Multilayer Ceramic Capacitors

High Temperature

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Electronic Components
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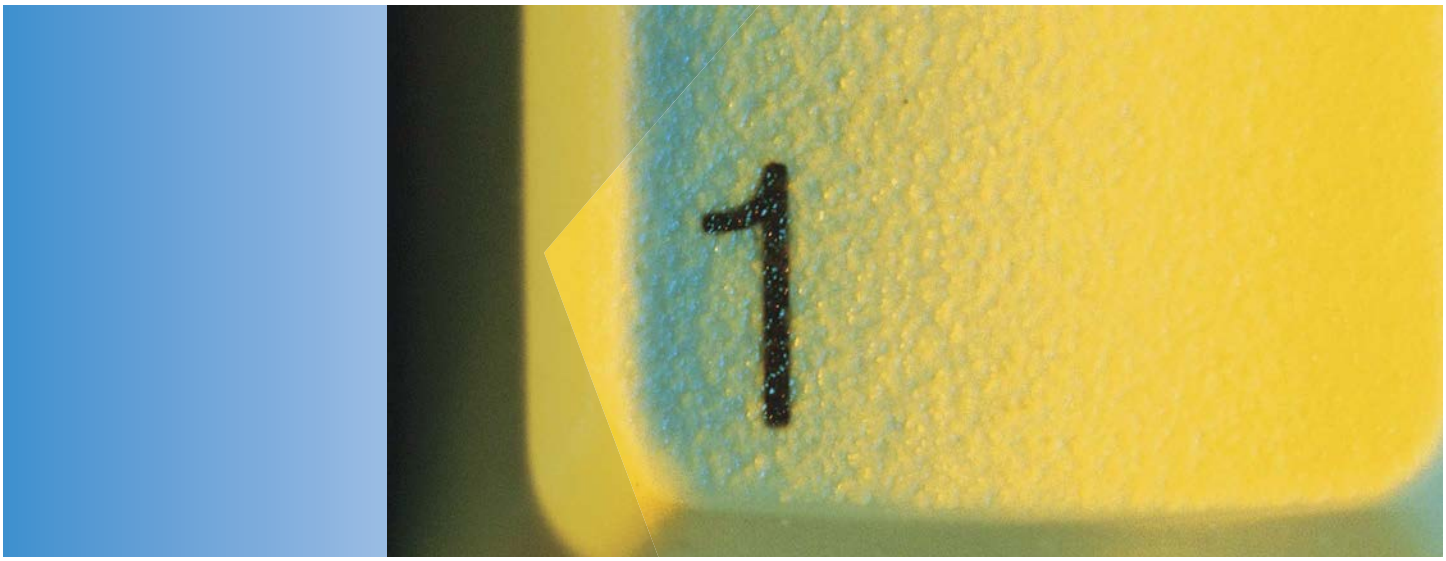

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When you partner with KEMET, our entire global organization provides you with the coordinated service you need. No bouncing from supplier to supplier. No endless phone calls and web browsing. We're your single, integrated source for electronic component solutions worldwide.

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Our commitment to product quality and on-time delivery has helped customers succeed for over 90 years. There's a reason KEMET components can be found in defense and aerospace equipment. Our reputation is built on a history of consistency, reliability and service.

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Working for a better world.

KEMET is dedicated to economically, environmentally and socially sustainable development. We've adopted the Electronic Industry Code of Conduct (EICC) to address all aspects of corporate responsibility. Our manufacturing facilities have won numerous environmental excellence awards and recognitions, and our supply chain is certified. We believe doing the right thing is in everyone's interest.

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.

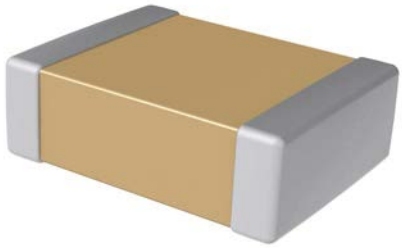
High Temperature 150°C, X8L Dielectric, 10 – 50 VDC (Commercial & Automotive Grade)

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.*

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:

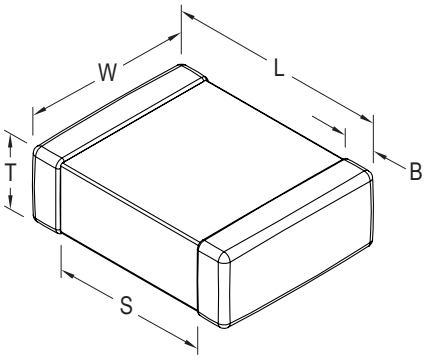
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design record and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

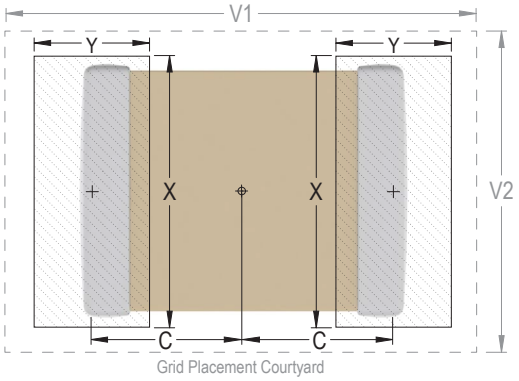
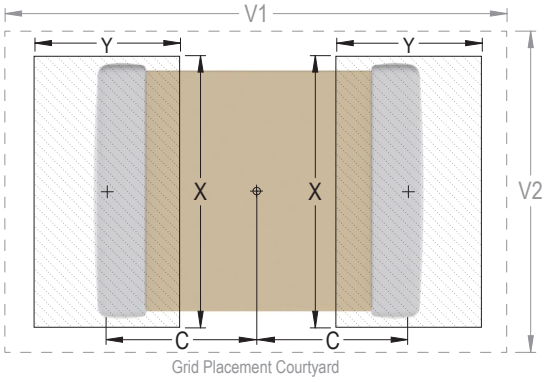


Table 3B – Land Pattern Design Recommendations per IPC–7351 – Flexible Termination

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.

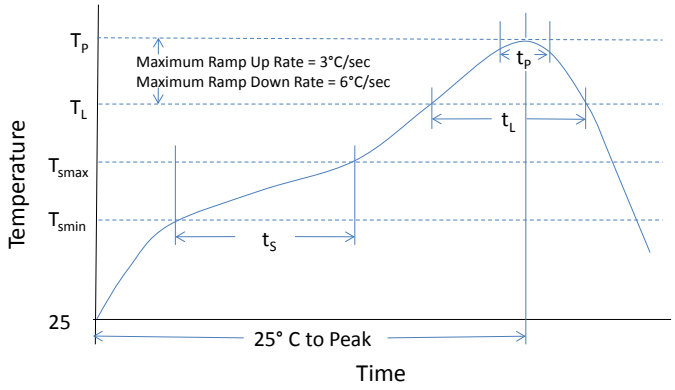


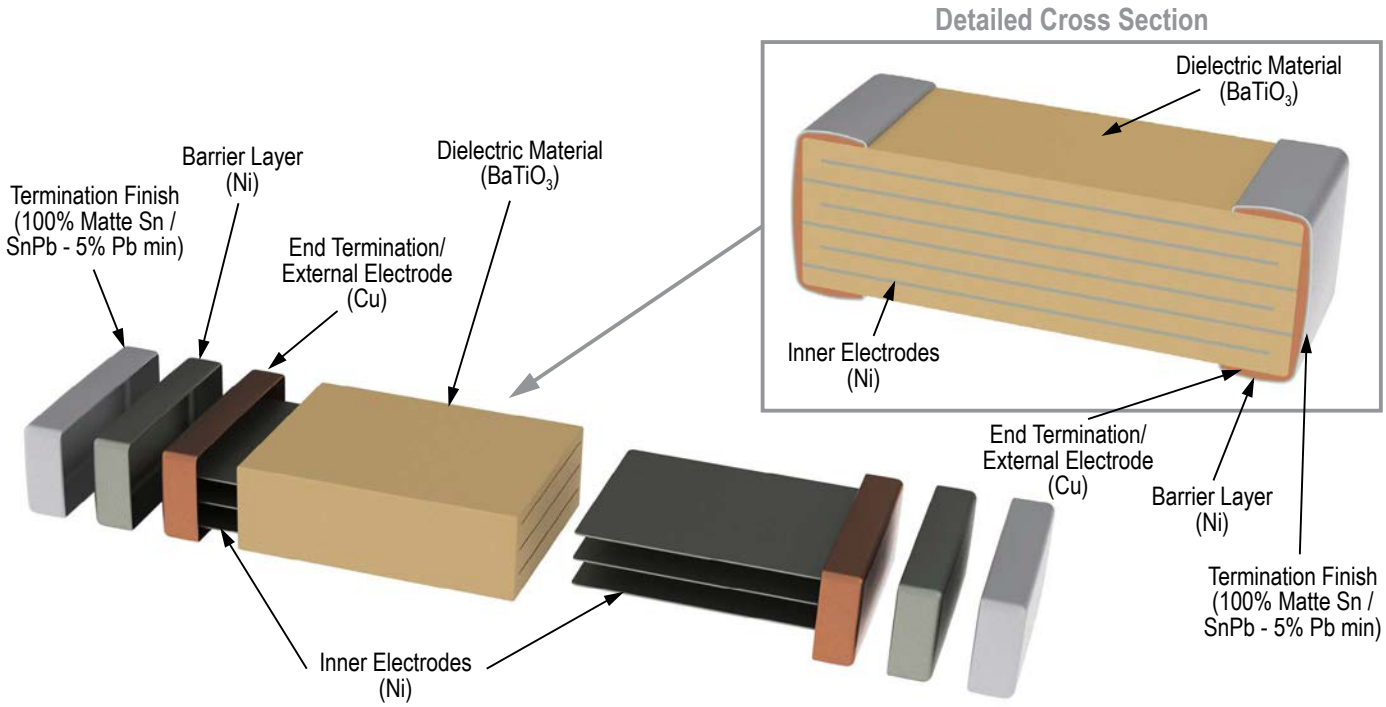
Table 4 – Performance & Reliability: Test Methods and Conditions

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.

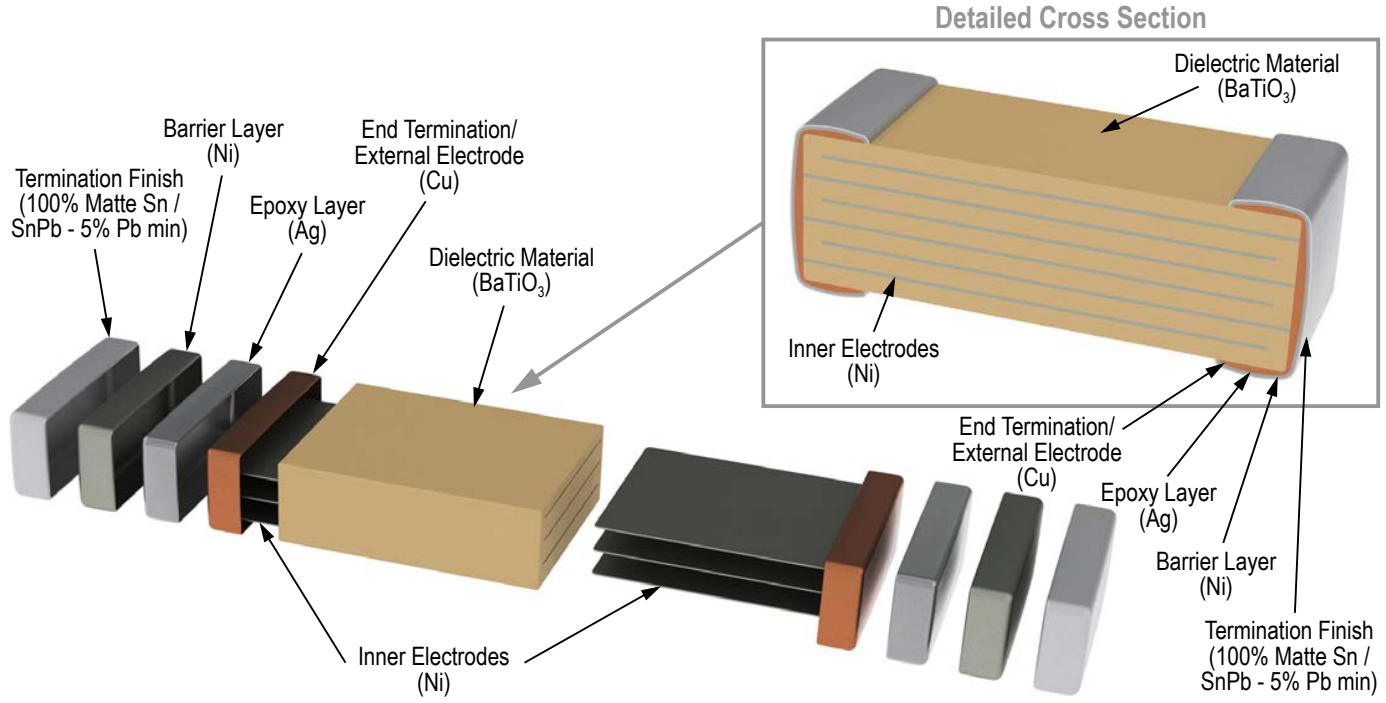
Storage and Handling

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



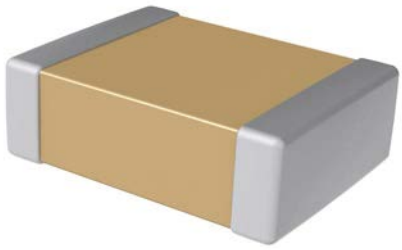
High Temperature 150°C, Ultra-Stable X8R Dielectric, 25 – 100 VDC (Commercial & Automotive Grade)

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.*

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:

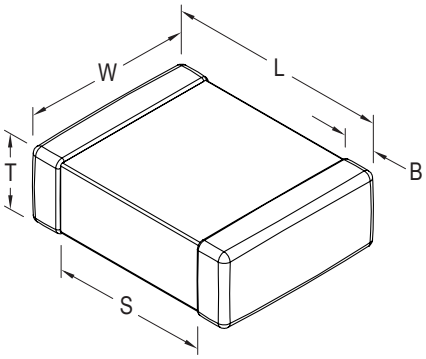
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design record and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

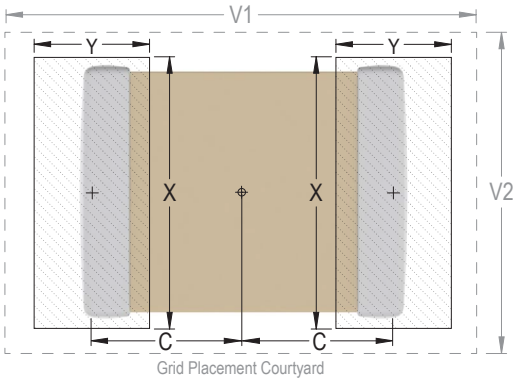
[1] *Only for capacitance values ≥ 22 µF*

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.

