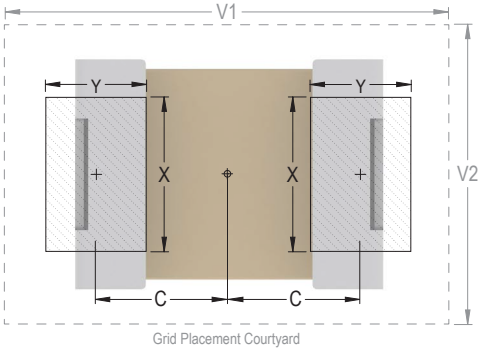
Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
JP	2220	3.50 ± 0.30	0	0	300	1,300
JR	2220	5.00 ± 0.50	0	0	200	800

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
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.



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.

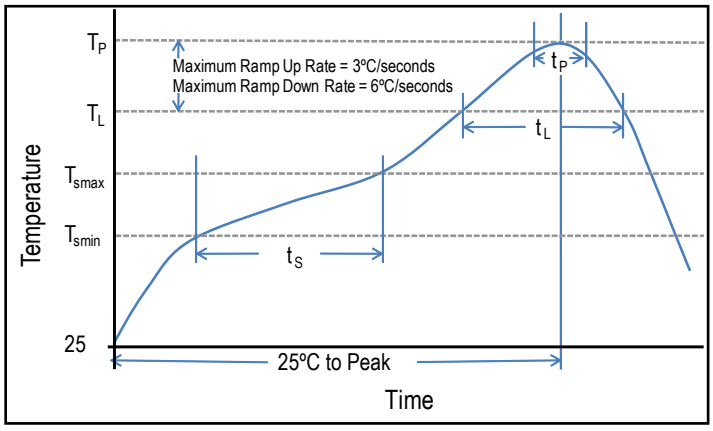


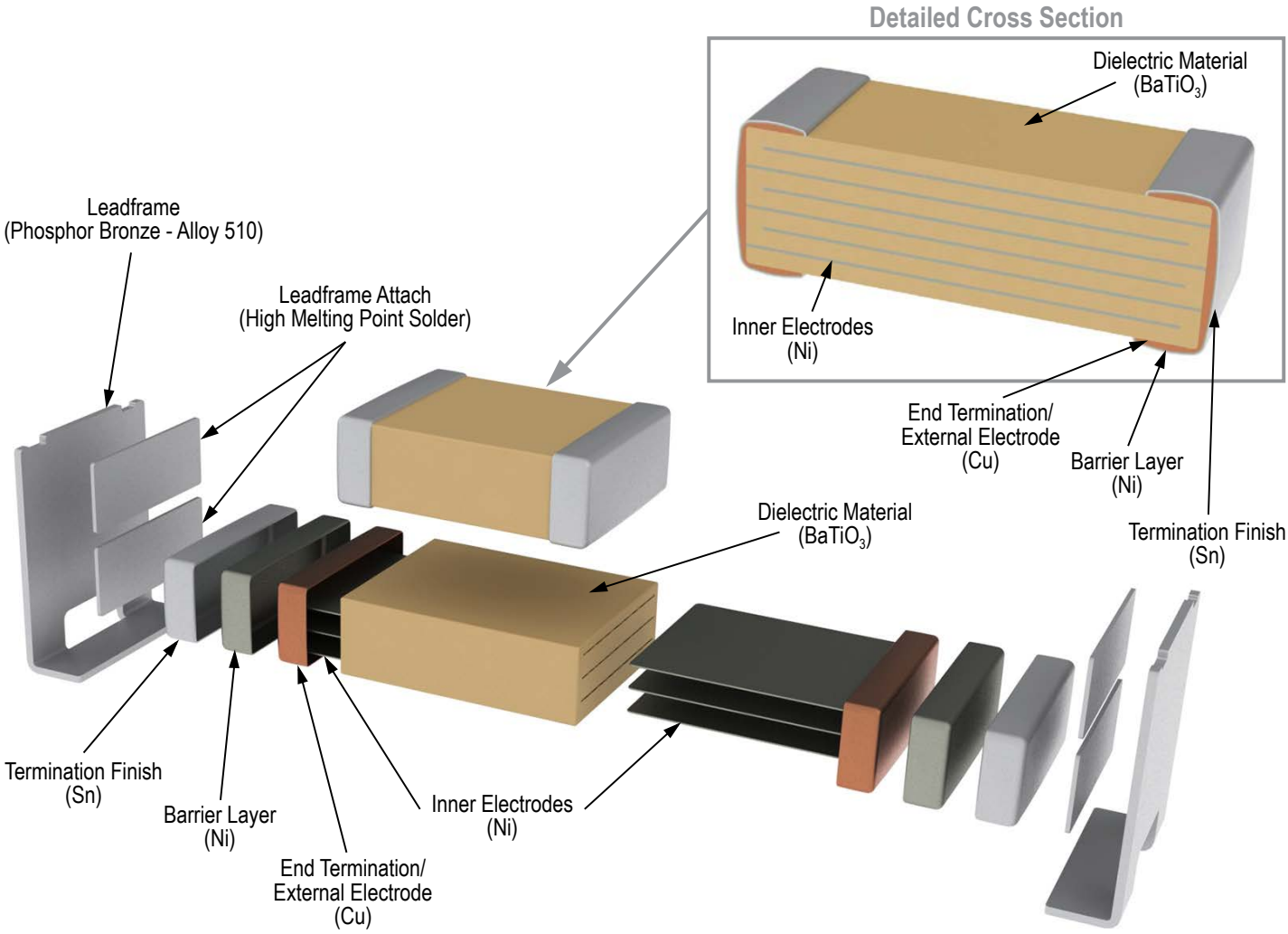
Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 155°C, dry heat @ 235°C
		b) Method B @ 215°C category 3
		c) Method D, category 3 @ 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 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

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.

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

Overview

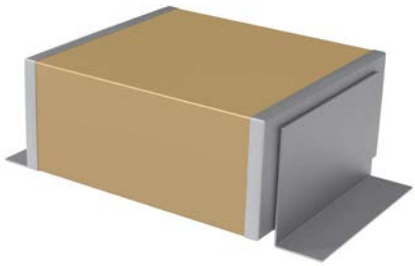
KPS HV (KEMET Power Solutions, High Voltage), Large Case (≥ 1515), SM Series capacitors in C0G dielectric are designed to meet robust performance standards required in higher reliability industrial applications. Utilizing lead-frame technology, SM Series devices isolate the multilayer ceramic chip component 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	2 significant digits + 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.

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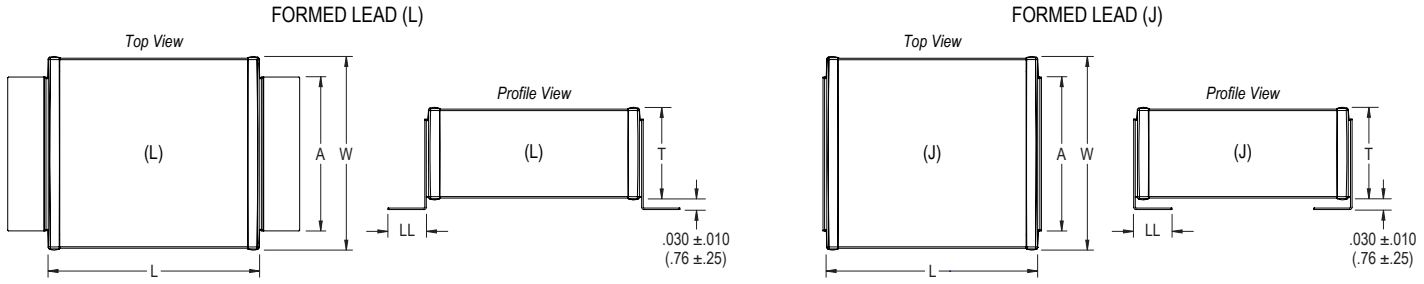
Dimensions – Inches (Millimeters)



Style/ Size	L Length	W Width	T Thickness Maximum	A Lead Width Maximum	LL Lead Length (Formed "L")	LL Lead Length (Formed "J")
SM20	0.150 ± 0.015 (3.81 ± 0.38)	0.150 ± 0.015 (3.81 ± 0.38)	0.130 (3.30)	0.100 (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'd

- 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 @ 25ºC	0.15%
Insulation Resistance (IR) Limit @ 25°C	1,000 megohm microfarads or 100 GΩ (Rated voltage DC applied for 120 ±5 seconds @ 25°C for voltage rating of ≤ 500 VDC) (500 VDC applied for 120 ±5 seconds @ 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																								
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																								
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																	J, K, M, P, Z
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			
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		J, K, M, P, Z
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			
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 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.