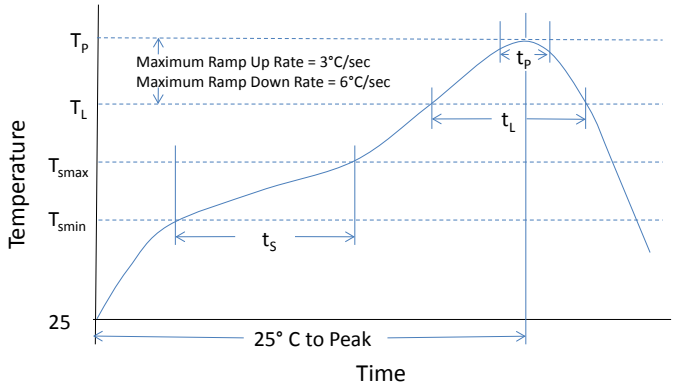


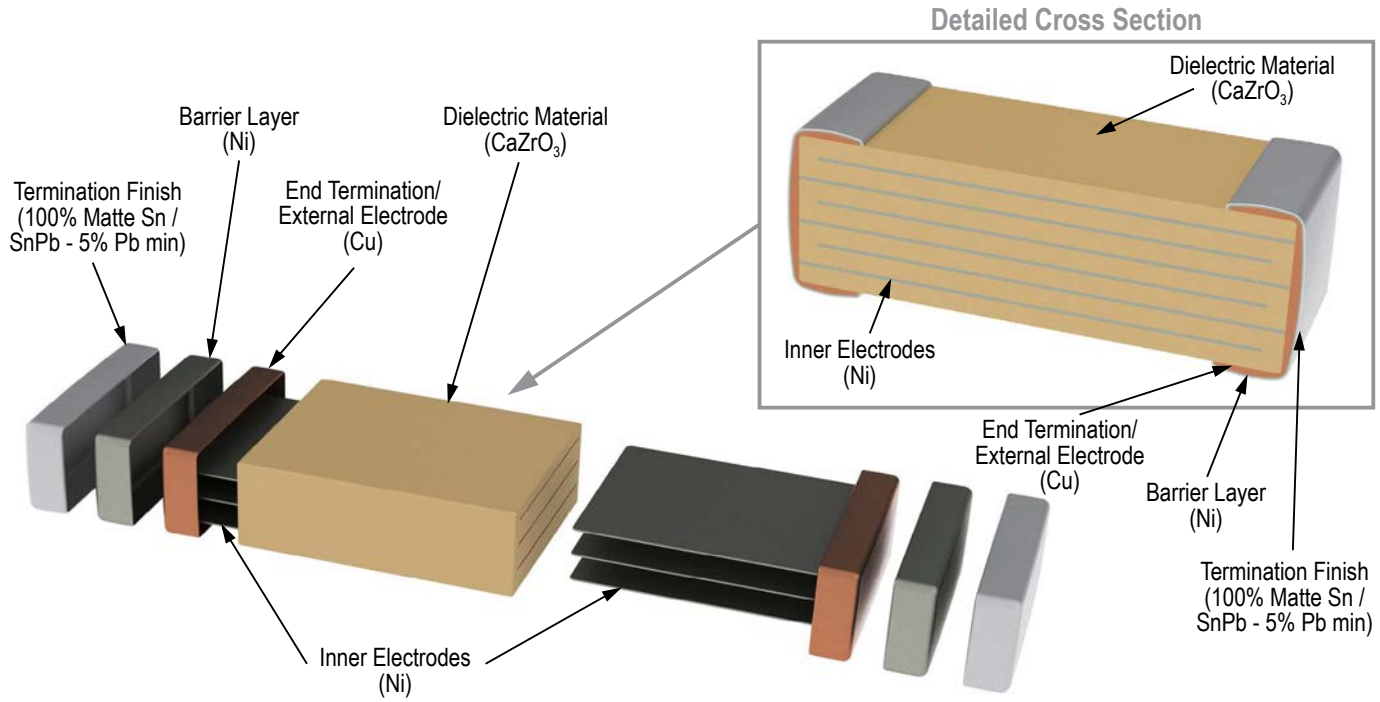
Table 4 – Performance & Reliability: Test Methods and Conditions

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:

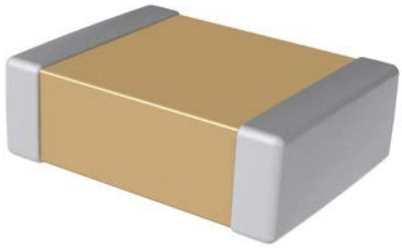
- C0G, Ultra Stable X8R and Y5V dielectric devices
- EIA 0402 case size devices
- EIA 0603 case size devices with Flexible Termination option.
- KPS Commercial and Automotive grade stacked devices.

These capacitors are supplied unmarked only.

High Temperature 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.



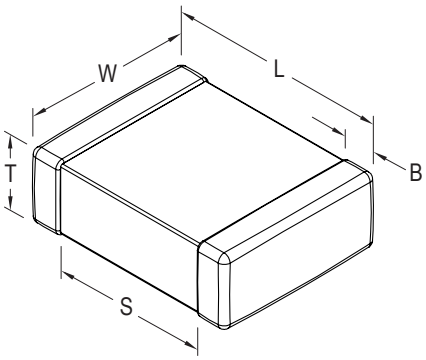
Ordering Information

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.*

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

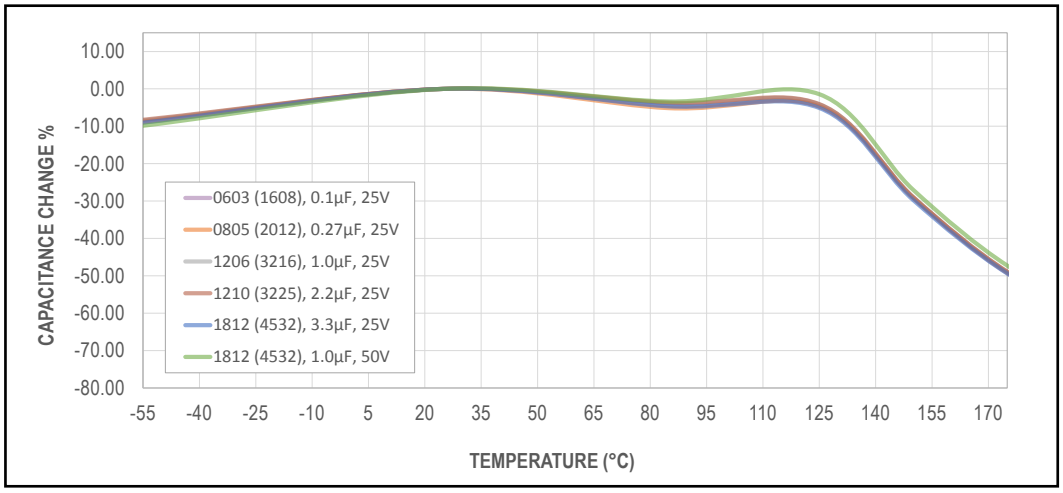
Rated DC Voltage	Dissipation Factor
16/25	3.5%
>25	2.5%

Post Environmental Limits

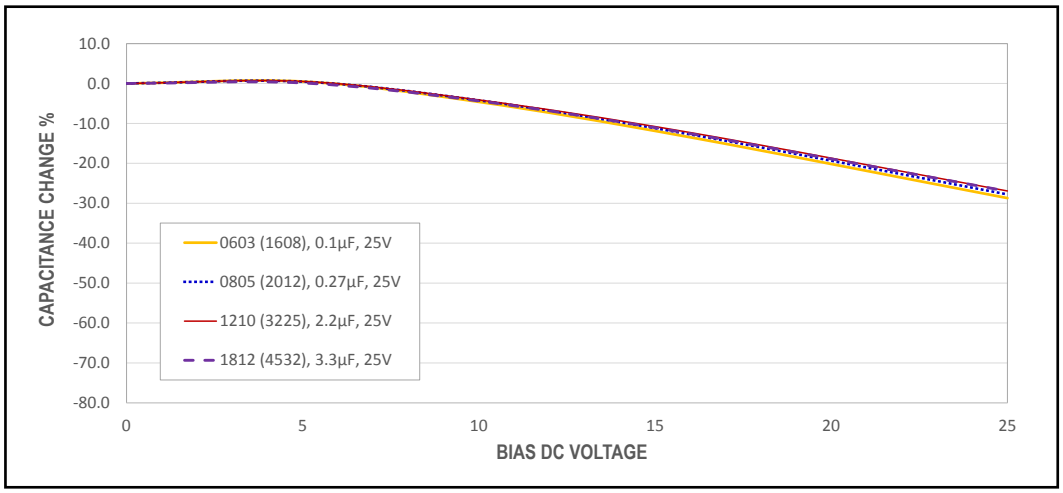
High Temperature Life, Biased Humidity, Moisture Resistance					
Dielectric	Rated DC Voltage	Capacitance Value	Dissipation Factor (Maximum %)	Capacitance Shift	Insulation Resistance
X7R	16/25	All	5.0	± 20%	10% of Initial Limit
	>25		3.0		

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)

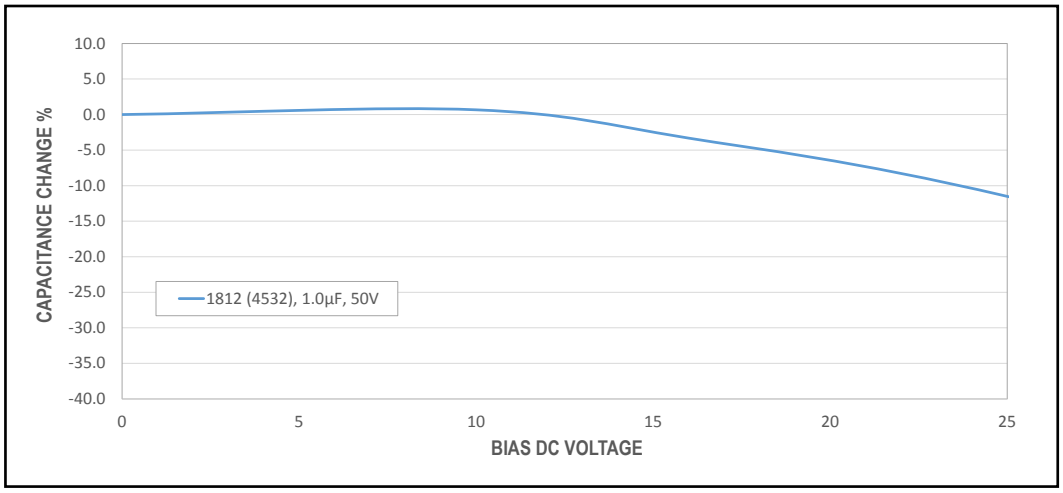


Table 1 – Capacitance Range/Selection Waterfall (0402 – 1812 Case Sizes)

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.

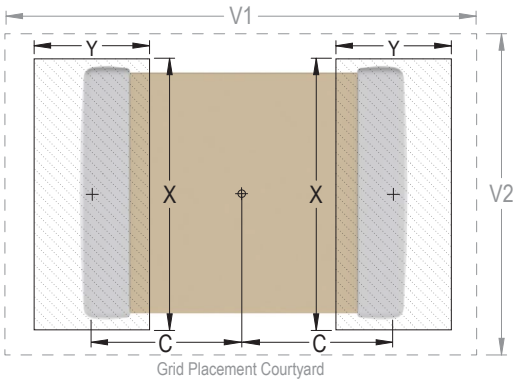
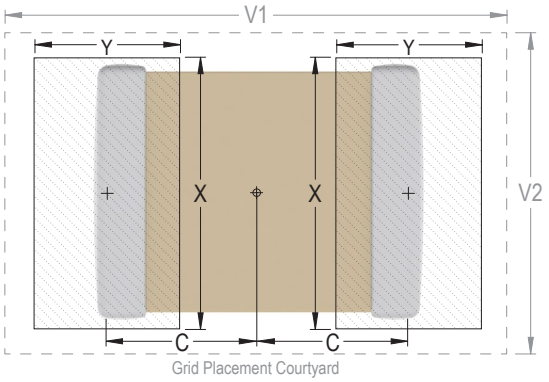


Table 3B – Land Pattern Design Recommendations per IPC–7351 – Flexible Termination

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.

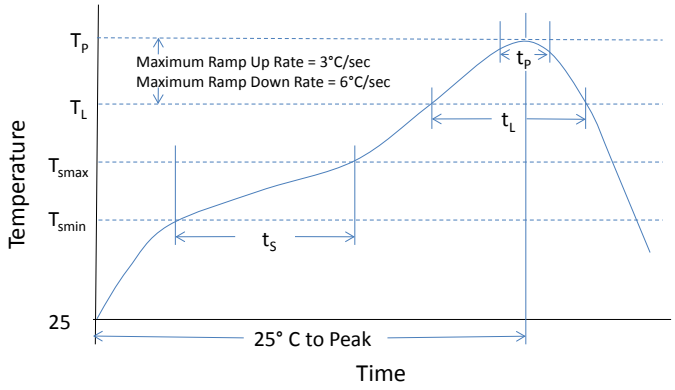


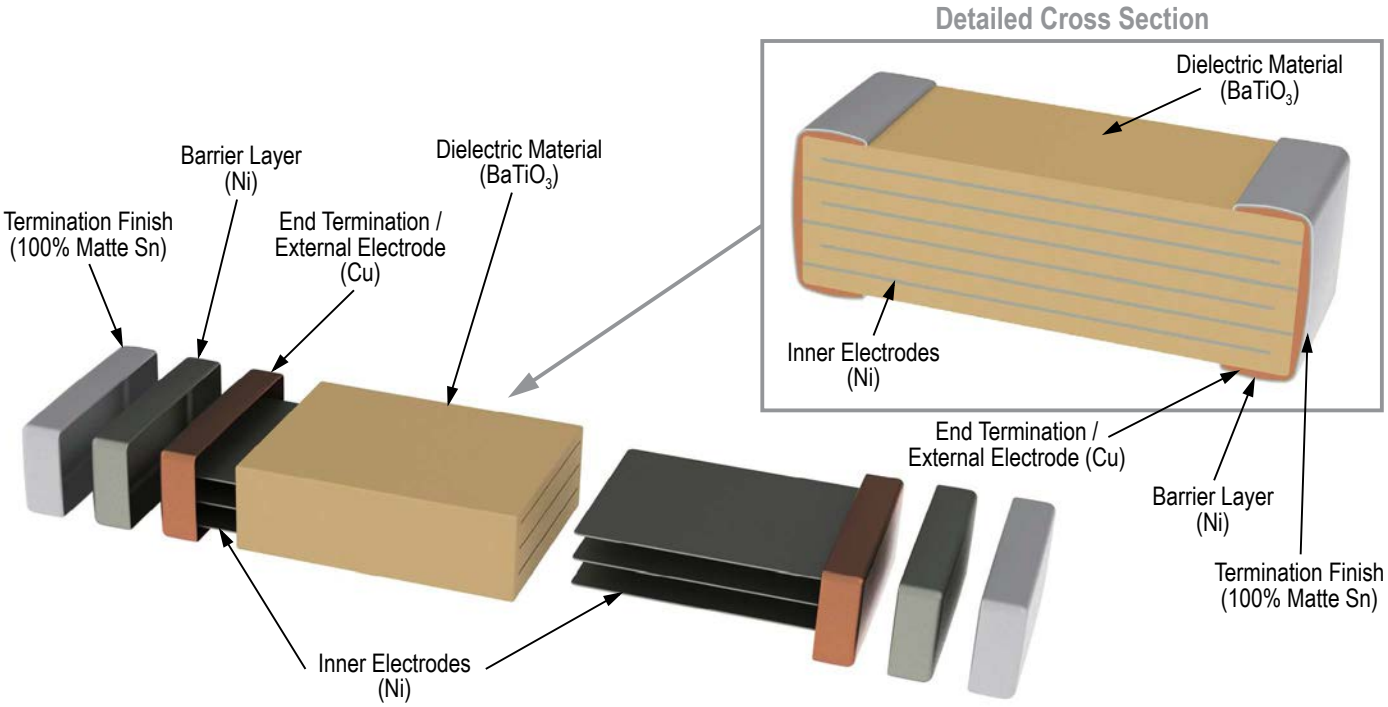
Table 4 – Performance & Reliability: Test Methods and Conditions

<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>

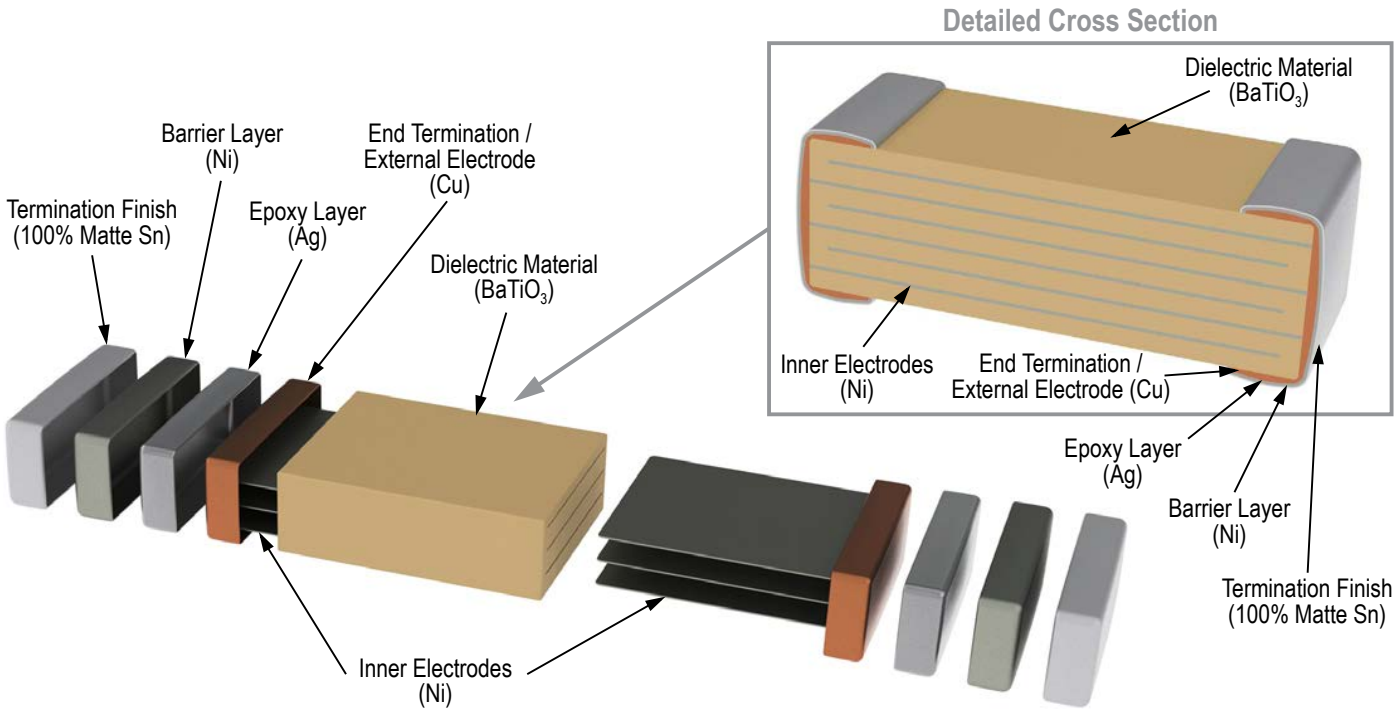
Storage and Handling

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



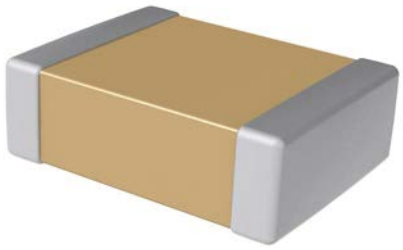
High Temperature 200°C, C0G Dielectric, 10 – 200 VDC (Industrial Grade)

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.

Packaging C-Spec Ordering Options Table

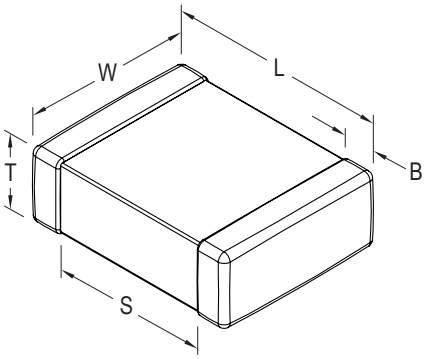
Termination Finish Options	Packaging Type/Options	Packaging Ordering Code (C-Spec)
Standard Packaging – Unmarked[3]		
C = 100% Matte Sn L = SnPb (5% Pb min.) F = Gold (Au) 30 – 50 µin G = Gold (Au) 100 µin minimum	Bulk Bag	Blank[1]
	Waffle Tray[2]	7292
	7" Tape & Reel	TU
	13" Reel	7411 (EIA 0603 and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

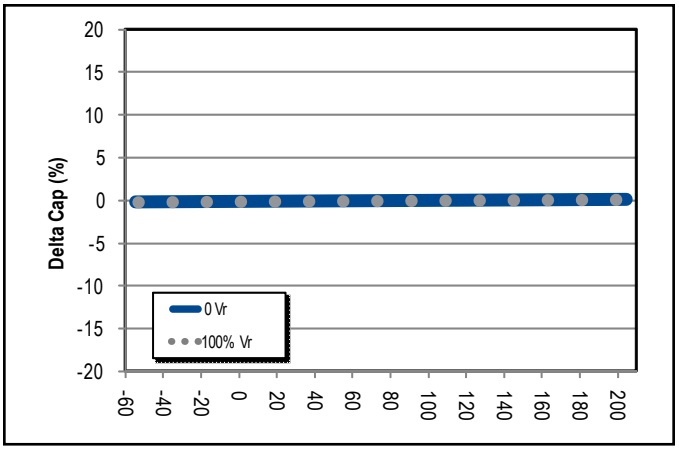
[1]DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.
[2]Capacitance and dissipation factor (DF) measured under the following conditions:
1 MHz ±100 kHz and 1.0 ±0.2 Vrms if capacitance ≤ 1,000 pF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

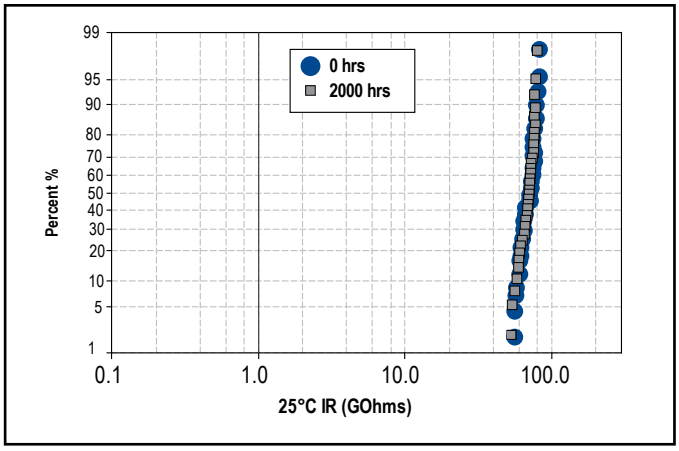
High Temperature Life, Biased Humidity, Moisture Resistance					
Dielectric	Rated DC Voltage	Capacitance Value	Dissipation Factor (Maximum %)	Capacitance Shift	Insulation Resistance
C0G	All	All	0.5	0.3% or ±0.25 pF	10% of Initial Limit

Electrical Characteristics

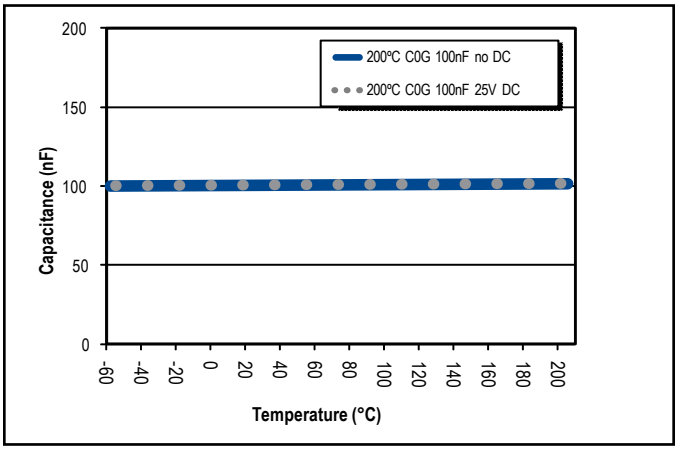
Delta Cap vs. Temperature (Typical)



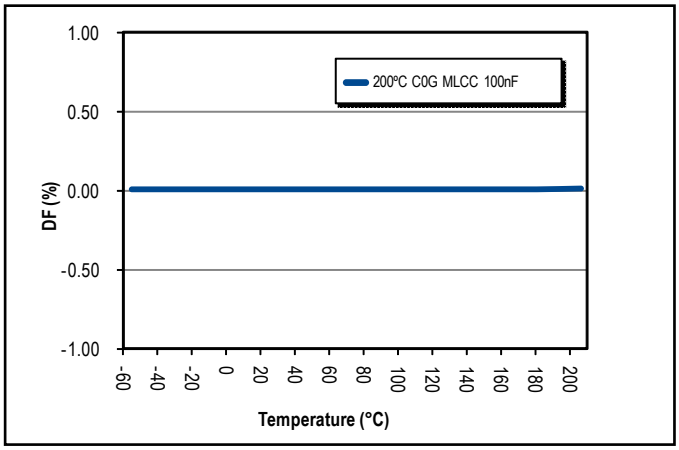
C1210H104J1GAC - Life Test IR Distribution (Lognormal)



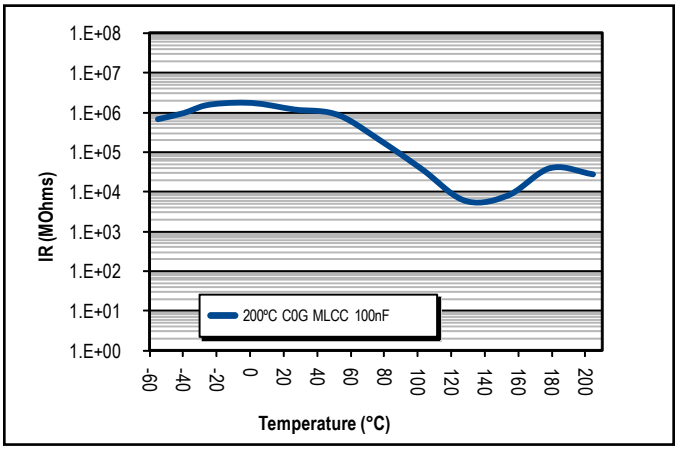
Capacitance vs. Temperature with 25 V DC Bias (Rated Voltage)



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)

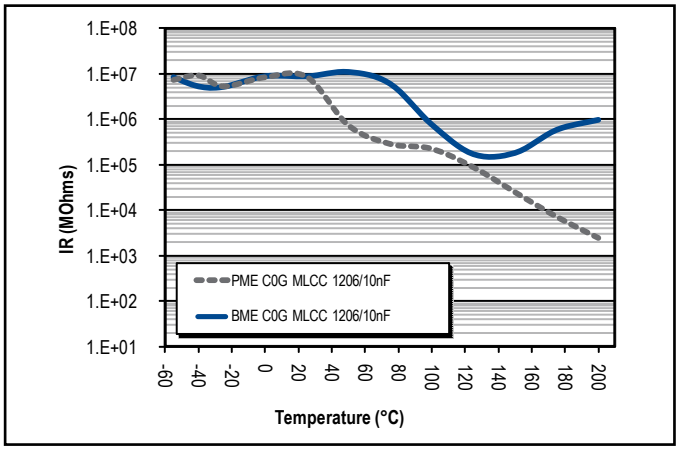


Table 1A – Capacitance Range/Selection Waterfall (0402 – 1206 Case Sizes)

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).
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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
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

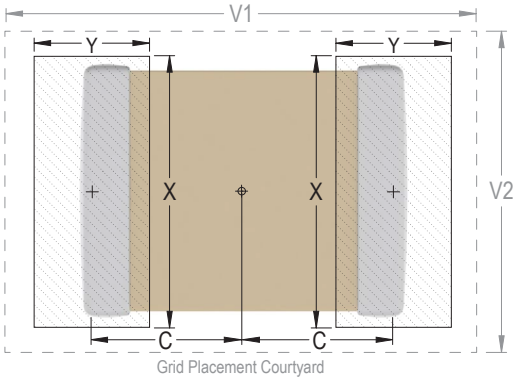
[1] *Only for capacitance values ≥ 22 µF*

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.

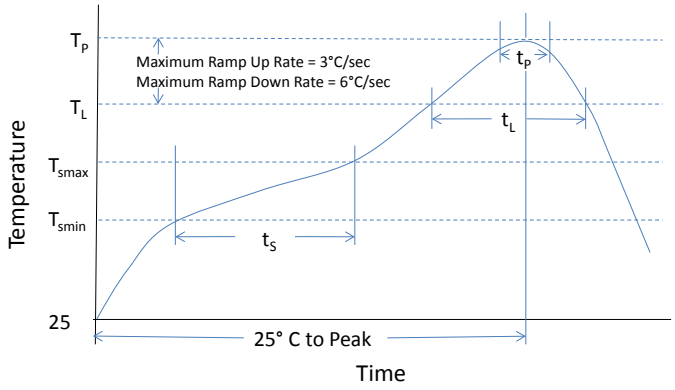


Table 4 – Performance & Reliability: Test Methods and Conditions

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

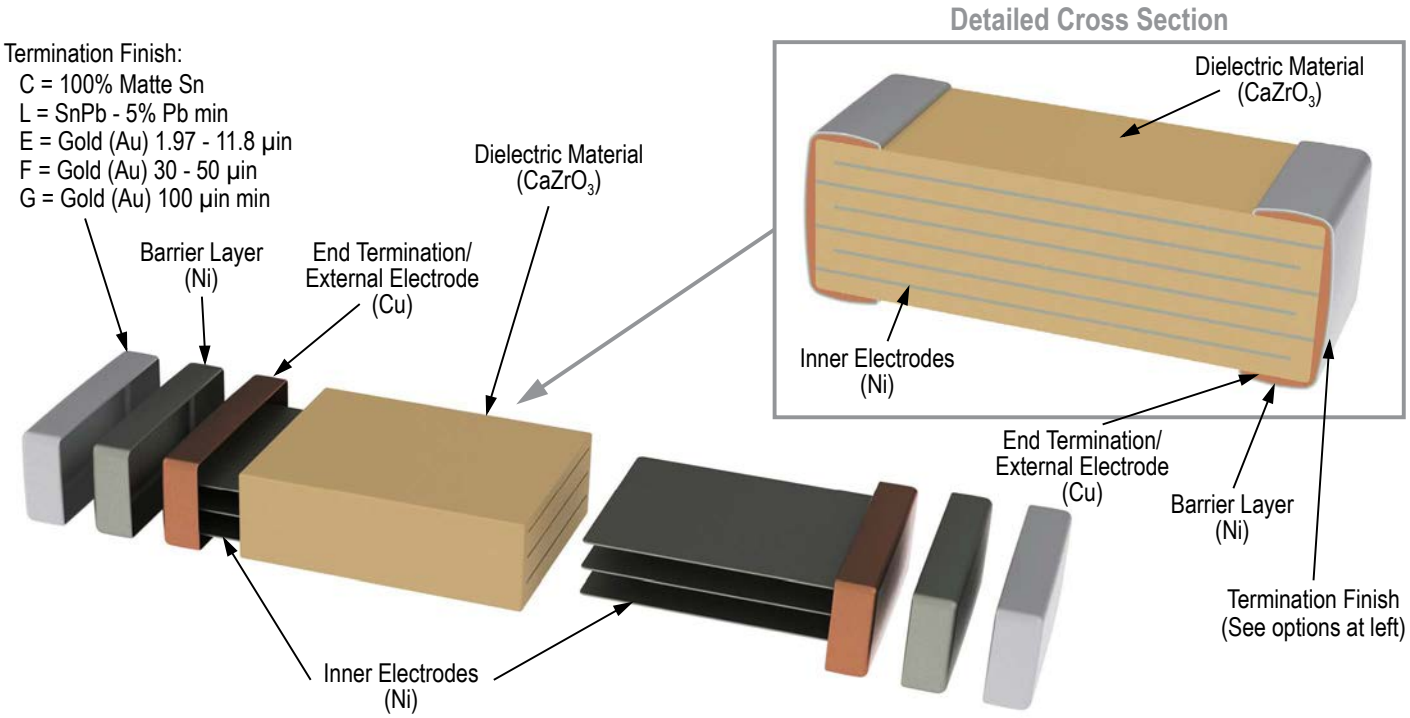
Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will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

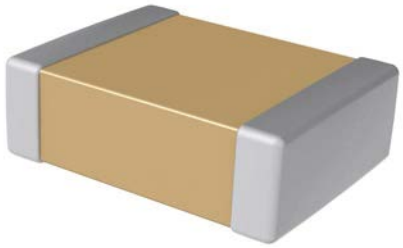
HV-HT Series, High Voltage, High Temperature 200°C, C0G Dielectric, 500 – 2,000 VDC (Industrial Grade)

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.*

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.

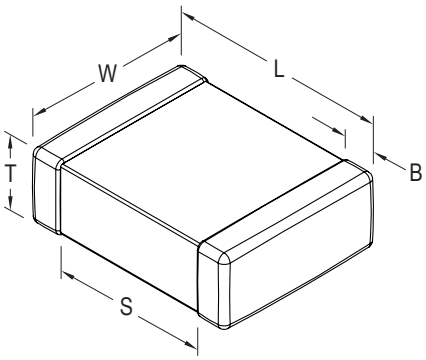
Qualification/Certification

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)*
KEMET reserves the right to substitute product with an improved temperature characteristic, tighter capacitance tolerance and/or higher voltage capability within the same form factor (configuration and dimensions).
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Table 1C – Capacitance Range/Selection Waterfall (2824 – 4540 Case Sizes)

Capacitance	Cap Code	Case Size/ Series			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.

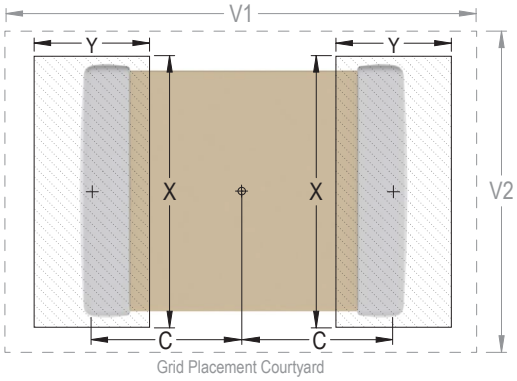
[3] Also commonly referred to as “Chip Carrier” or “Molded Tray”. All tray packaging options offer static protection.

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.