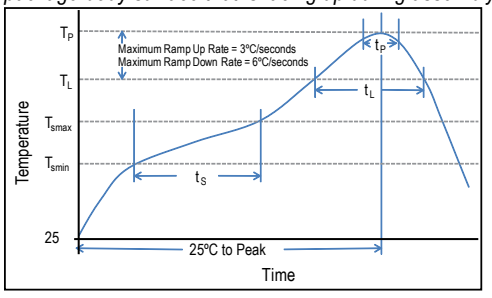


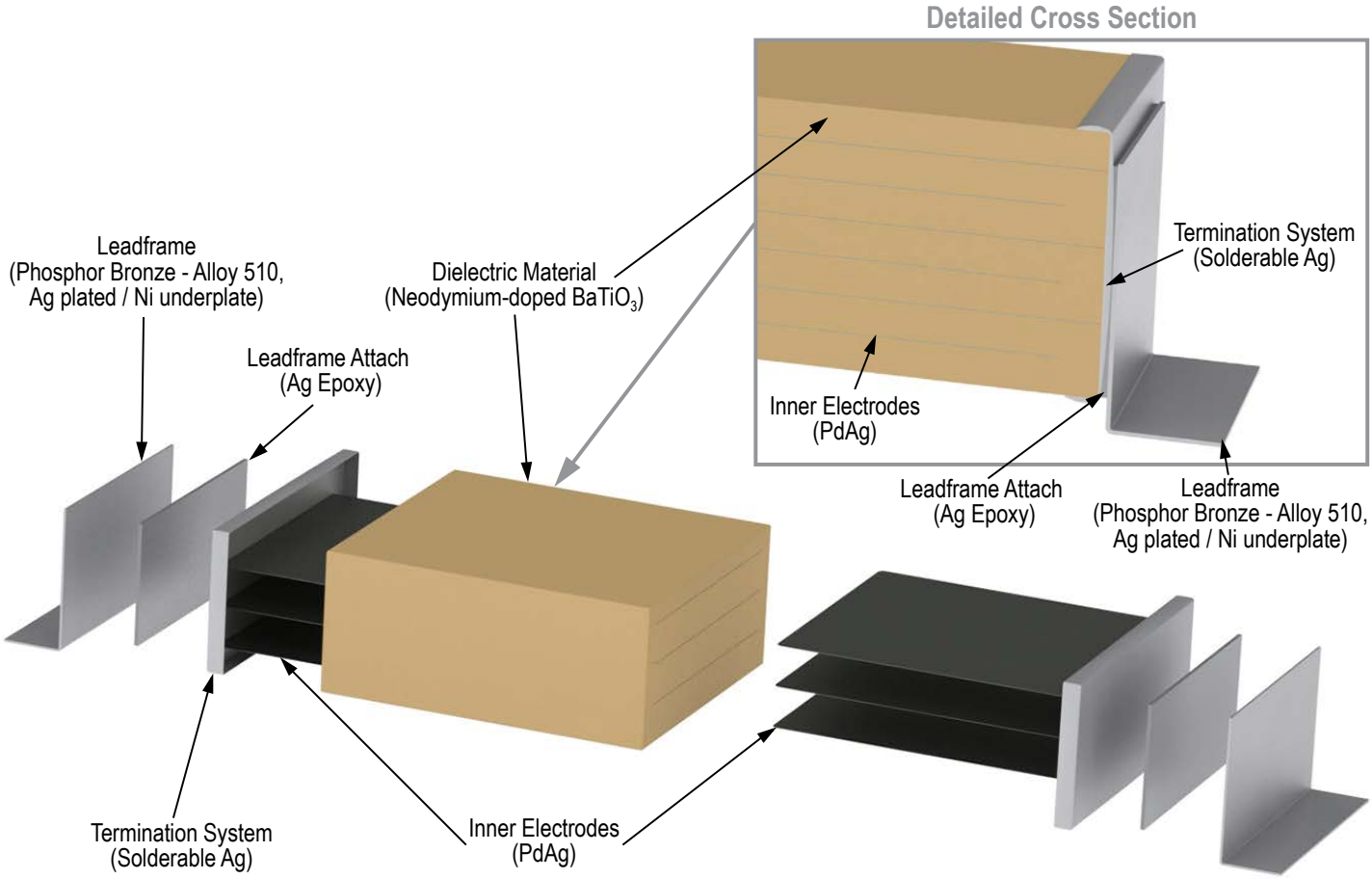
Table 3 – Performance & Reliability: Test Methods and Conditions

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 @ 155°C, dry heat @ 235°C
		b) Method B @ 215°C category 3
		c) Method D, category 3 @ 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

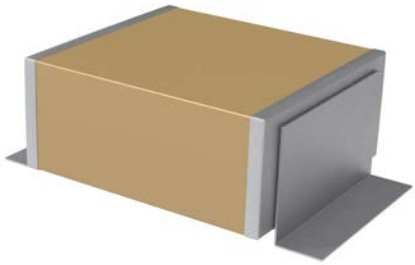
KPS HV (KEMET Power Solutions, High Voltage), Large Case (≥ 1515), SM Series capacitors in X7R dielectric are designed to meet robust performance standards required in higher reliability industrial applications. Utilizing lead-frame technology, SM Series devices isolate the multilayer ceramic chip component 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 SM21 SM22 SM23 SM24 SM25 SM26	SM30 SM31 SM33 SM34 SM35 SM36	B = X7R	Two significant digits + number of zeros	K = ±10% M = ±20%	501 = 500 102 = 1,000 202 = 2,000 302 = 3,000 402 = 4,000 502 = 5,000 752 = 7,500 103 = 10,000	A = Formed "L" B = Formed "J"	Blank = None M = Group A per MIL–PRF–49467

[1] Standard lead configuration is formed "J". If the appropriate character is excluded from the ordering code, the assumed lead configuration will be formed "J".

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

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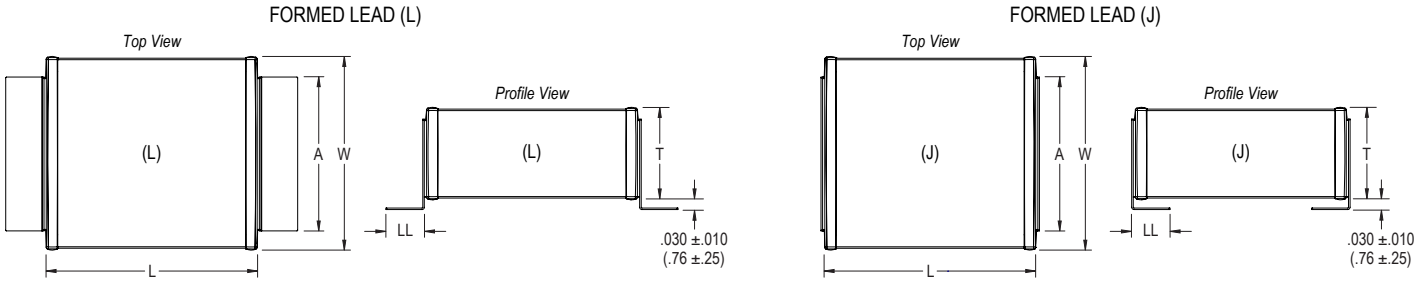
Dimensions – Inches (Millimeters)



Style/ Size	L Length	W Width	T Thickness Max.	A Lead Width Max.	LL Lead Length (Formed "L")	LL Lead Length (Formed "J")
SM20	0.150 ± 0.015 (3.81 ± 0.38)	0.150 ± 0.015 (3.81 ± 0.38)	0.130 (3.30)	0.100 (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'd

- 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 @ 25°C	2.5%
Insulation Resistance (IR) Limit @ 25°C	1,000 megohm microfarads or 100 GΩ (Rated voltage DC applied for 120 ±5 seconds @ 25°C for voltage rating of ≤ 500 VDC) (500 VDC applied for 120 ±5 seconds @ 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																				K, M
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			
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						

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																								
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							K, M
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				
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'd

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																
1.2 µF	125						125																	
1.5 µF	155						155																	
1.8 µF	185						185																	**K, M**
2.2 µF							225																	
2.7 µF							275																	
2.9 µF							295																	

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																								
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																							
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								

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	K, M, P, Z
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					
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 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.

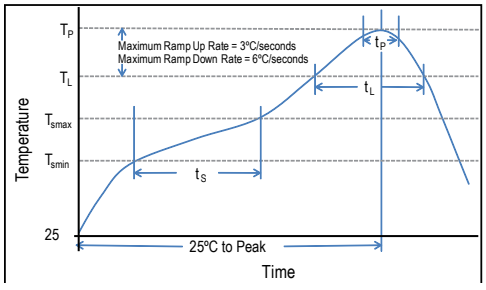


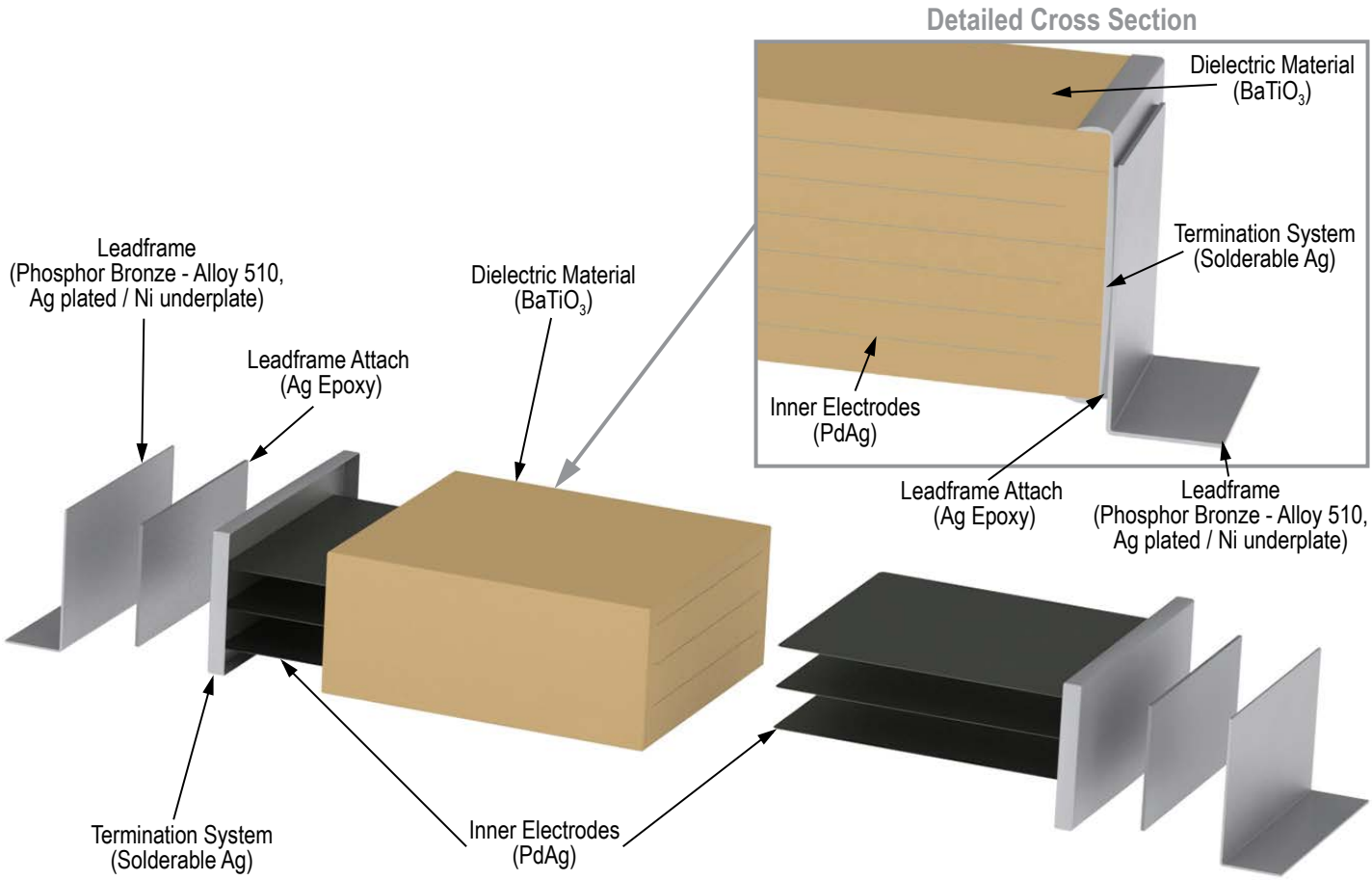
Table 3 – Performance & Reliability: Test Methods and Conditions

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 @ 155°C, dry heat @ 235°C
		b) Method B @ 215°C category 3
		c) Method D, category 3 @ 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.

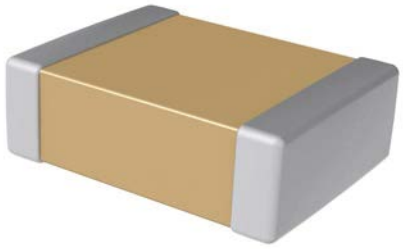
HV-HT Series, High Voltage, High Temperature 200°C, C0G Dielectric, 500 – 2,000 VDC (Industrial Grade)

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 + 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 min.) E = Gold (Au) 1.97 – 11.8 µin F = Gold (Au) 30 – 50 µin G = Gold (Au) 100 µin min.	See "Packaging C-Spec Ordering Options Table" below

[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.*

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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 – 50 µin G = Gold (Au) 100 µin min.	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 – 50 µin G = Gold (Au) 100 µin min.	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 thru 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 – 11.8 µin)

[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 & 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.

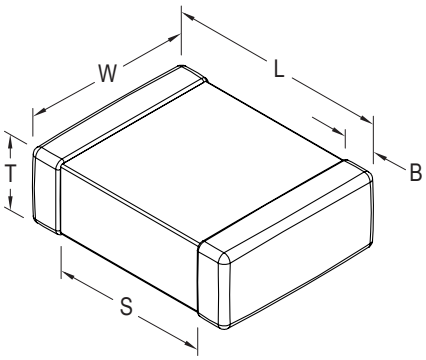
Qualification/Certification

High temperature (200ºC) Industrial grade products meet or exceed the requirements outlined in Table 4, Performance & Reliability. Qualification packages are available for review and download on our website at www.kemet.com/hightemp

Environmental Compliance

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

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 (.079) ± 0.20 (.008)	1.25 (.049) ± 0.20 (.008)	See Table 2 for Thickness	0.50 (0.02) ± 0.25 (.010)	0.75 (.030)	"Solder Wave or Solder Reflow"
1206	3216	3.20 (.126) ± 0.20 (.008)	1.60 (.063) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)	N/A	
1210	3225	3.20 (.126) ± 0.20 (.008)	2.50 (.098) ± 0.20 (.008)		0.50 (0.02) ± 0.25 (.010)		Solder Reflow Only
1808	4520	4.70 (.185) ± 0.50 (.020)	2.00 (.079) ± 0.20 (.008)		0.60 (.024) ± 0.35 (.014)		
1812	4532	4.50 (.177) ± 0.30 (.012)	3.20 (.126) ± 0.30 (.012)		0.60 (.024) ± 0.35 (.014)		
1825	4564	4.50 (.177) ± 0.30 (.012)	6.40 (.252) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2220	5650	5.70 (.224) ± 0.40 (.016)	5.00 (.197) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2225	5664	5.60 (.220) ± 0.40 (.016)	6.40 (.248) ± 0.40 (.016)		0.60 (.024) ± 0.35 (.014)		
2824	7260	7.10 (.280) ± 0.40 (.016)	6.10 (.240) ± 0.40 (.016)		1.27 (.050) ± 0.40 (.016)		
3040	7610	7.60 (.300) ± 0.40 (.016)	10.20 (.402) ± 0.40 (.016)		1.27 (.050) ± 0.40 (.016)		
3640	9210	9.10 (.358) ± 0.40 (.016)	10.20 (.402) ± 0.40 (.016)		1.27 (.050) ± 0.40 (.016)		
4540	-	11.40 (.449) ± 0.40 (.016)	10.20 (.402) ± 0.40 (.016)		1.27 (.050) ± 0.40 (.016)		

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)	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)
[2]Dissipation Factor (DF) Maximum Limit @ 25°C	0.1%
[3]Insulation Resistance (IR) Minimum Limit @ 25°C	1000 megohm microfarads or 100 GΩ (500 VDC applied for 120 ±5 secs @ 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

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

**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.

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 F G J K M	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	LA	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				

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

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'd

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)*
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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	1,550
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 out standard "bulk bag" packaging.