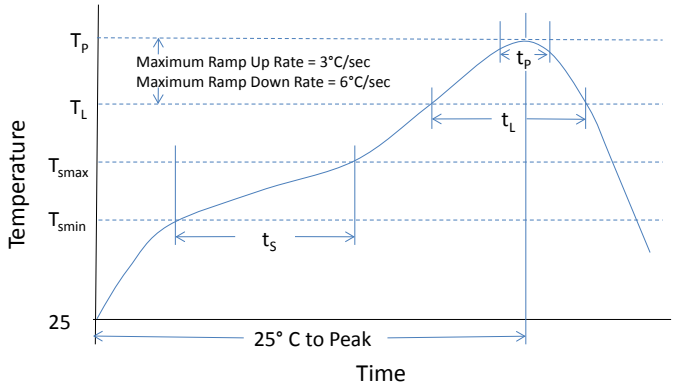


Table 4 – Performance & Reliability: Test Methods and Conditions

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

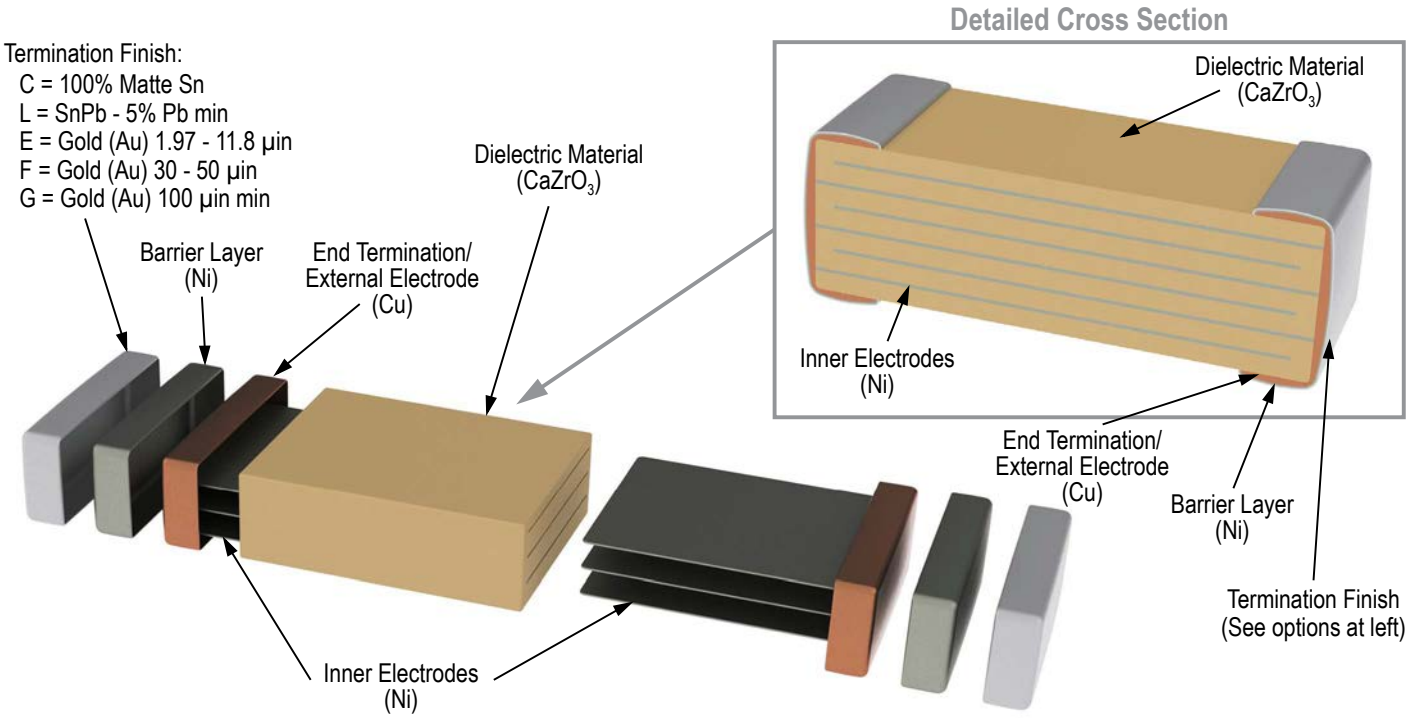
Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will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

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

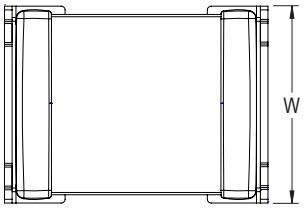
KEMET Automotive C-Spec	PPAP (Product Part Approval Process) Level				
	1	2	3	4	5
KEMET assigned[1]	●	●	●	●	●
AUTO	○		○		

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

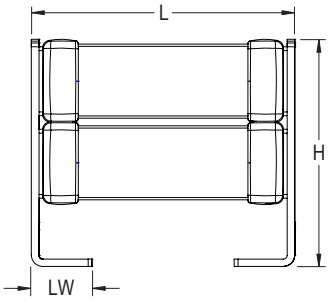
● Part Number specific PPAP available
○ Product family PPAP only

Dimensions – Millimeters (Inches)

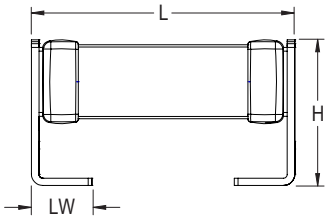
Single or Double Chip Stack



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

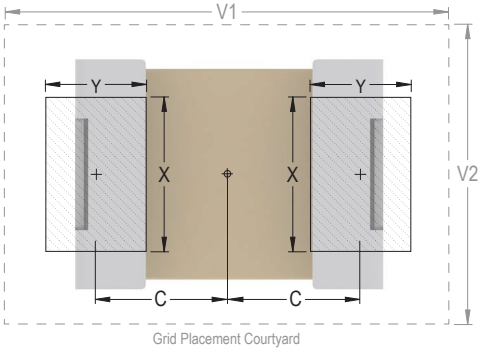
Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
FV	1210	3.35 ± 0.10	0	0	600	2,000
FW	1210	6.15 ± 0.15	0	0	300	1,000
JP	2220	3.50 ± 0.30	0	0	300	1,300
JR	2220	5.00 ± 0.50	0	0	200	800

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.

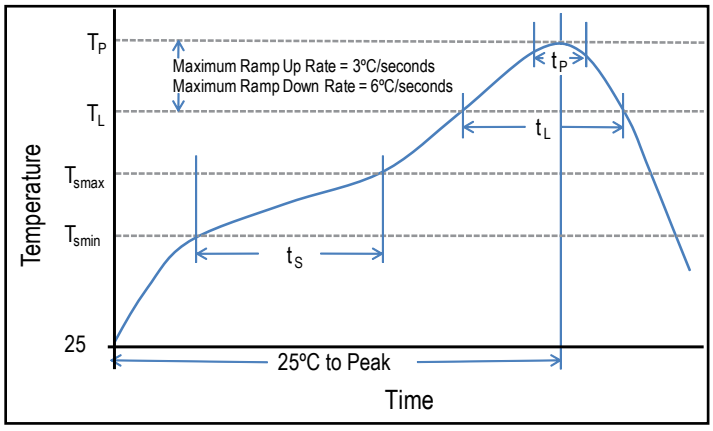


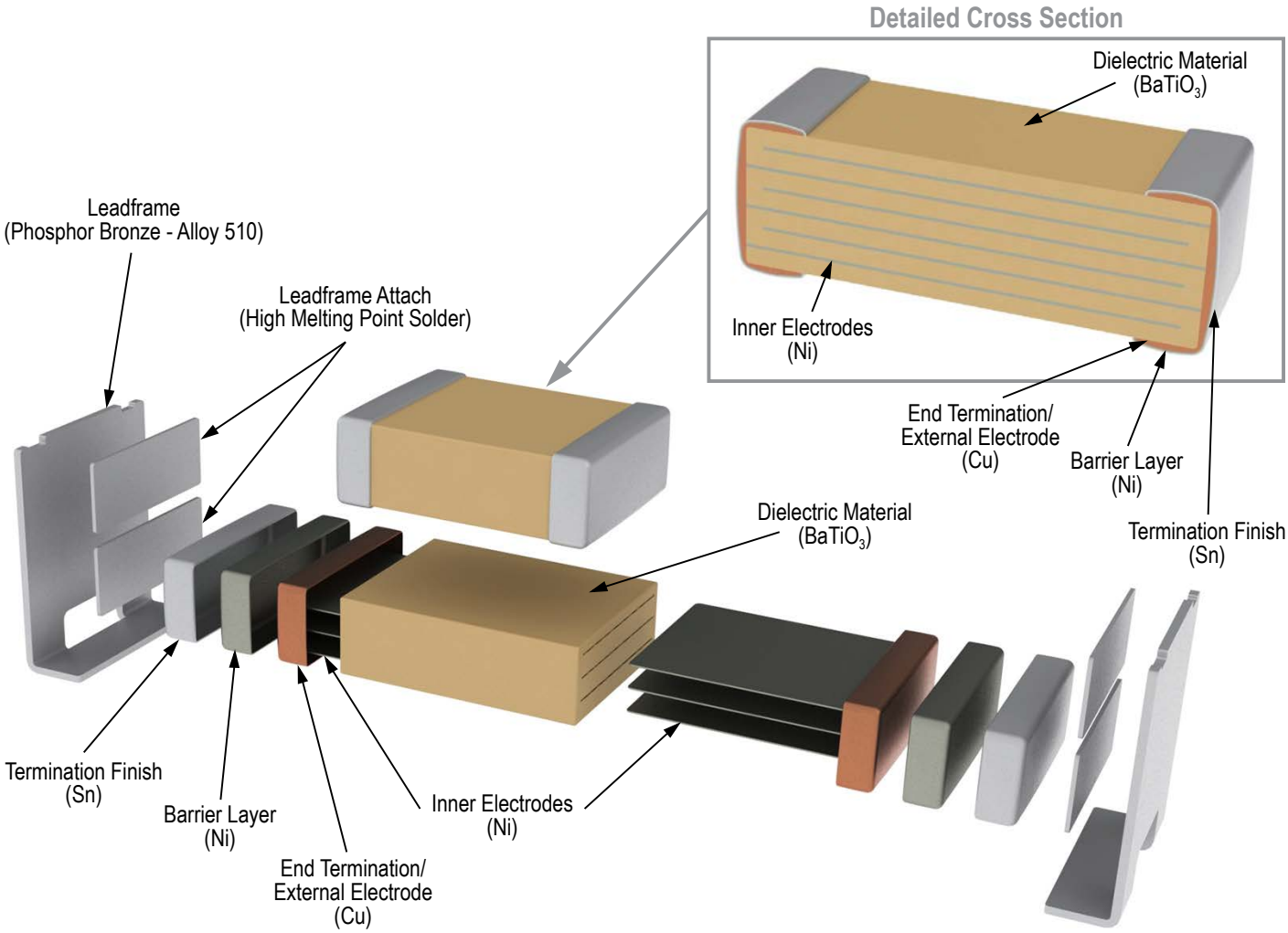
Table 4 – Performance & Reliability: Test Methods and Conditions

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.

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.

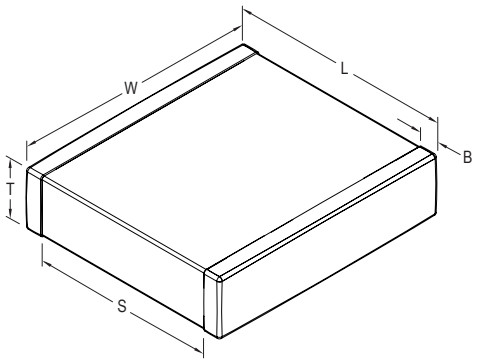
Benefits

- 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)

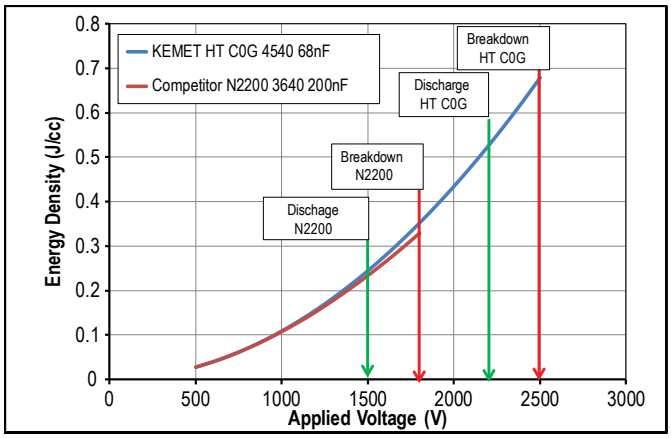
[1]DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.
[2]Capacitance and dissipation factor (DF) measured under the following conditions:
1 MHz ±100 kHz and 1.0 Vrms ±0.2 V if capacitance ≤ 1,000 pF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

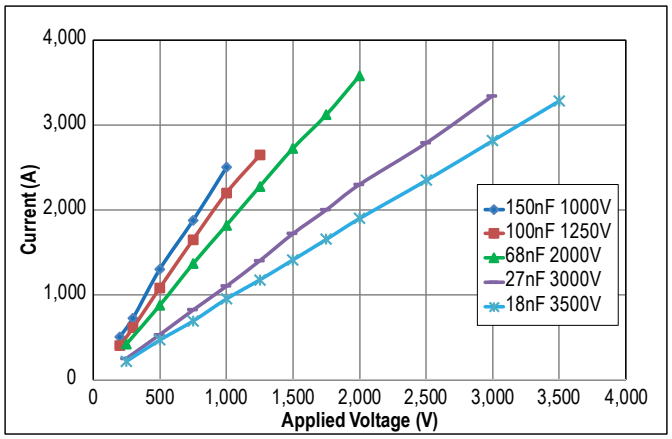


Table 1 – Pulse Discharge Series, Capacitance Range Waterfall

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**	

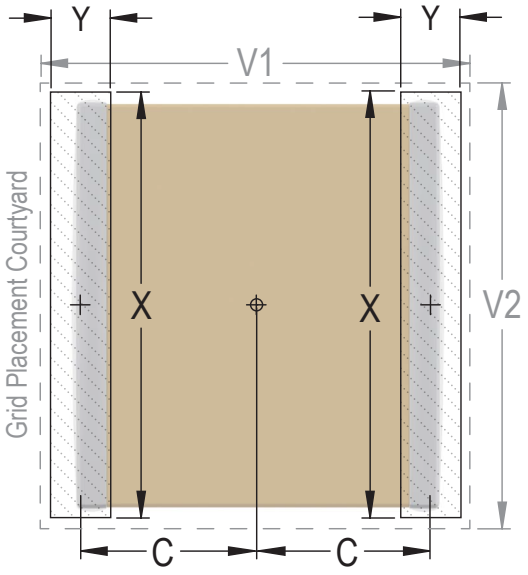
Package quantity based on finished chip thickness specifications.

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.

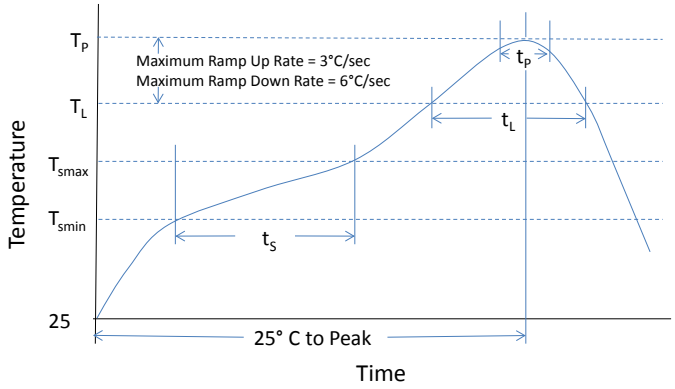


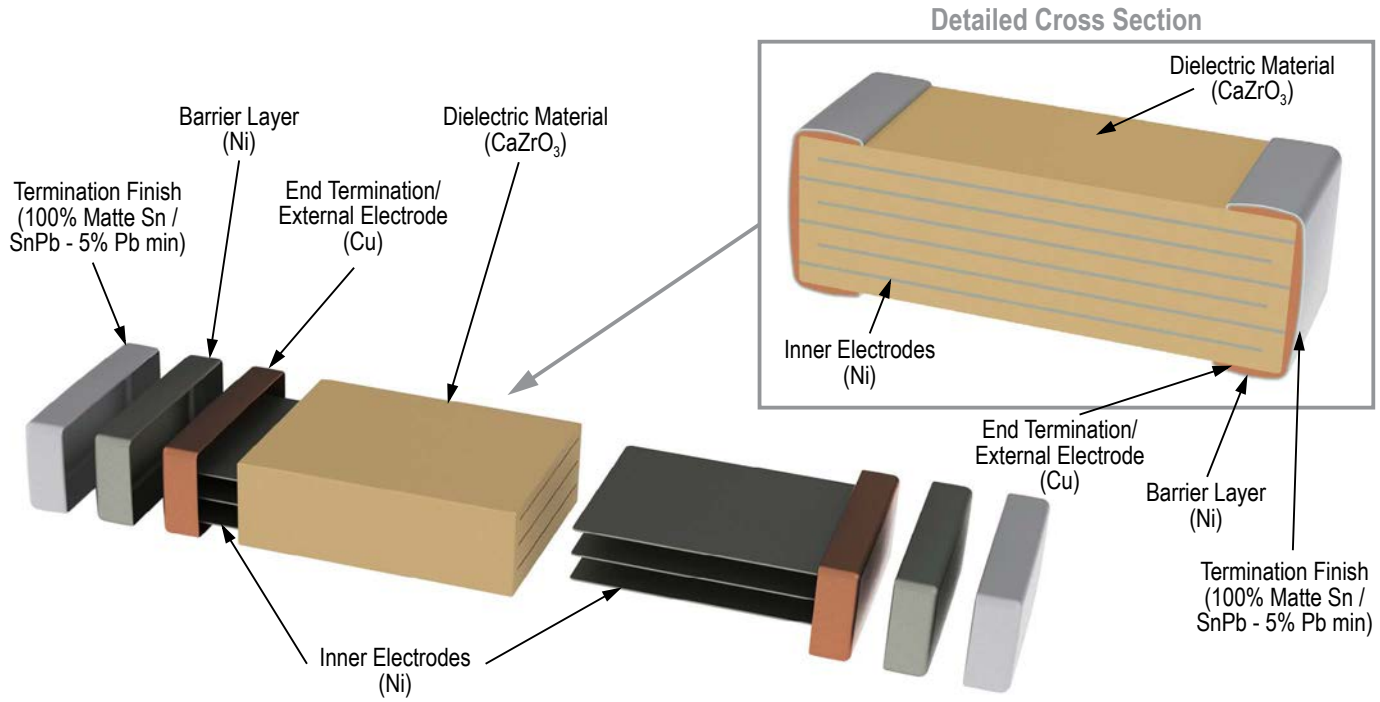
Table 4 – Performance & Reliability: Test Methods and Conditions

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.