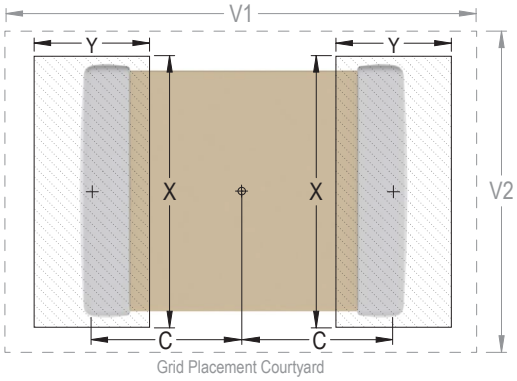
[3] Also commonly referred to as “Chip Carrier” or “Molded Tray”. All tray packaging options offer static protection.

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.

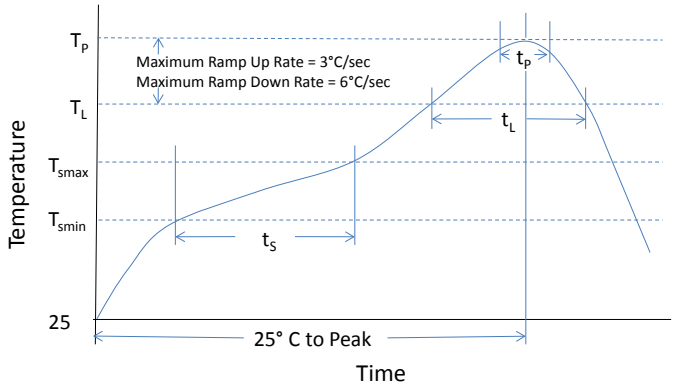


Table 4 – Performance & Reliability: Test Methods and Conditions

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 @ 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

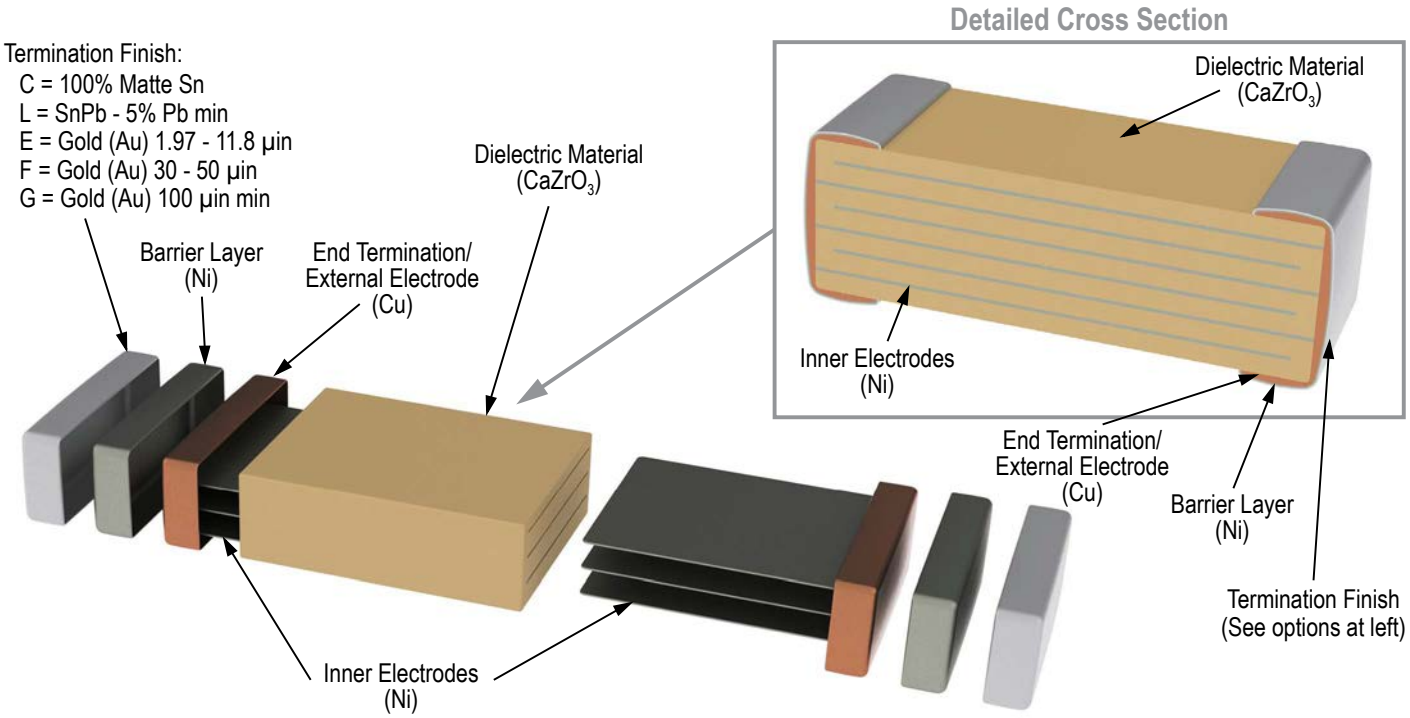
Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will 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 – 50 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.

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 Temp (200°C)	Two significant digits + 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 min.)	See "Packaging C-Spec Ordering Options Table" below

[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.

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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.

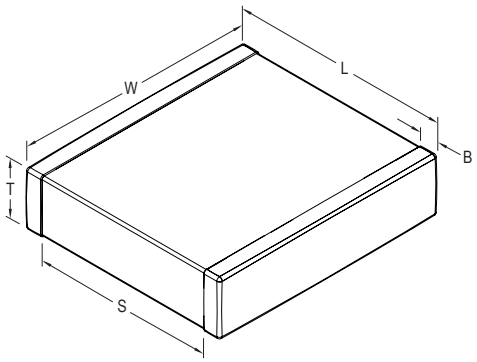
Benefits

- 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 @ 25°C	0.1%
[3]Insulation Resistance (IR) Minimum Limit @ 25°C	1,000 megohm microfarads or 100 GΩ (500 VDC applied for 120 ±5 seconds @ 25°C)

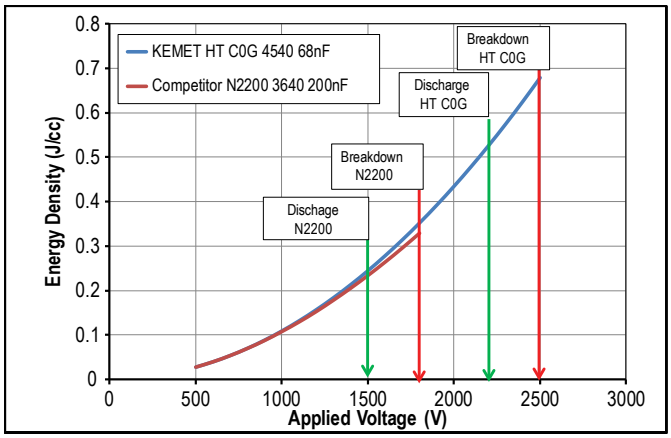
[1]DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.
[2]Capacitance and dissipation factor (DF) measured under the following conditions:
1 MHz ±100 kHz and 1.0 Vrms ±0.2 V if capacitance ≤ 1,000 pF
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

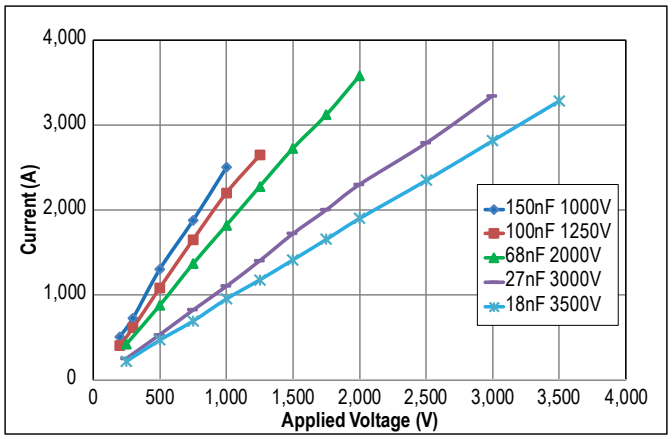


Table 1 – Pulse Discharge Series, Capacitance Range Waterfall

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	1,550
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**	

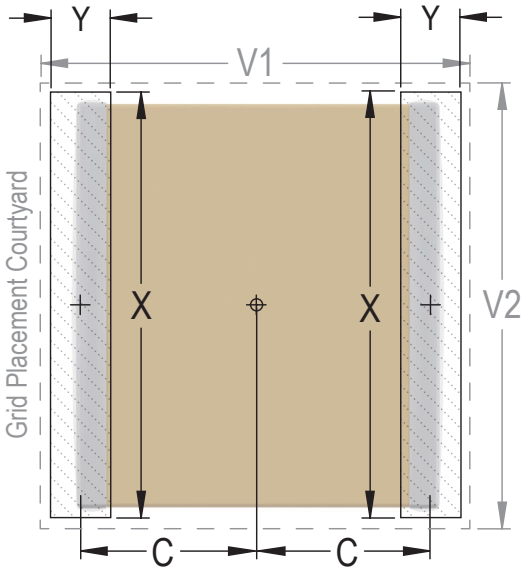
Package quantity based on finished chip thickness specifications.