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.

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

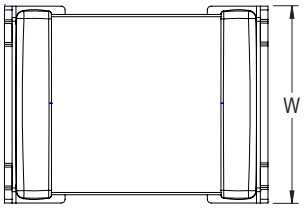
KEMET Automotive C-Spec	PPAP (Product Part Approval Process) Level				
	1	2	3	4	5
KEMET assigned[1]	●	●	●	●	●
AUTO	○		○		

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

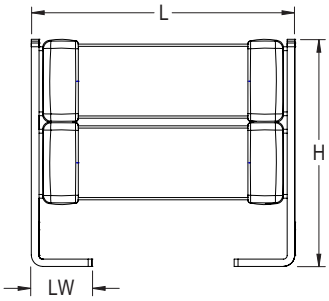
● Part Number specific PPAP available
○ Product family PPAP only

Dimensions – Millimeters (Inches)

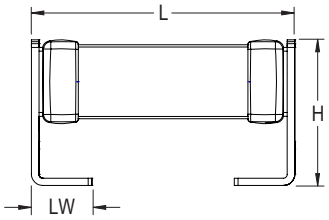
Single or Double Chip Stack



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

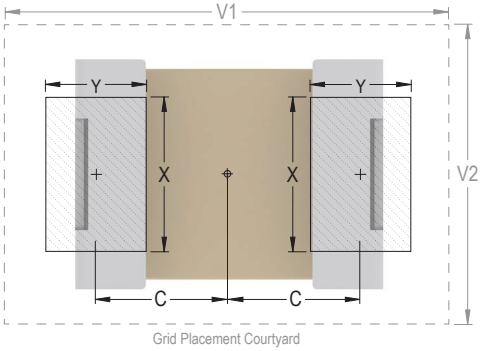
Thickness Code	Case Size	Thickness ± Range (mm)	Paper Quantity		Plastic Quantity	
			7" Reel	13" Reel	7" Reel	13" Reel
FV	1210	3.35 ± 0.10	0	0	600	2,000
FW	1210	6.15 ± 0.15	0	0	300	1,000
JP	2220	3.50 ± 0.30	0	0	300	1,300
JR	2220	5.00 ± 0.50	0	0	200	800

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.

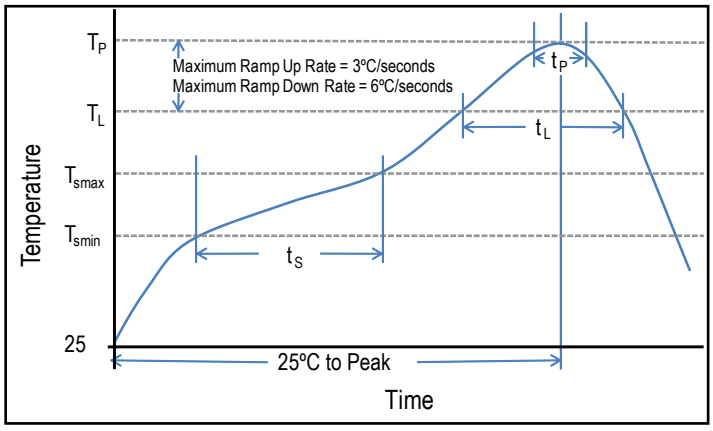


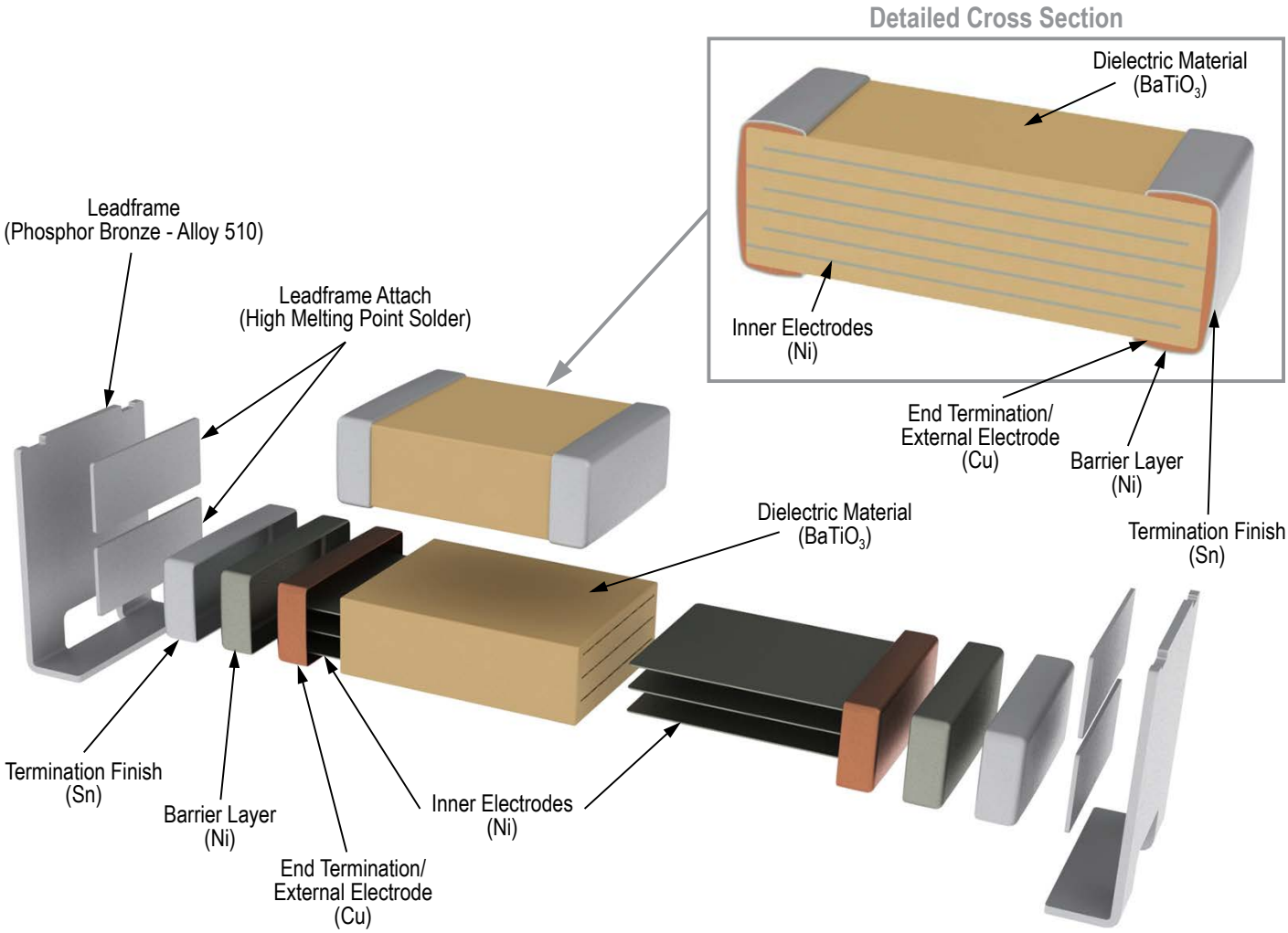
Table 4 – Performance & Reliability: Test Methods and Conditions

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.

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

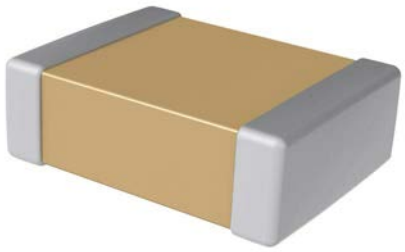
Overview

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.

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:

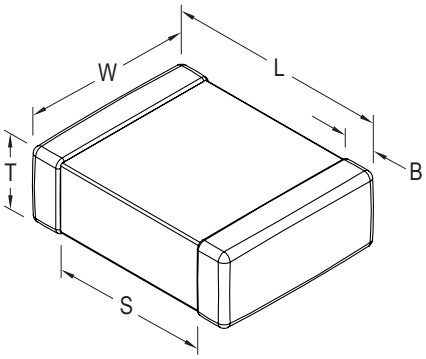
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design record and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that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

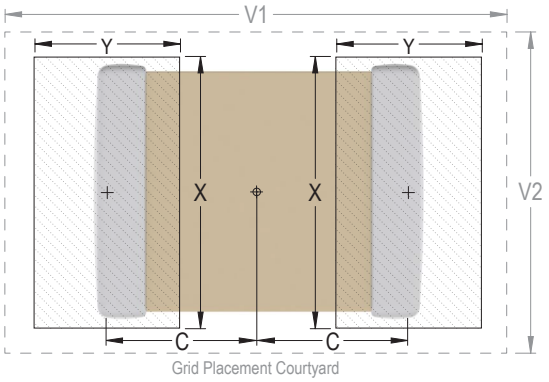


Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC–7351

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

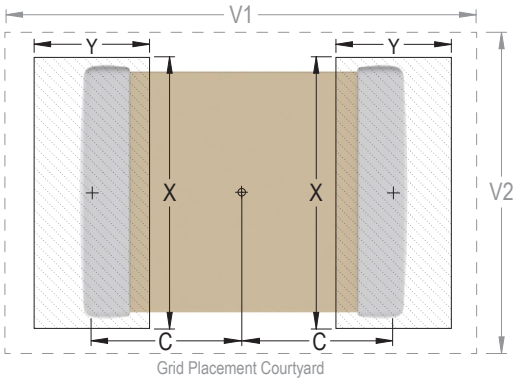
[1] *Only for capacitance values ≥ 22 µF*

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.

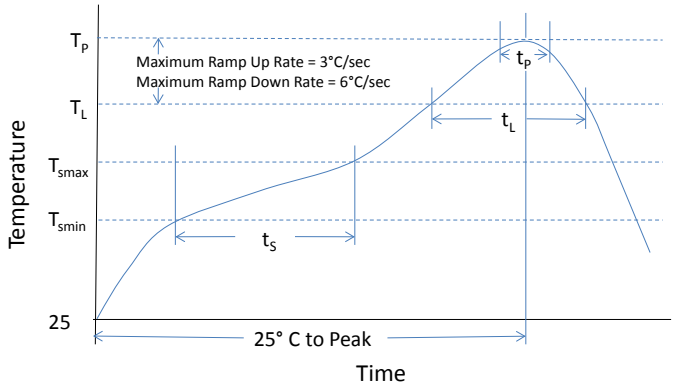


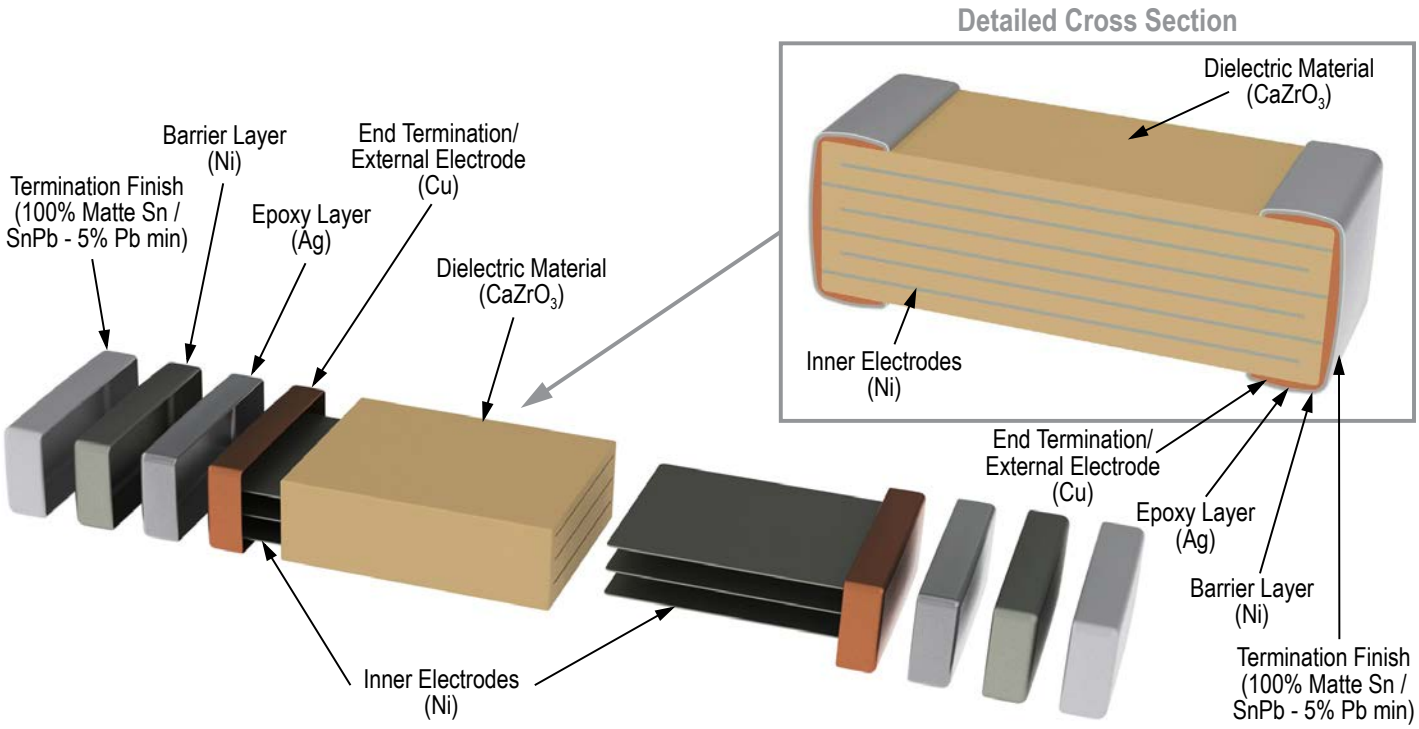
Table 4 – Performance & Reliability: Test Methods and Conditions

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.

High Temperature 200°C, Radial, Molded, C0G Dielectric, 50 – 200 VDC (Industrial Grade)

Overview

KEMET's High Temperature 200ºC epoxy molded radial through-hole ceramic capacitors in C0G dielectric features a robust and proprietary base metal dielectric system that offers industry-leading performance in extreme high pressure and high temperature environments up to 200°C. These capacitors are designed specifically to withstand the severe shock and vibration conditions associated with deep-well and horizontal drilling activities and are well suited for use in aerospace engine compartments, geophysical probes, hybrid and electric automotive motor drives and defense applications.

As high temperature electronic module complexity increases, the size reduction of components becomes more and more critical. These devices are significantly smaller by volume than most competitor radial molded capacitors, allowing for downsizing and replacement opportunities of larger high temperature precious metal electrode (PME) and base metal electrode (BME) dielectric system devices. They feature gold-plated lead wires for temperature resistance and an epoxy molded case for environmental protection and mechanical durability.

With virtually no capacitance change at 200°C and rated voltage applied, these radial molded capacitors in C0G dielectric 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, as well as low ESR at high frequencies.

Ordering Information

C	052	H	272	F	2	G	5	G	A	7301
Ceramic	Style/Size	Specification/ Series	Capacitance Code (pF)	Capacitance Tolerance[1]	Rated Voltage (VDC)	Dielectric	Design	Lead Finish[2]	Failure Rate	Packaging C-Spec[3]
	052 062	H = High Temp 200°C	2 significant digits + number of zeros Use 9 for 1.0 – 9.9 pF ex. 2.2 pF = 229	B = ±0.1 pF C = ±0.25 pF D = ±0.5 pF F = ±1% G = ±2% J = ±5% K = ±10%	5 = 50 1 = 100 2 = 200	G = C0G	5 = Multilayer	G = Gold (Au)	A = N/A	Blank = Bulk Bag T250 = 250 pcs / 12" Reel T500 = 500 pcs / 12" Reel T1K0 = 1,000 pcs / 12" Reel 7301 = Full Reel Qty / 12" Reel 7303 = Full Reel Qty / 12" Reel 7061 = Bulk Tray

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

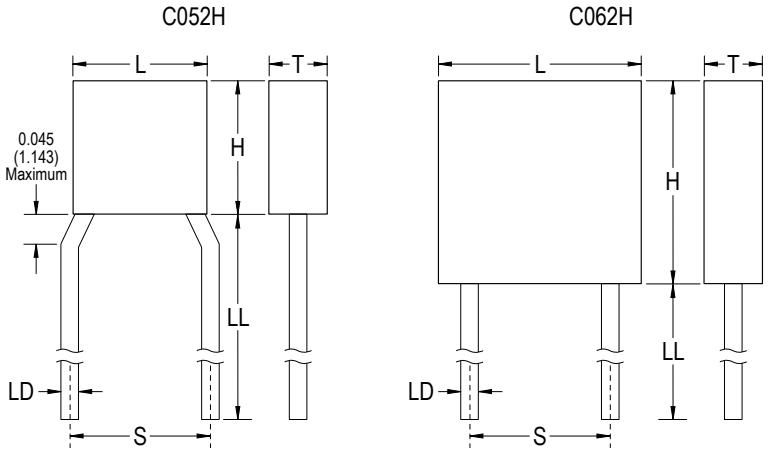
[2] Wire lead materials and finishes: Alternative lead materials and finishes may be available. Contact KEMET for details.