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})	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.

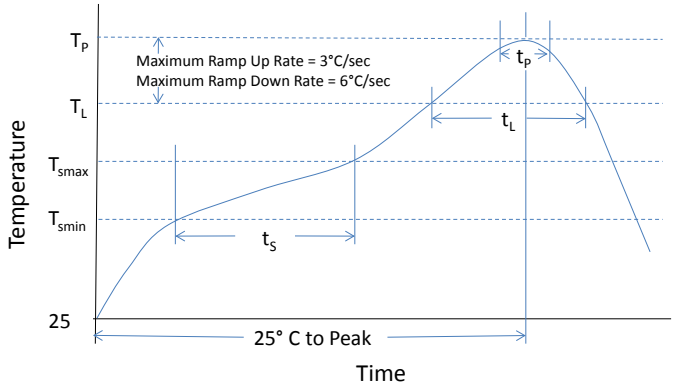


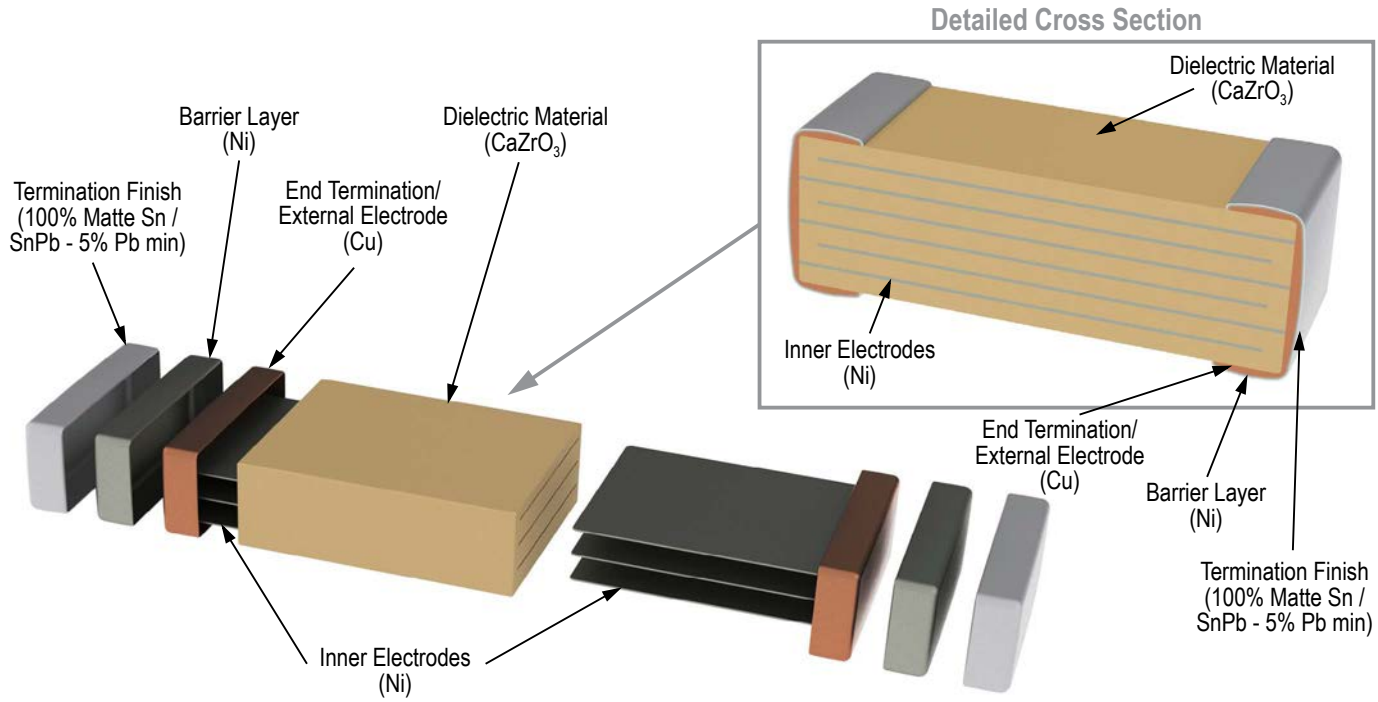
Table 4 – Performance & Reliability: Test Methods and Conditions

Product Qualification Test Plan	
Reliability/Environmental Tests per MIL–STD–202//JESD22	
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 @ 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.

Capacitor Marking (Optional):

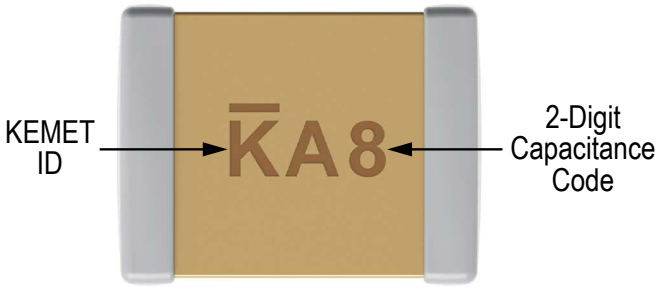
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic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

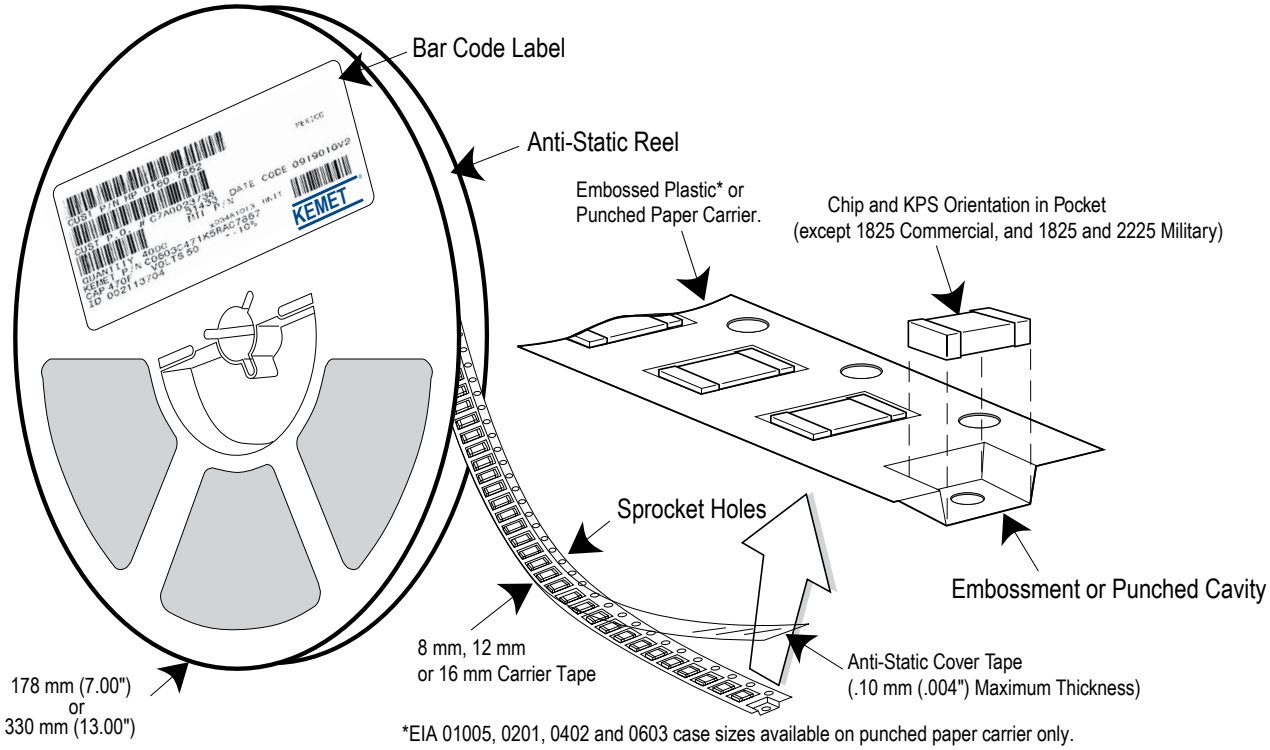


Capacitor Marking (Optional) cont'd

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	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 – Surface Mount Devices