[3] Default packaging for this product series is "Bulk Bag". KEMET will assume "Bulk Bag" packaging is required when the 15th thru 18th character positions are left blank.

[3] C-Spec 7301 can only be used when ordering 052 style/size.

[3] C-Spec 7303 can only be used when ordering 062 style/size.

Dimensions – Inches (Millimeters)



Series	S Lead Spacing	L Length	H Height	T Thickness	LD Lead Diameter	LL Lead Length Minimum
C052H	0.20 ±0.015 (5.08 ±0.38)	0.19 ±0.01 (4.83 ±0.25)	0.19 ±0.01 (4.83 ±0.25)	0.09 ±0.01 (2.29 ±0.25)	0.025 +0.004/ -0.002 (0.635 +0.102/ -0.051)	1.25 (31.75)
C062H		0.29 ±0.01 (7.37 ±0.25)	0.29 ±0.01 (7.37 ±0.25)	0.09 ±0.01 (2.29 ±0.25)		

Benefits

- Operating temperature range of -55°C to +200°C
- High shock and vibration capability
- Base Metal Electrode (BME) dielectric system
- RoHS and REACH compliant
- Radial through-hole form factor
- Gold (Au) plated wire lead finish
- Military designation styles CK/CKR05 and CK/CKR06
- Molded case
- High breakdown voltage strength
- DC voltage ratings of 50 V, 100 V & 200 V
- Capacitance offerings ranging from 1.0 pF up to 0.22 µF
- Available capacitance tolerances of ±0.1 pF, ±0.25 pF, ±0.5 pF, ±1%, ±2%, ±5%, & ±10%
- 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 +200°C
- No capacitance decay with time
- Non-polar device, minimizing installation concerns
- Encapsulation meets flammability standard UL 94V-0
- Halogen-free

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, 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 shock and vibration, high temperature, high levels of board flexure and/or temperature cycling. Programs supported include down-hole exploration, aerospace engine compartments, geophysical probes, hybrid and electric automotive motor drives and defense. Markets include military, industrial, aerospace, and automotive.

Qualification

These devices are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 2, Performance & Reliability.

Environmental Compliance

RoHS compliant and halogen-free. These devices utilize exemption 7(a) of the RoHS directive.

Series	RoHS Compliant	RoHS Exemption Code[1]	Halogen Free
C052H	Yes	7(a)	Yes
C062H	Yes	7(a)	Yes

[1] *7(a): Lead in high melting temperature type solders*

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 % Cap Loss/Decade Hour)	0%
Dielectric Withstanding Voltage	250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA at 25°C)
Dissipation Factor (DF) Maximum Limit at 25°C	0.1%
Insulation Resistance (IR) Limit at 25°C	1,000 MΩ microfarads or 100 GΩ (Rated voltage applied for 120 ±5 seconds)

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 V_{rms} ±0.2 V if capacitance ≤ 1,000 pF

1 kHz ±50Hz and 1.0 V_{rms} ±0.2 V 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	DF (%)	Capacitance Shift	IR
C0G	All	All	0.5	0.3% or ±0.25 pF	10% of Initial Limit

Table 1A – C052 Style/Size (0.20" Lead Spacing), Capacitance Range Waterfall

C052 Style/Size (0.20" Lead Spacing)				
Rated Voltage (VDC)		**50**	**100**	**200**
Voltage Code		**5**	**1**	**2**
Capacitance	**Capacitance Tolerance**	**Capacitance Code (Available Capacitance)**		
1 pF	B = ±0.1pF C = ±0.25pF D = ±0.5pF	C052H109(1)5G5GA(3)	C052H109(1)1G5GA(3)	C052H109(1)2G5GA(3)
1.2 pF		C052H129(1)5G5GA(3)	C052H129(1)1G5GA(3)	C052H129(1)2G5GA(3)
1.5 pF		C052H159(1)5G5GA(3)	C052H159(1)1G5GA(3)	C052H159(1)2G5GA(3)
1.8 pF		C052H189(1)5G5GA(3)	C052H189(1)1G5GA(3)	C052H189(1)2G5GA(3)
2.2 pF		C052H229(1)5G5GA(3)	C052H229(1)1G5GA(3)	C052H229(1)2G5GA(3)
2.7 pF		C052H279(1)5G5GA(3)	C052H279(1)1G5GA(3)	C052H279(1)2G5GA(3)
3.3 pF		C052H339(1)5G5GA(3)	C052H339(1)1G5GA(3)	C052H339(1)2G5GA(3)
3.9 pF		C052H399(1)5G5GA(3)	C052H399(1)1G5GA(3)	C052H399(1)2G5GA(3)
4.7 pF		C052H479(1)5G5GA(3)	C052H479(1)1G5GA(3)	C052H479(1)2G5GA(3)
5.6 pF		C052H569(1)5G5GA(3)	C052H569(1)1G5GA(3)	C052H569(1)2G5GA(3)
6.8 pF		C052H689(1)5G5GA(3)	C052H689(1)1G5GA(3)	C052H689(1)2G5GA(3)
8.2 pF		C052H829(1)5G5GA(3)	C052H829(1)1G5GA(3)	C052H829(1)2G5GA(3)
10 pF	F = ±1% G = ±2% J = ±5% K = ±10%	C052H100(2)5G5GA(3)	C052H100(2)1G5GA(3)	C052H100(2)2G5GA(3)
12 pF		C052H120(2)5G5GA(3)	C052H120(2)1G5GA(3)	C052H120(2)2G5GA(3)
15 pF		C052H150(2)5G5GA(3)	C052H150(2)1G5GA(3)	C052H150(2)2G5GA(3)
18 pF		C052H180(2)5G5GA(3)	C052H180(2)1G5GA(3)	C052H180(2)2G5GA(3)
22 pF		C052H220(2)5G5GA(3)	C052H220(2)1G5GA(3)	C052H220(2)2G5GA(3)
27 pF		C052H270(2)5G5GA(3)	C052H270(2)1G5GA(3)	C052H270(2)2G5GA(3)
33 pF		C052H330(2)5G5GA(3)	C052H330(2)1G5GA(3)	C052H330(2)2G5GA(3)
39 pF		C052H390(2)5G5GA(3)	C052H390(2)1G5GA(3)	C052H390(2)2G5GA(3)
47 pF		C052H470(2)5G5GA(3)	C052H470(2)1G5GA(3)	C052H470(2)2G5GA(3)
56 pF		C052H560(2)5G5GA(3)	C052H560(2)1G5GA(3)	C052H560(2)2G5GA(3)
68 pF		C052H680(2)5G5GA(3)	C052H680(2)1G5GA(3)	C052H680(2)2G5GA(3)
82 pF		C052H820(2)5G5GA(3)	C052H820(2)1G5GA(3)	C052H820(2)2G5GA(3)
100 pF		C052H101(2)5G5GA(3)	C052H101(2)1G5GA(3)	C052H101(2)2G5GA(3)
120 pF		C052H121(2)5G5GA(3)	C052H121(2)1G5GA(3)	C052H121(2)2G5GA(3)
150 pF		C052H151(2)5G5GA(3)	C052H151(2)1G5GA(3)	C052H151(2)2G5GA(3)
180 pF		C052H181(2)5G5GA(3)	C052H181(2)1G5GA(3)	C052H181(2)2G5GA(3)
220 pF		C052H221(2)5G5GA(3)	C052H221(2)1G5GA(3)	C052H221(2)2G5GA(3)
270 pF		C052H271(2)5G5GA(3)	C052H271(2)1G5GA(3)	C052H271(2)2G5GA(3)
330 pF		C052H331(2)5G5GA(3)	C052H331(2)1G5GA(3)	C052H331(2)2G5GA(3)
390 pF		C052H391(2)5G5GA(3)	C052H391(2)1G5GA(3)	C052H391(2)2G5GA(3)
470 pF		C052H471(2)5G5GA(3)	C052H471(2)1G5GA(3)	C052H471(2)2G5GA(3)
560 pF		C052H561(2)5G5GA(3)	C052H561(2)1G5GA(3)	C052H561(2)2G5GA(3)
680 pF		C052H681(2)5G5GA(3)	C052H681(2)1G5GA(3)	C052H681(2)2G5GA(3)
820 pF		C052H821(2)5G5GA(3)	C052H821(2)1G5GA(3)	C052H821(2)2G5GA(3)
1,000 pF		C052H102(2)5G5GA(3)	C052H102(2)1G5GA(3)	C052H102(2)2G5GA(3)
1,200 pF		C052H122(2)5G5GA(3)	C052H122(2)1G5GA(3)	C052H122(2)2G5GA(3)
1,500 pF		C052H152(2)5G5GA(3)	C052H152(2)1G5GA(3)	C052H152(2)2G5GA(3)
1,800 pF		C052H182(2)5G5GA(3)	C052H182(2)1G5GA(3)	C052H182(2)2G5GA(3)
2,200 pF		C052H222(2)5G5GA(3)	C052H222(2)1G5GA(3)	C052H222(2)2G5GA(3)
Rated Voltage (VDC)		**50**	**100**	**200**
Voltage Code		**5**	**1**	**2**

(1) (2) To complete ordering code, insert the proper character for capacitance tolerance: (See table above for character definitions)

(1) Available capacitance tolerances: B, C, D

(2) Available capacitance tolerances: F, G, J, K

(3) To complete ordering code, enter the four-digit numeric or alphanumeric "Packaging C-Spec Ordering Code." See details below:

Blank = Bulk Bag
T250 = 250 pcs / 12" Reel
T500 = 500pcs / 12" Reel
T1K0 = 1,000 pcs / 12" reel
7301 = Full Reel Qty / 12" reel
7303 = Full Reel Qty / 12" reel
7061 = Bulk Tray

These products are protected under U.S. Patents 7172985 & 7670981, other patents pending, and any foreign counterparts.

Table 1A – C052 Style/Size (0.20" Lead Spacing), Capacitance Range Waterfall cont'd

C052 Style/Size (0.20" Lead Spacing)				
Rated Voltage (VDC)		**50**	**100**	**200**
Voltage Code		**5**	**1**	**2**
Capacitance	**Capacitance Tolerance**	**Capacitance Code (Available Capacitance)**		
2,700 pF	F = ±1% G = ±2% J = ±5% K = ±10%	C052H272(2)5G5GA(3)	C052H272(2)1G5GA(3)	C052H272(2)2G5GA(3)
3,300 pF		C052H332(2)5G5GA(3)	C052H332(2)1G5GA(3)	C052H332(2)2G5GA(3)
3,900 pF		C052H392(2)5G5GA(3)	C052H392(2)1G5GA(3)	
4,700 pF		C052H472(2)5G5GA(3)	C052H472(2)1G5GA(3)	
5,600 pF		C052H562(2)5G5GA(3)	C052H562(2)1G5GA(3)	
6,800 pF		C052H682(2)5G5GA(3)	C052H682(2)1G5GA(3)	
8,200 pF		C052H822(2)5G5GA(3)	C052H822(2)1G5GA(3)	
0.01 µF		C052H103(2)5G5GA(3)	C052H103(2)1G5GA(3)	
0.012 µF		C052H123(2)5G5GA(3)	C052H123(2)1G5GA(3)	
0.015 µF		C052H153(2)5G5GA(3)	C052H153(2)1G5GA(3)	
0.018 µF		C052H183(2)5G5GA(3)	C052H183(2)1G5GA(3)	
0.022 µF		C052H223(2)5G5GA(3)	C052H223(2)1G5GA(3)	
0.027 µF		C052H273(2)5G5GA(3)	C052H273(2)1G5GA(3)	
0.033 µF		C052H333(2)5G5GA(3)	C052H333(2)1G5GA(3)	
0.039 µF		C052H393(2)5G5GA(3)	C052H393(2)1G5GA(3)	
0.047 µF		C052H473(2)5G5GA(3)	C052H473(2)1G5GA(3)	
0.056 µF		C052H563(2)5G5GA(3)		
0.068 µF		C052H683(2)5G5GA(3)		
0.082 µF		C052H823(2)5G5GA(3)		
0.1 µF		C052H104(2)5G5GA(3)		
Rated Voltage (VDC)		**50**	**100**	**200**
Voltage Code		**5**	**1**	**2**

(1) (2) To complete ordering code, insert the proper character for capacitance tolerance: (See table above for character definitions)

(1) Available capacitance tolerances: B, C, D

(2) Available capacitance tolerances: F, G, J, K

(3) To complete ordering code, enter the four-digit numeric or alphanumeric "Packaging C-Spec Ordering Code." See details below:

Blank = Bulk Bag
T250 = 250 pcs / 12" Reel
T500 = 500pcs / 12" Reel
T1K0 = 1,000 pcs / 12" reel
7301 = Full Reel Qty / 12" reel
7303 = Full Reel Qty / 12" reel
7061 = Bulk Tray

These products are protected under U.S. Patents 7172985 & 7670981, other patents pending, and any foreign counterparts.

Table 1B – C062 Style/Size (0.20" Lead Spacing), Capacitance Range Waterfall

C062 Style/Size (0.20" Lead Spacing)				
Rated Voltage (VDC)		50	100	200
Voltage Code		5	1	2
Capacitance	Capacitance Tolerance	Capacitance Code (Available Capacitance)		
4,700 pF	F = ±1% G = ±2% J = ±5% K = ±10%			C062H472(1)2G5GA(2)
5,600 pF				C062H562(1)2G5GA(2)
6,800 pF				C062H682(1)2G5GA(2)
0.056 µF			C062H563(1)1G5GA(2)	
0.068 µF			C062H683(1)1G5GA(2)	
0.082 µF			C062H823(1)1G5GA(2)	
0.1 µF			C062H104(1)1G5GA(2)	
0.12 µF		C062H124(1)5G5GA(2)	C062H124(1)1G5GA(2)	
0.15 µF		C062H154(1)5G5GA(2)		
0.18 µF		C062H184(1)5G5GA(2)		
0.22 µF		C062H224(1)5G5GA(2)		
Rated Voltage (VDC)		50	100	200
Voltage Code		5	1	2

(1) To complete ordering code, insert the proper character for capacitance tolerance: (See table above for character definitions)

(1) Available capacitance tolerances: F, G, J, K

(2) To complete ordering code, enter the four-digit numeric or alphanumeric "Packaging C-Spec Ordering Code." See details below:

Blank = Bulk Bag
T250 = 250 pcs / 12" Reel
T500 = 500pcs / 12" Reel
T1K0 = 1,000 pcs / 12" reel
7301 = Full Reel Qty / 12" reel
7303 = Full Reel Qty / 12" reel
7061 = Bulk Tray

These products are protected under U.S. Patents 7172985 & 7670981, other patents pending, and any foreign counterparts.

Packaging Quantities

Packaging Options		Bulk Bag (default) [1]	Bulk Tray	Tape and Reel				
		Packaging Quantities [3]						
Ordering Code C-Spec [2]		n/a	7061	T250	T500	T1K0	7301	7303
Style/ Series	C052H	100 pcs / bag	50 pcs / tray	250	500	1,000	2,000	n/a
	C062H	100 pcs / bag	40 pcs / tray	250	500	1,000	n/a	1,500

[1] Default packaging for this product series is "Bulk Bag". KEMET will assume " Bulk Bag" packaging is required unless a valid C-spec is included in the 15th thru 18th character positions of the ordering code. For more information see "Ordering Information" section of this document.

[1, 2] The " Ordering Code C-Spec" is a four-digit code that follows the KEMET part number and identifies any special packaging or processing requirements. Failure to include a C-Spec when ordering will result in the default packaging option. Default packaging for this product series is "Bulk Bag".

[3] Packaging quantities reported above are considered "minimum order quantities" and are mandatory.