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

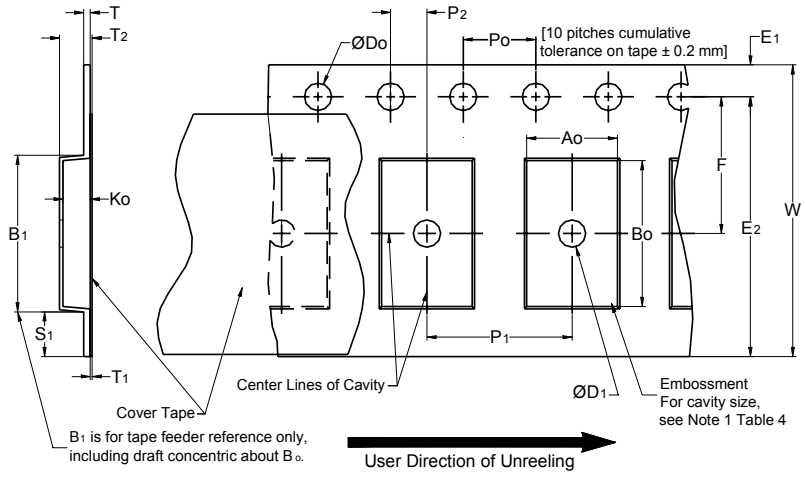


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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

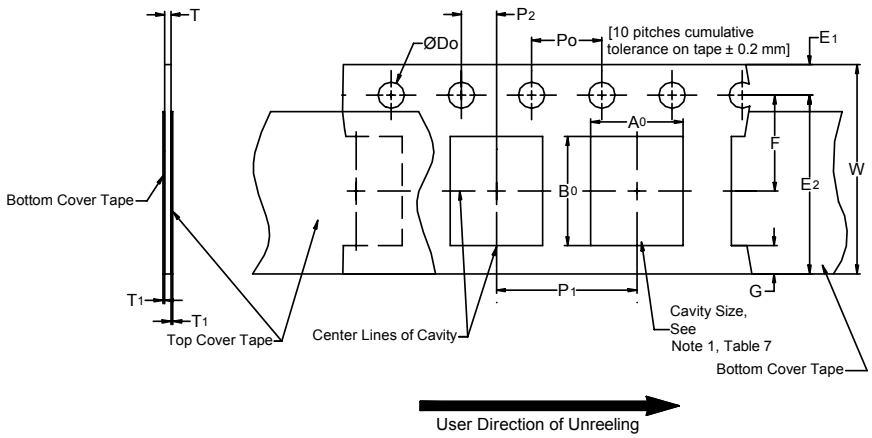


Table 7 – Punched (Paper) Carrier Tape Dimensions

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).

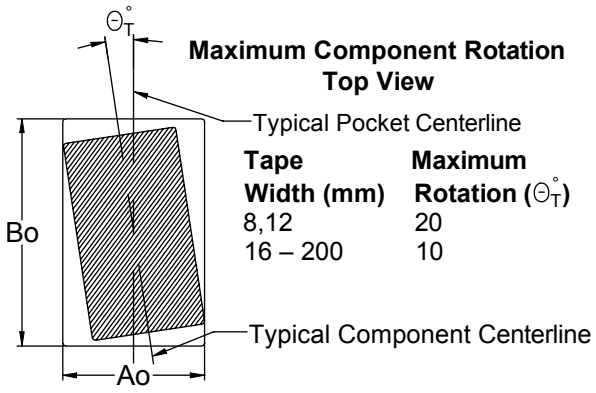
Packaging Information Performance Notes

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



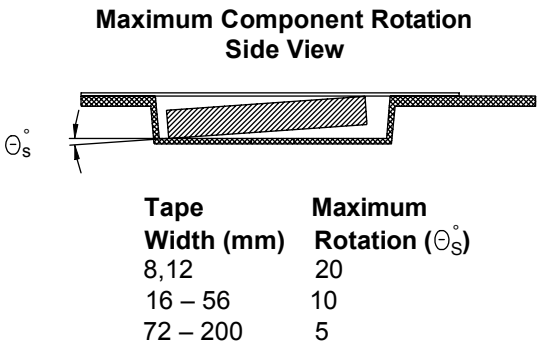


Figure 4 – Maximum Lateral Movement

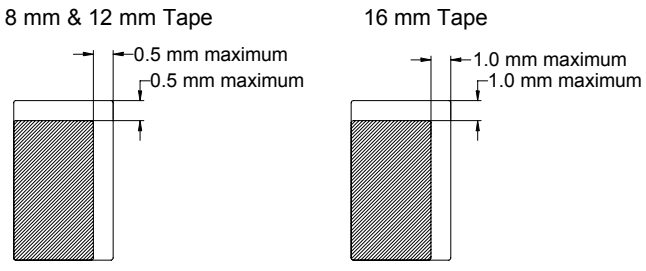


Figure 5 – Bending Radius

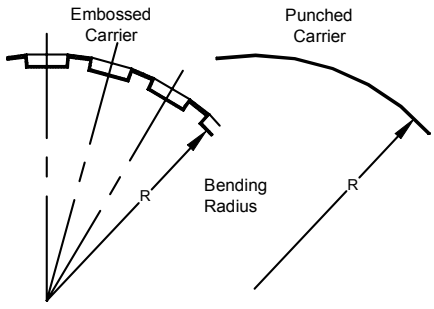
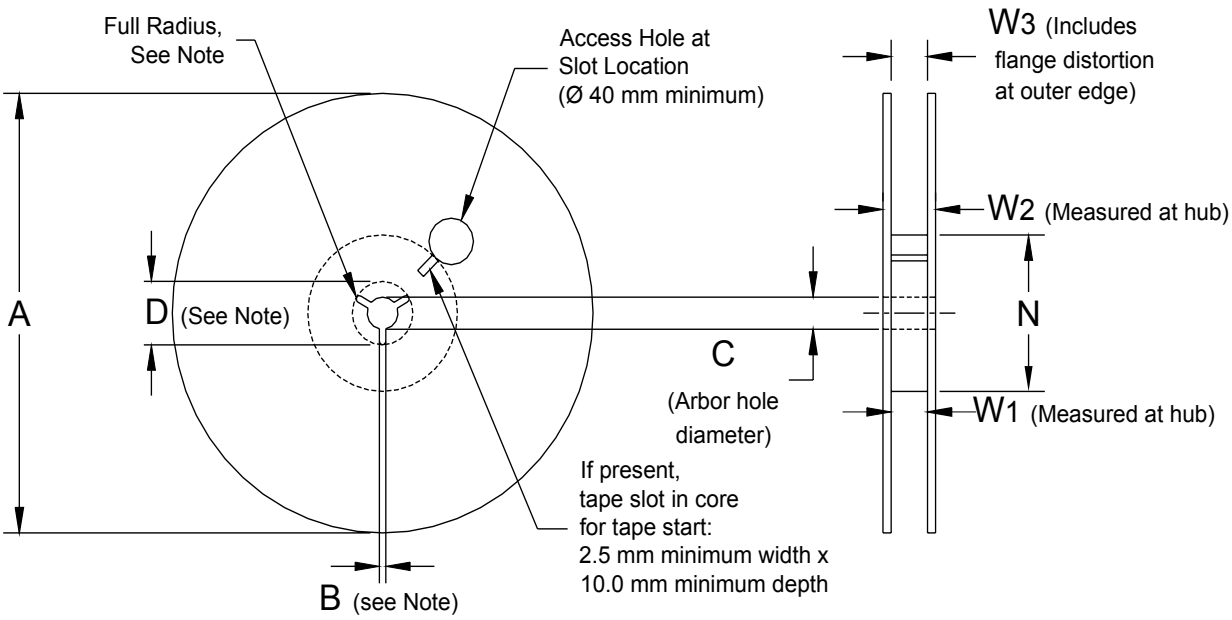