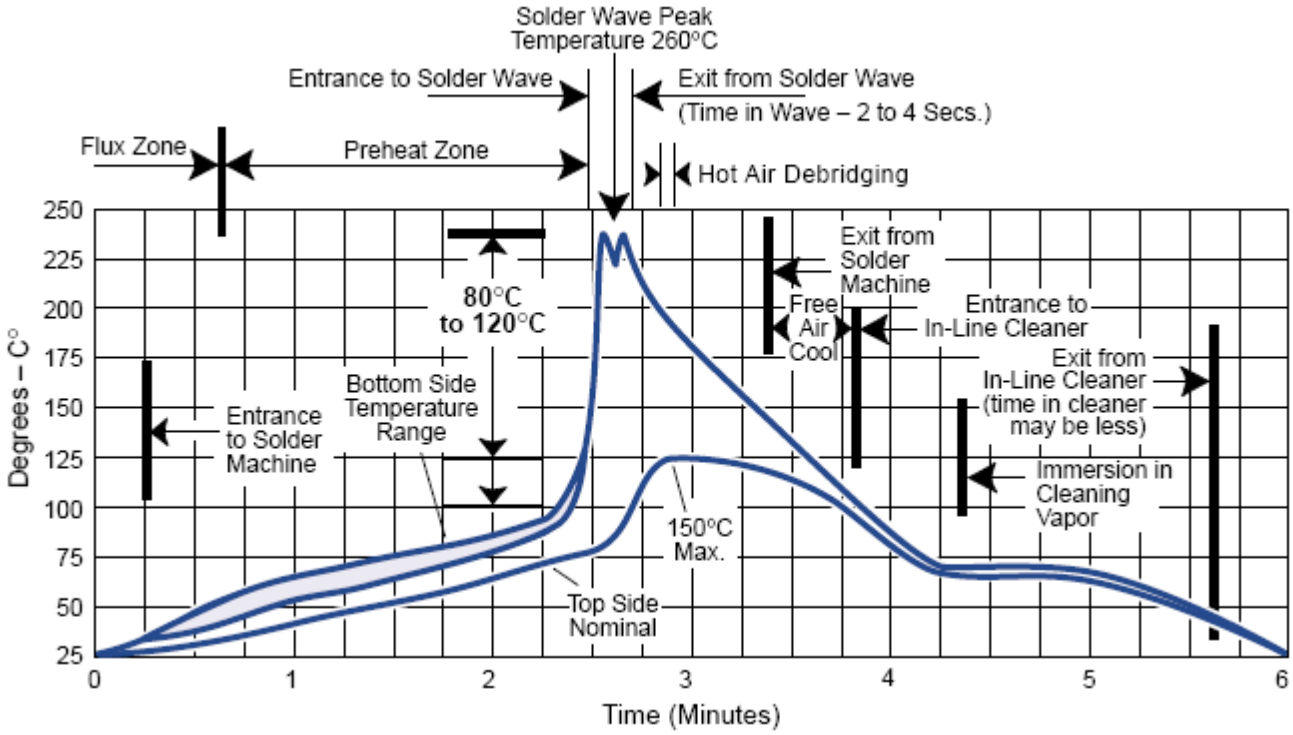
Soldering Process

Recommended Soldering Technique:

- Solder Wave
- Hand Soldering (Manual)

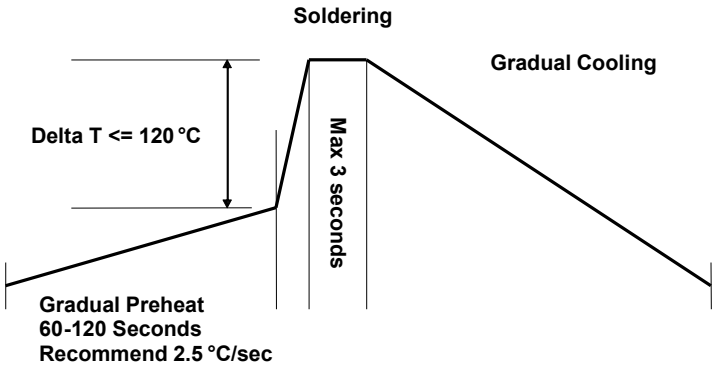
Recommended Soldering Profile:

- Optimum Wave Solder Profile



- Hand Soldering (Manual)

Manual Solder Profile with Pre -heating



KEMET recommends following the guidelines and techniques outlined in technical bulletins F2103 and F9207.

Table 2 – Performance & Reliability: Test Methods and Conditions

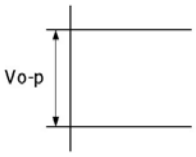
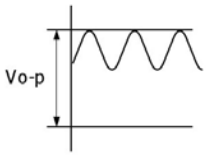
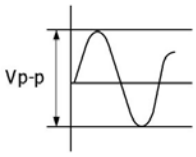
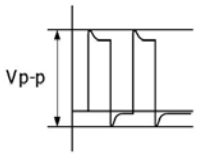
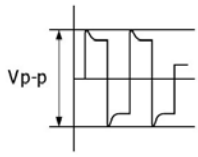
Stress	Reference	Test or Inspection Method
Solderability	J–STD–002	Method A at 235°C, category 3
Temperature Cycling	JESD22 Method JA–104	50 cycles (-55°C to 220°C), measurement at 24 ±4 hours after test conclusion. 30 minutes maximum dwell time at each temperature extreme. 8 minutes maximum transition time.
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.
Immersion	MIL–STD–202 Method 104	Test condition B
Storage Life	MIL–STD–202 Method 108	Unpowered 1,000 hours at 200°C. Measurement at 24 hours ±4 hours after test conclusion. IR Measurement at 150°C
High Temperature Life	MIL–STD–202 Method 108	1,000 hours at 200°C with rated voltage applied.
High Temperature Lead Pull	KEMET Defined Test	Peel to Failure (25ºC and 200ºC): 4 lbs (1.84 kg) minimum
Vibration	MIL–STD–202 Method 204	5g 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 – 2000 Hz.
Resistance to Soldering Heat	MIL–STD–202 Method 210	Test Condition B, Solder dip. Note: no preheat of samples.
Terminal Strength	MIL–STD–202 Method 211	Test Condition A. 454g 5 – 10 s; Bend test © 227g, 3 bends
Mechanical Shock	MIL–STD–202 Method 213	Test Condition D. Figure 1 of Method 213.
Resistance to Solvents	MIL–STD–202 Method 215	Add aqueous wash chemical – OKEM Clean or equivalent.

Storage & Handling

The un-mounted storage life of a through-hole (leaded) ceramic capacitor is dependent upon storage and atmospheric conditions as well as packaging materials. While the ceramic chips enveloped under the epoxy coating themselves are quite robust in most environments, solderability of the wire lead on the final epoxy-coated product will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature and exposure to direct sunlight – reels may soften or warp, and tape peel force may increase. KEMET recommends storing the un-mounted capacitors in their original packaging, in a location away from direct sunlight, and where the temperature and relative humidity do not exceed 40 degrees centigrade and 70% respectively. For optimum solderability, capacitor stock should be used promptly, preferably within 18 months of receipt. For applications requiring pre-tinning of components, storage life may be extended if solderability is verified. Before cleaning, bonding or molding these devices, it is important to verify that your process does not affect product quality and performance. KEMET recommends testing and evaluating the performance of a cleaned, bonded or molded product prior to implementing and/or qualifying any of these processes.

Application Notes

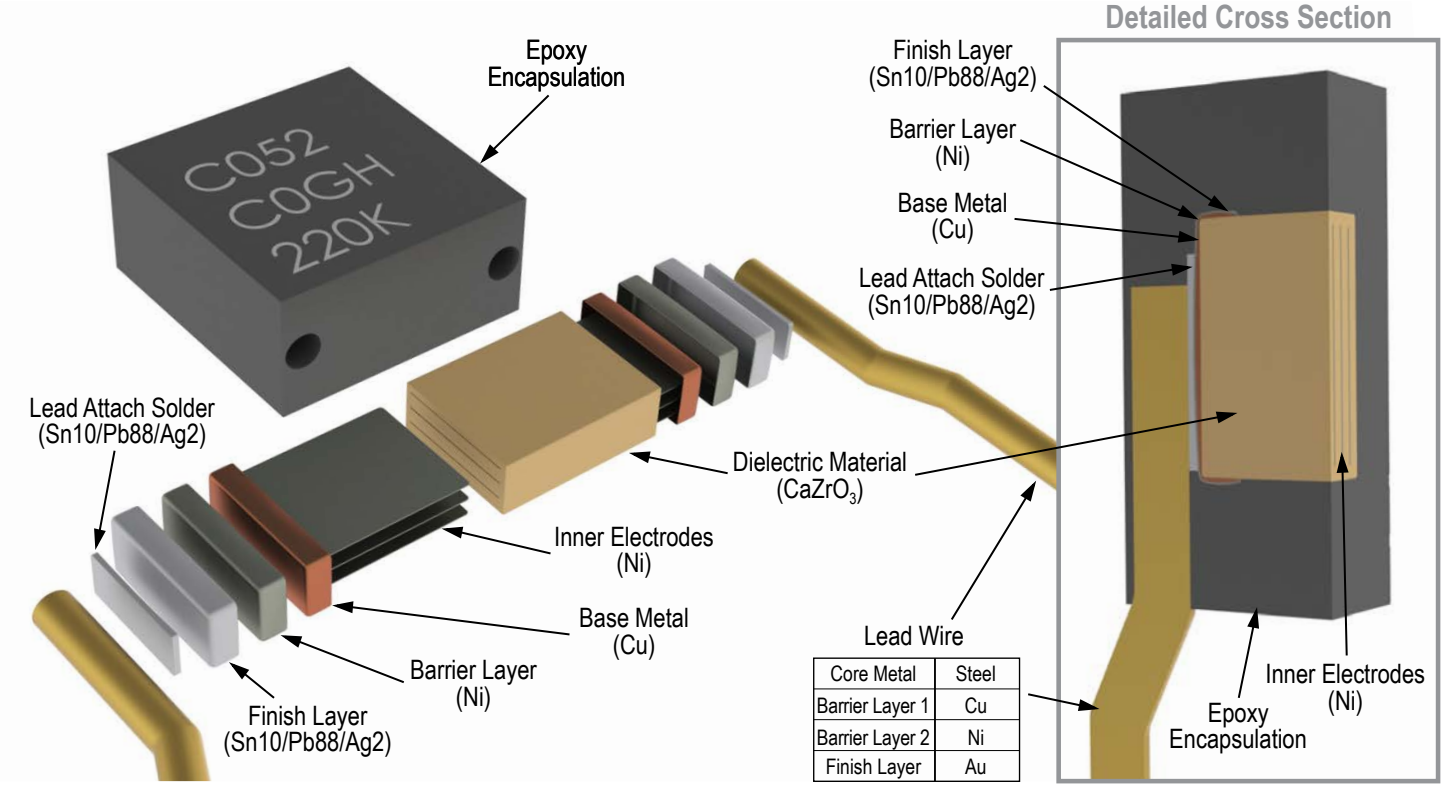
Working Voltage:
Application voltage (Vp-p or Vo-p) must not exceed the voltage rating of the capacitor. Irregular voltages can be generated for a transient period of time when voltage is initially applied and/or removed from a circuit. It is important to choose a capacitor with a voltage rating greater than or equal to these irregular voltages.

Voltage	DC Voltage	DC+AC Voltage	AC Voltage	Pulse Voltage (1)	Pulse Voltage (2)
Positional Measurement					

Operating Temperature and Self-Generating Heat:
The surface temperature of a capacitor should be kept below the upper limit of its rated operating temperature range. Be sure to take into account the heat generated by the capacitor itself. When the capacitor is used in a high-frequency current, pulse current or similar current, it may self-generate heat due to dielectric loss. Temperature rise due to self-generated heating should not exceed 20°C (while operated at an atmosphere temperature of 25°C).

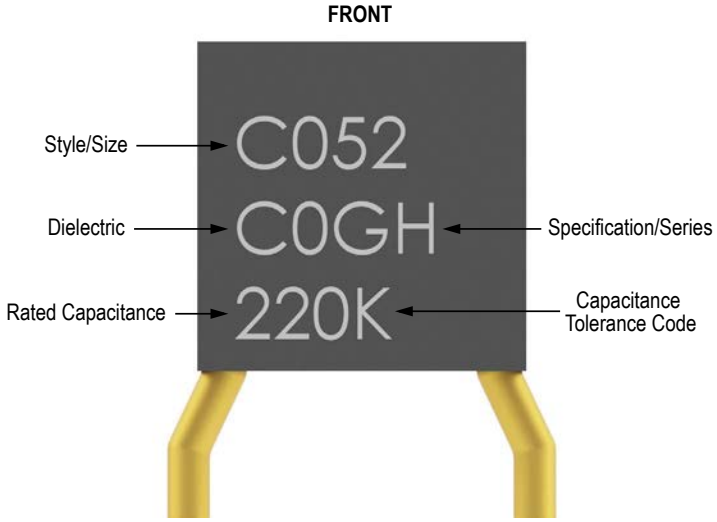
FAILURE TO FOLLOW THE ABOVE CAUTIONS MAY RESULT, WORST CASE, IN A SHORT CIRCUIT AND CAUSE FUMING OR PARTIAL DISPERSION WHEN THE PRODUCT IS USED.

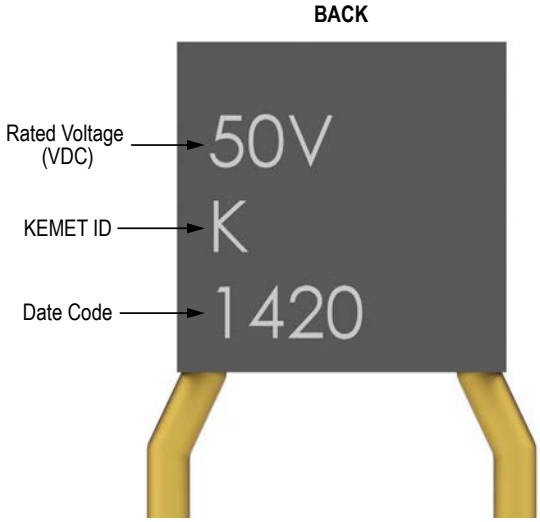
Construction



Core Metal	Steel
Barrier Layer 1	Cu
Barrier Layer 2	Ni
Finish Layer	Au

Marking





Date Code	
14	20
Manufacturing Year: 14 = 2014	Manufacturing Week: 20 = Week 20 (of mfg. calendar year)

Radial Through-Hole Multilayer Ceramic Capacitors

High Temperature 200°C, Radial, Molded, X7R Dielectric, 50 – 200 VDC (Industrial Grade)

Overview

KEMET's High Temperature 200ºC epoxy molded radial through-hole ceramic capacitors in X7R dielectric feature a robust and proprietary dielectric system that offers industry-leading performance in extreme high pressure and high temperature environments up to 200°C. These capacitors are designed specifically to withstand the severe shock and vibration conditions associated with deep-well and horizontal drilling activities and are well suited for use in aerospace engine compartments, geophysical probes, hybrid and electric automotive motor drives and defense applications.

As high temperature electronic module complexity increases, the size reduction of components becomes more and more critical. These devices are significantly smaller by volume than most competitor radial molded capacitors, allowing for downsizing and replacement opportunities of larger high temperature precious metal electrode (PME) and base metal electrode (BME) dielectric system devices. They feature gold-plated lead wires for temperature resistance and an epoxy molded case for environmental protection and mechanical durability.

These epoxy molded radial through-hole ceramic capacitors in X7R dielectric achieve high dielectric breakdown, low leakage current and minimal parametric shift while maintaining predictable performance characteristics with respect to variations in temperature, applied voltage and time. These devices are suited for bypass and decoupling applications or for frequency discriminating circuits where Q and stability of capacitance characteristics are not critical. Capacitance change is limited to ±15% from -55°C to +125°C and +15% / -55% at +200°C.

Ordering Information

C	062	H	105	K	5	R	5	G	A	7303
Ceramic	Style/Size	Specification/ Series	Capacitance Code (pF)	Capacitance Tolerance[1]	Rated Voltage (VDC)	Dielectric	Design	Lead Finish[2]	Failure Rate	Packaging C-Spec[3]
	052 062	H = High Temp 200°C	2 significant digits + number of zeros Use 9 for 1.0 – 9.9 pF ex. 2.2 pF = 229	J = ±5% K = ±10% M = ±20%	5 = 50 1 = 100 2 = 200	R = X7R	5 = Multilayer	G = Gold (Au)	A = N/A	Blank = Bulk Bag T250 = 250 pcs / 12" Reel T500 = 500 pcs / 12" Reel T1K0 = 1,000 pcs / 12" Reel 7301 = Full Reel Qty / 12" Reel 7303 = Full Reel Qty / 12" Reel 7061 = Bulk Tray

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

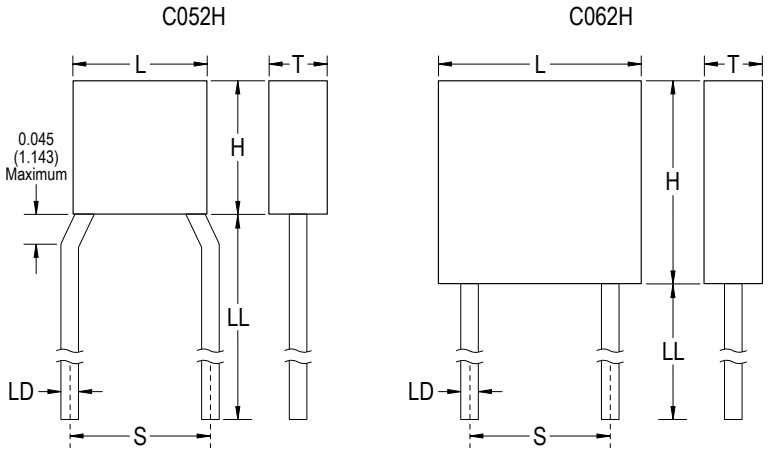
[2] Wire lead materials and finishes: Alternative lead materials and finishes may be available. Contact KEMET for details.

[3] Default packaging for this product series is "Bulk Bag". KEMET will assume "Bulk Bag" packaging is required when the 15th thru 18th character positions are left blank.

[3] C-Spec 7301 can only be used when ordering 052 style/size.

[3] C-Spec 7303 can only be used when ordering 062 style/size.