Figure 6 – Reel Dimensions



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

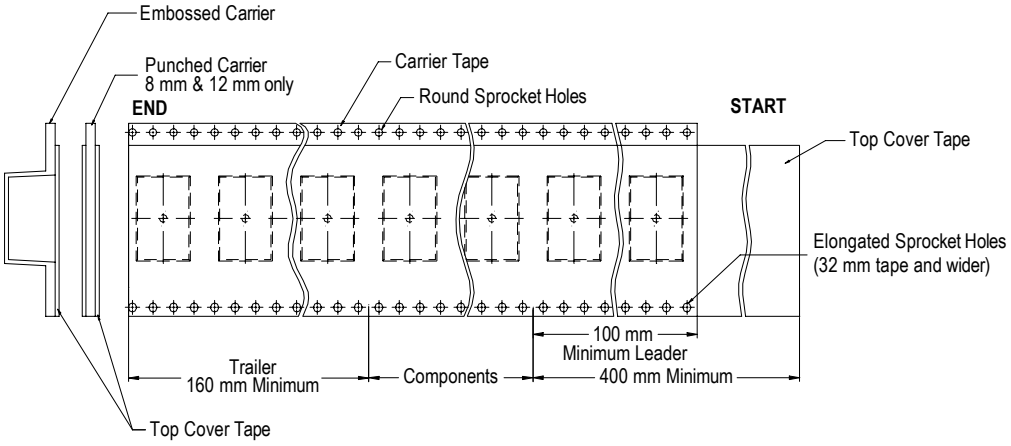
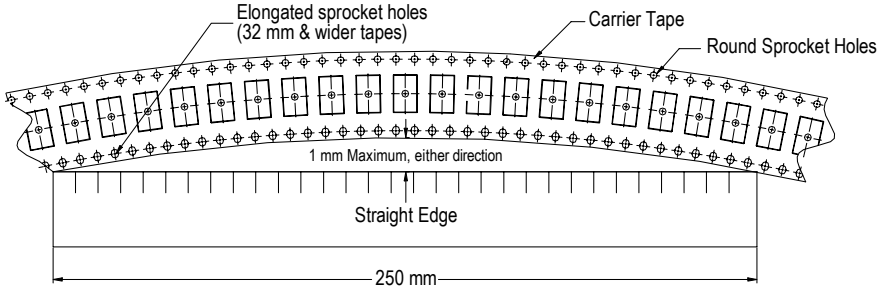


Figure 8 – Maximum Camber



Tape & Reel Packaging Information – KPS Devices

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.

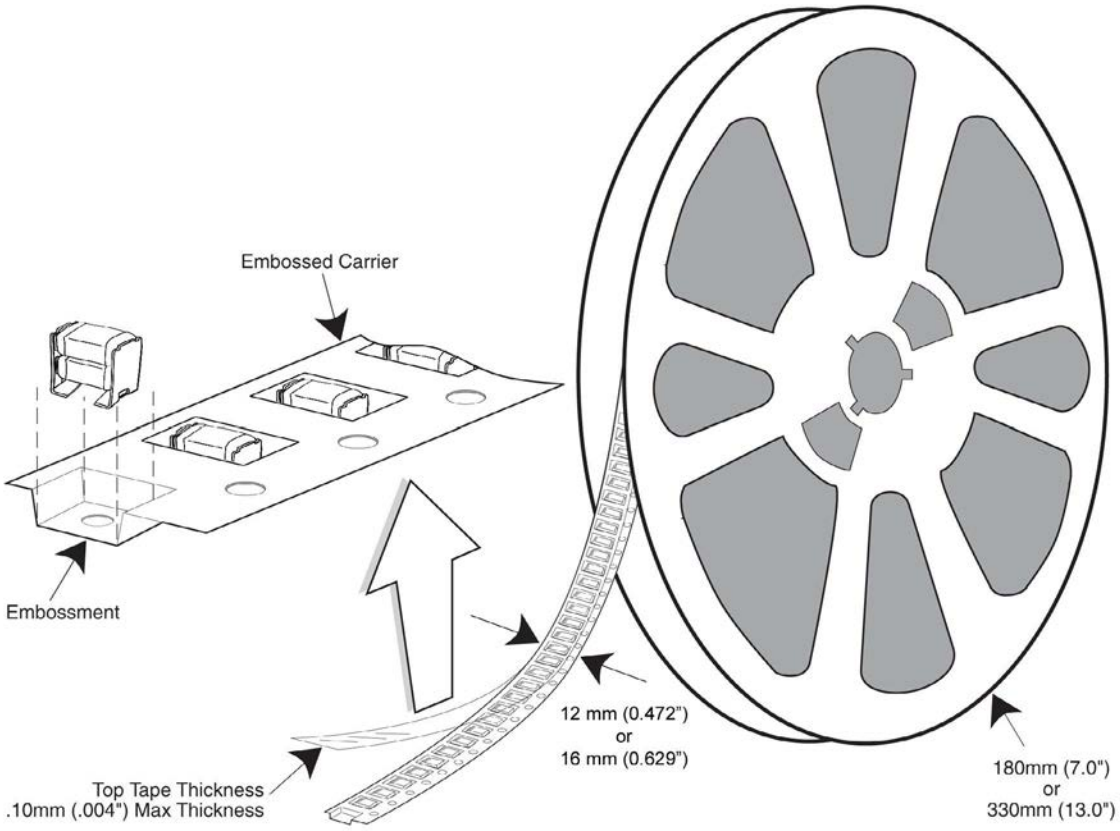


Table 5 – Carrier Tape Configuration – Embossed Plastic (mm)

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 & 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

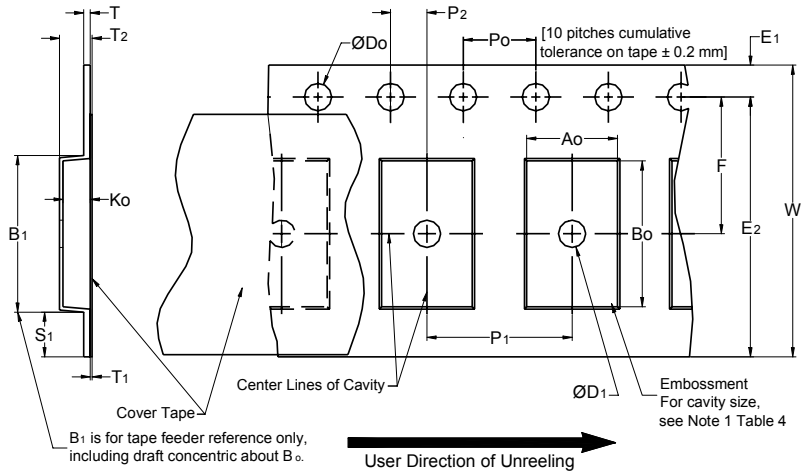


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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 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

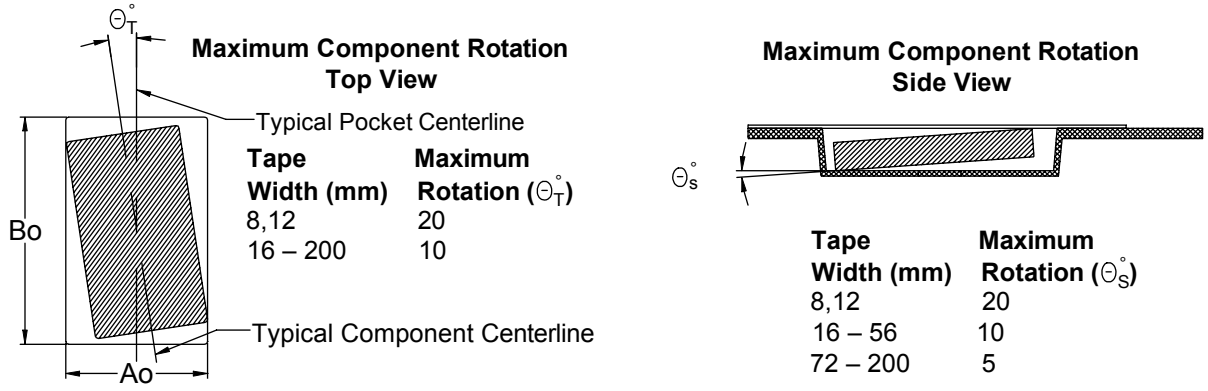


Figure 3 – Maximum Lateral Movement

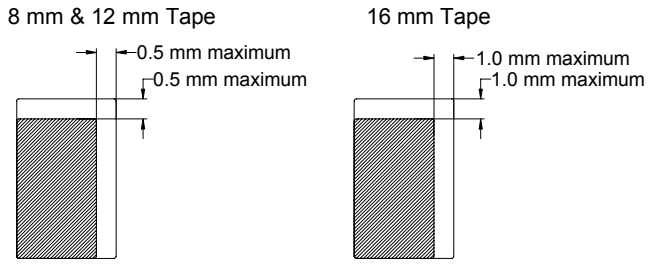


Figure 4 – Bending Radius

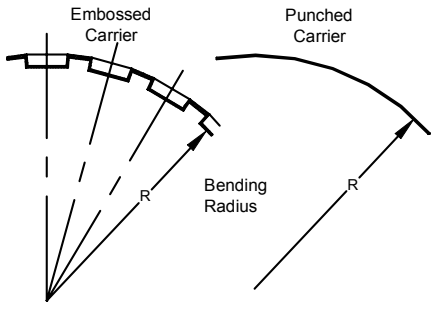
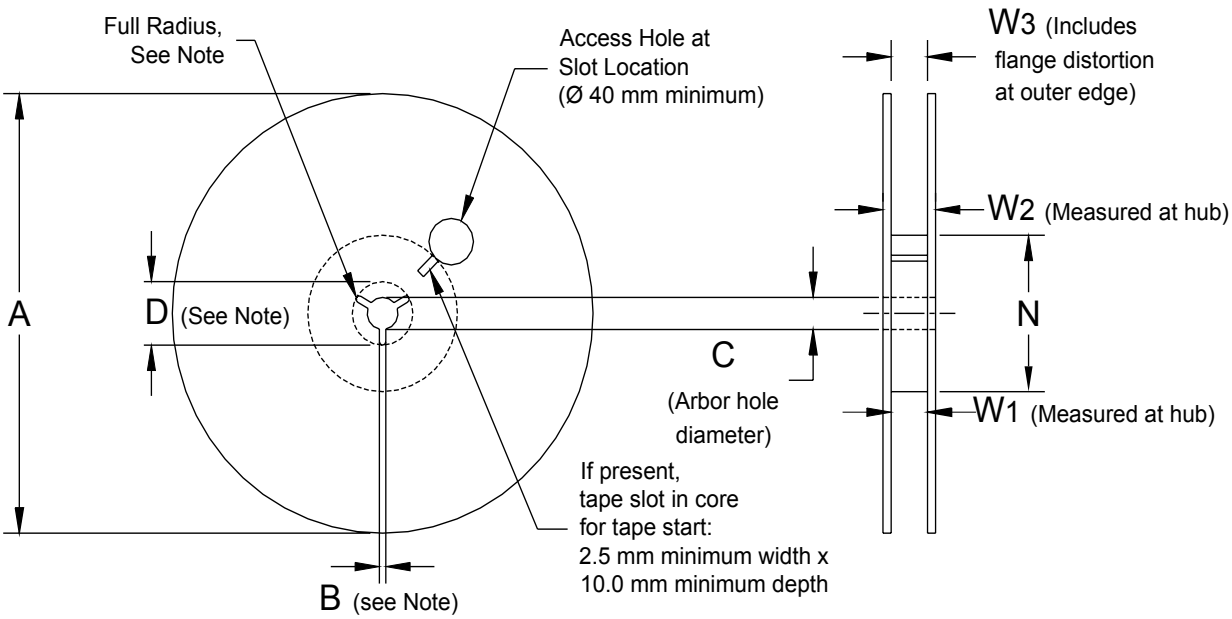


Figure 5 – Reel Dimensions



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

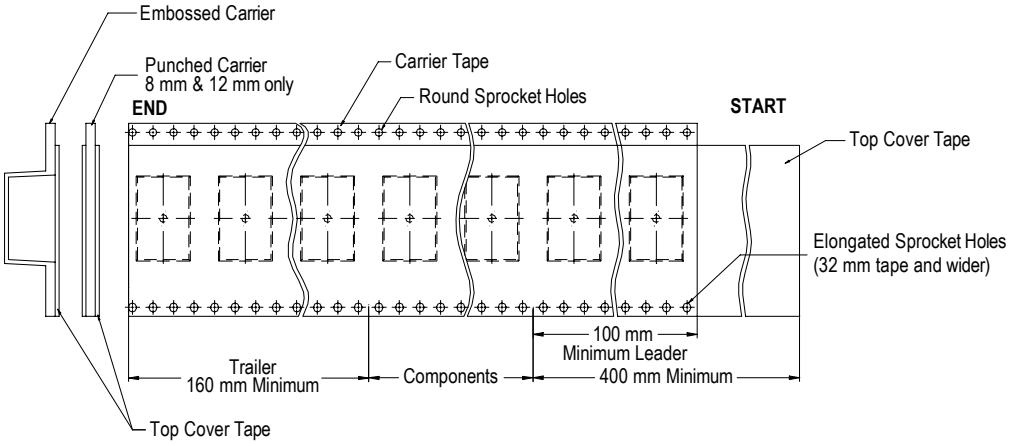
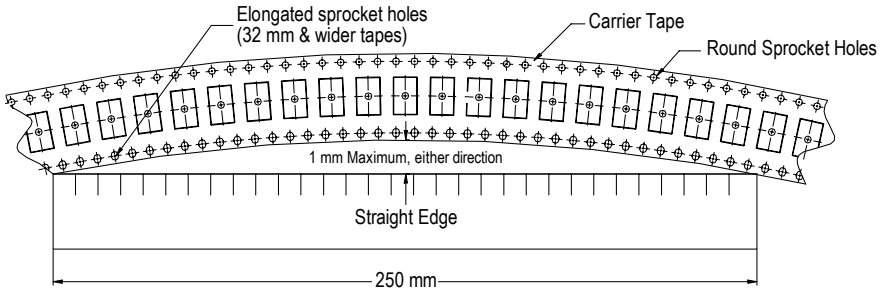


Figure 7 – Maximum Camber



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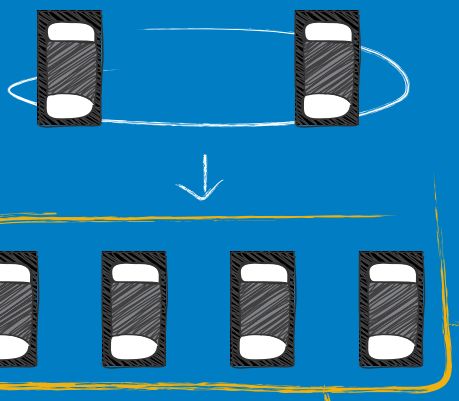

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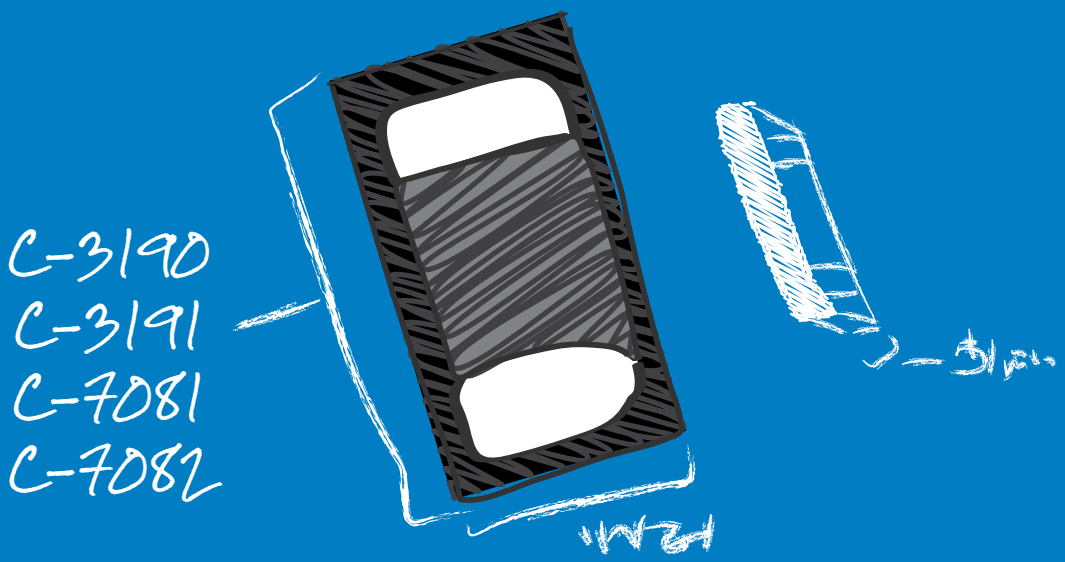

C-3190 = Automotive grade 7" reel unmarked
C-3191 = Automotive grade 13" reel unmarked
C-7081 = Commercial grade 7" reel unmarked
C-7082 = Commercial grade 13" reel unmarked

Coming soon: 0805 EIA case size under development

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