Dimensions – Inches (Millimeters)



Series	S Lead Spacing	L Length	H Height	T Thickness	LD Lead Diameter	LL Lead Length Minimum
C052H	0.20 ±0.015 (5.08 ±0.38)	0.19 ±0.01 (4.83 ±0.25)	0.19 ±0.01 (4.83 ±0.25)	0.09 ±0.01 (2.29 ±0.25)	0.025 +0.004/ -0.002 (0.635 +0.102/ -0.051)	1.25 (31.75)
C062H		0.29 ±0.01 (7.37 ±0.25)	0.29 ±0.01 (7.37 ±0.25)	0.09 ±0.01 (2.29 ±0.25)		

Benefits

- Operating temperature range of -55°C to +200°C
- X7R temperature stable dielectric
- High shock and vibration capability
- Radial through-hole form factor
- Gold (Au) plated wire lead finish
- Base metal electrode (BME) and precious metal electrode (PME) dielectric systems.
- RoHS and REACH compliant (most select values)
- Military designation styles CK/CKR05 and CK/CKR06
- Molded case
- High breakdown voltage strength
- DC voltage ratings of 50 V, 100 V & 200 V
- Capacitance offerings ranging from 1,000 pF to 1.0 µF
- Available capacitance tolerances of ±5%, ±10% & ±20%
- Low ESR and ESL
- Predictable performance characteristics with respect to variations in temperature, applied voltage and time
- Non-polar device, minimizing installation concerns
- Encapsulation meets flammability standard UL 94V-0
- Halogen-free

Applications

Typical applications include decoupling, bypass, 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 shock and vibration, high temperature, high levels of board flexure and/or temperature cycling. Markets include military, industrial, aerospace, and automotive.

Qualification

These devices are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 2, Performance & Reliability.

Environmental Compliance

RoHS compliance is dependent upon series and rated capacitance value.

Series	Rated Capacitance	RoHS Compliant	RoHS Exemption Code[1]	Halogen Free
C052H	All	Yes	7(a)	Yes
C062H	< 0.27µF	Yes	7(a)	Yes
C062H	≥ 0.27µF	No	n/a	Yes

[1] *7(a): Lead in high melting temperature type solders*

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)	±15% (-55°C to +125°C), +15% / -55% (200°C)
Capacitance Change with Reference to +25°C and 100% Rated VDC Applied	+15% / -30% (-55°C to +125°C), +15% / -60% (200°C)
Aging Rate (Maximum % Cap Loss/Decade Hour)	3%
Dielectric Withstanding Voltage	250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA at 25°C)
Dissipation Factor (DF) Maximum Limit at 25°C	2.50%
Insulation Resistance (IR) Limit at 25°C	1,000 MΩ microfarads or 100 GΩ (Rated voltage applied for 120 ±5 seconds)

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 V_{rms} if capacitance ≤ 10 µF

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

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

Post Environmental Limits

High Temperature Life, Biased Humidity, Moisture Resistance					
Dielectric	Rated DC Voltage	Capacitance Value	DF (%)	Capacitance Shift	IR
X7R	> 25	All	3.0	±20%	10% of Initial Limit

Table 1A – C052 Style/Size (0.20" Lead Spacing), Capacitance Range Waterfall

C052 Style/Size (0.20" Lead Spacing)				
Rated Voltage (VDC)		**50**	**100**	**200**
Voltage Code		**5**	**1**	**2**
Capacitance	**Capacitance Tolerance**	**Capacitance Code (Available Capacitance)**		
1,000 pF	J = ±5% K = ±10% M = ±20%	C052H102(1)5R5GA(2)	C052H102(1)1R5GA(2)	C052H102(1)2R5GA(2)
1,200 pF		C052H122(1)5R5GA(2)	C052H122(1)1R5GA(2)	C052H122(1)2R5GA(2)
1,500 pF		C052H152(1)5R5GA(2)	C052H152(1)1R5GA(2)	C052H152(1)2R5GA(2)
1,800 pF		C052H182(1)5R5GA(2)	C052H182(1)1R5GA(2)	C052H182(1)2R5GA(2)
2,200 pF		C052H222(1)5R5GA(2)	C052H222(1)1R5GA(2)	C052H222(1)2R5GA(2)
2,700 pF		C052H272(1)5R5GA(2)	C052H272(1)1R5GA(2)	C052H272(1)2R5GA(2)
3,300 pF		C052H332(1)5R5GA(2)	C052H332(1)1R5GA(2)	C052H332(1)2R5GA(2)
3,900 pF		C052H392(1)5R5GA(2)	C052H392(1)1R5GA(2)	
4,700 pF		C052H472(1)5R5GA(2)	C052H472(1)1R5GA(2)	
5,600 pF		C052H562(1)5R5GA(2)	C052H562(1)1R5GA(2)	
6,800 pF		C052H682(1)5R5GA(2)	C052H682(1)1R5GA(2)	
8,200 pF		C052H822(1)5R5GA(2)	C052H822(1)1R5GA(2)	
0.01 µF		C052H103(1)5R5GA(2)	C052H103(1)1R5GA(2)	
0.012 µF		C052H123(1)5R5GA(2)	C052H123(1)1R5GA(2)	
0.015 µF		C052H153(1)5R5GA(2)	C052H153(1)1R5GA(2)	
0.018 µF		C052H183(1)5R5GA(2)	C052H183(1)1R5GA(2)	
0.022 µF		C052H223(1)5R5GA(2)	C052H223(1)1R5GA(2)	
0.027 µF		C052H273(1)5R5GA(2)	C052H273(1)1R5GA(2)	
0.033 µF		C052H333(1)5R5GA(2)	C052H333(1)1R5GA(2)	
0.039 µF		C052H393(1)5R5GA(2)	C052H393(1)1R5GA(2)	
0.047 µF		C052H473(1)5R5GA(2)	C052H473(1)1R5GA(2)	
0.056 µF		C052H563(1)5R5GA(2)		
0.068 µF		C052H683(1)5R5GA(2)		
0.082 µF		C052H823(1)5R5GA(2)		
0.1 µF		C052H104(1)5R5GA(2)		
Rated Voltage (VDC)		**50**	**100**	**200**
Voltage Code		**5**	**1**	**2**

(1) To complete ordering code, insert the proper character for capacitance tolerance: (See table above for character definitions)

(1) Available capacitance tolerances: J, K, M

(2) To complete ordering code, enter the four-digit numeric or alphanumeric "Packaging C-Spec Ordering Code." See details below:

Blank = Bulk Bag
T250 = 250 pcs / 12" Reel
T500 = 500pcs / 12" Reel
T1K0 = 1,000 pcs / 12" reel
7301 = Full Reel Qty / 12" reel
7303 = Full Reel Qty / 12" reel
7061 = Bulk Tray

These products are protected under U.S. Patents 7172985 & 7670981, other patents pending, and any foreign counterparts.

Table 1B – C062 Style/Size (0.20" Lead Spacing), Capacitance Range Waterfall

C062 Style/Size (0.20" Lead Spacing)				
Rated Voltage (VDC)		**50**	**100**	**200**
Voltage Code		**5**	**1**	**2**
Capacitance	**Capacitance Tolerance**	**Capacitance Code (Available Capacitance)**		
4,700 pF	J = ±5% K = ±10% M = ±20%			C062H472(1)2R5GA(2)
5,600 pF				C062H562(1)2R5GA(2)
6,800 pF				C062H682(1)2R5GA(2)
0.056 µF			C062H563(1)1R5GA(2)	
0.068 µF			C062H683(1)1R5GA(2)	
0.082 µF			C062H823(1)1R5GA(2)	
0.1 µF			C062H104(1)1R5GA(2)	
0.12 µF		C062H124(1)5R5GA(2)	C062H124(1)1R5GA(2)	
0.15 µF		C062H154(1)5R5GA(2)		
0.18 µF		C062H184(1)5R5GA(2)		
0.22 µF		C062H224(1)5R5GA(2)		
0.27 µF		C062H274(1)5R5GA(2)		
0.33 µF		C062H334(1)5R5GA(2)		
0.39 µF		C062H394(1)5R5GA(2)		
0.47 µF		C062H474(1)5R5GA(2)		
0.56 µF		C062H564(1)5R5GA(2)		
0.68 µF		C062H684(1)5R5GA(2)		
0.82 µF		C062H824(1)5R5GA(2)		
1.0 µF		C062H105(1)5R5GA(2)		
Rated Voltage (VDC)		**50**	**100**	**200**
Voltage Code		**5**	**1**	**2**

(1) To complete ordering code, insert the proper character for capacitance tolerance: (See table above for character definitions)
(1) Available capacitance tolerances: J, K, M
(2) To complete ordering code, enter the four-digit numeric or alphanumeric "Packaging C-Spec Ordering Code." See details below:

Blank = Bulk Bag
T250 = 250 pcs / 12" Reel
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7061 = Bulk Tray

These products are protected under U.S. Patents 7172985 & 7670981, other patents pending, and any foreign counterparts.

Packaging Quantities

Packaging Options		Bulk Bag (default) [1]	Bulk Tray	Tape and Reel				
		Packaging Quantities [3]						
Ordering Code C-Spec [2]		n/a	7061	T250	T500	T1K0	7301	7303
Style/ Series	C052H	100 pcs / bag	50 pcs / tray	250	500	1,000	2,000	n/a
	C062H	100 pcs / bag	40 pcs / tray	250	500	1,000	n/a	1,500

[1] Default packaging for this product series is "Bulk Bag". KEMET will assume " Bulk Bag" packaging is required unless a valid C-spec is included in the 15th thru 18th character positions of the ordering code. For more information see "Ordering Information" section of this document.
[1, 2] The " Ordering Code C-Spec" is a four-digit code that follows the KEMET part number and identifies any special packaging or processing requirements. Failure to include a C-Spec when ordering will result in the default packaging option. Default packaging for this product series is "Bulk Bag".
[3] Packaging quantities reported above are considered "minimum order quantities" and are mandatory.

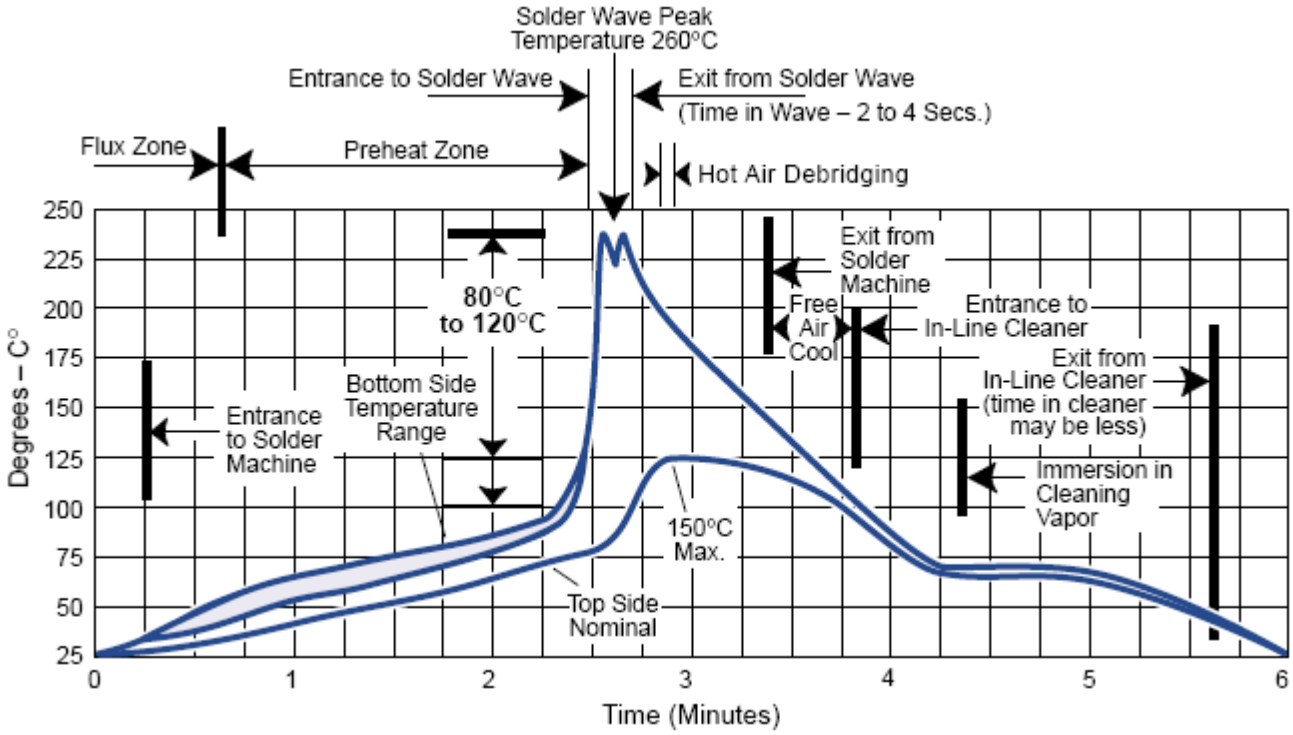
Soldering Process

Recommended Soldering Technique:

- Solder Wave
- Hand Soldering (Manual)

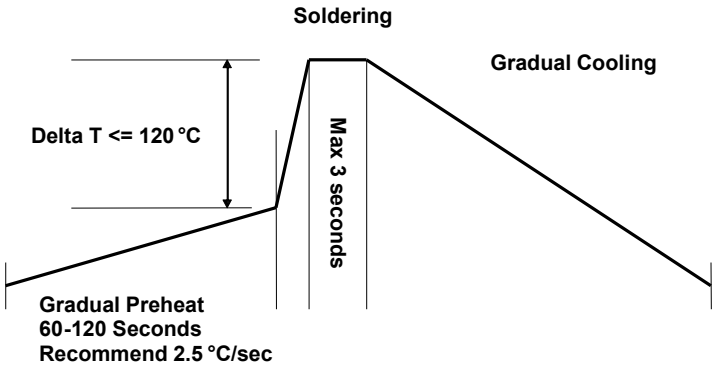
Recommended Soldering Profile:

- Optimum Wave Solder Profile



- Hand Soldering (Manual)

Manual Solder Profile with Pre -heating



KEMET recommends following the guidelines and techniques outlined in technical bulletins F2103 and F9207.

Table 2 – Performance & Reliability: Test Methods and Conditions

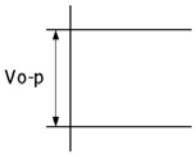
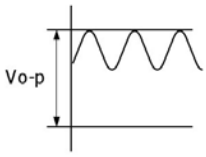
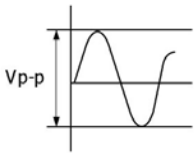
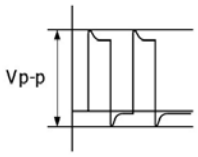
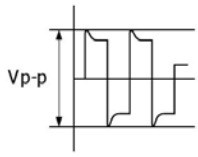
Stress	Reference	Test or Inspection Method
Solderability	J–STD–002	Method A at 235°C, category 3
Temperature Cycling	JESD22 Method JA–104	50 cycles (-55°C to 220°C), measurement at 24 ±4 hours after test conclusion. 30 minutes maximum dwell time at each temperature extreme. 8 minutes maximum transition time.
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.
Immersion	MIL–STD–202 Method 104	Test condition B
Storage Life	MIL–STD–202 Method 108	Unpowered 1,000 hours at 200°C. Measurement at 24 hours ±4 hours after test conclusion. IR Measurement at 150°C
High Temperature Life	MIL–STD–202 Method 108	1,000 hours at 200°C with rated voltage applied.
High Temperature Lead Pull	KEMET Defined Test	Peel to Failure (25ºC and 200ºC): 4 lbs (1.84 kg) minimum
Vibration	MIL–STD–202 Method 204	5g 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 – 2000 Hz.
Resistance to Soldering Heat	MIL–STD–202 Method 210	Test Condition B, Solder dip. Note: no preheat of samples.
Terminal Strength	MIL–STD–202 Method 211	Test Condition A. 454g 5 – 10 s; Bend test © 227g, 3 bends
Mechanical Shock	MIL–STD–202 Method 213	Test Condition D. Figure 1 of Method 213.
Resistance to Solvents	MIL–STD–202 Method 215	Add aqueous wash chemical – OKEM Clean or equivalent.

Storage & Handling

The un-mounted storage life of a through-hole (leaded) ceramic capacitor is dependent upon storage and atmospheric conditions as well as packaging materials. While the ceramic chips enveloped under the epoxy coating themselves are quite robust in most environments, solderability of the wire lead on the final epoxy-coated product will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature and exposure to direct sunlight – reels may soften or warp, and tape peel force may increase. KEMET recommends storing the un-mounted capacitors in their original packaging, in a location away from direct sunlight, and where the temperature and relative humidity do not exceed 40 degrees centigrade and 70% respectively. For optimum solderability, capacitor stock should be used promptly, preferably within 18 months of receipt. For applications requiring pre-tinning of components, storage life may be extended if solderability is verified. Before cleaning, bonding or molding these devices, it is important to verify that your process does not affect product quality and performance. KEMET recommends testing and evaluating the performance of a cleaned, bonded or molded product prior to implementing and/or qualifying any of these processes.

Application Notes

Working Voltage:
Application voltage (Vp-p or Vo-p) must not exceed the voltage rating of the capacitor. Irregular voltages can be generated for a transient period of time when voltage is initially applied and/or removed from a circuit. It is important to choose a capacitor with a voltage rating greater than or equal to these irregular voltages.

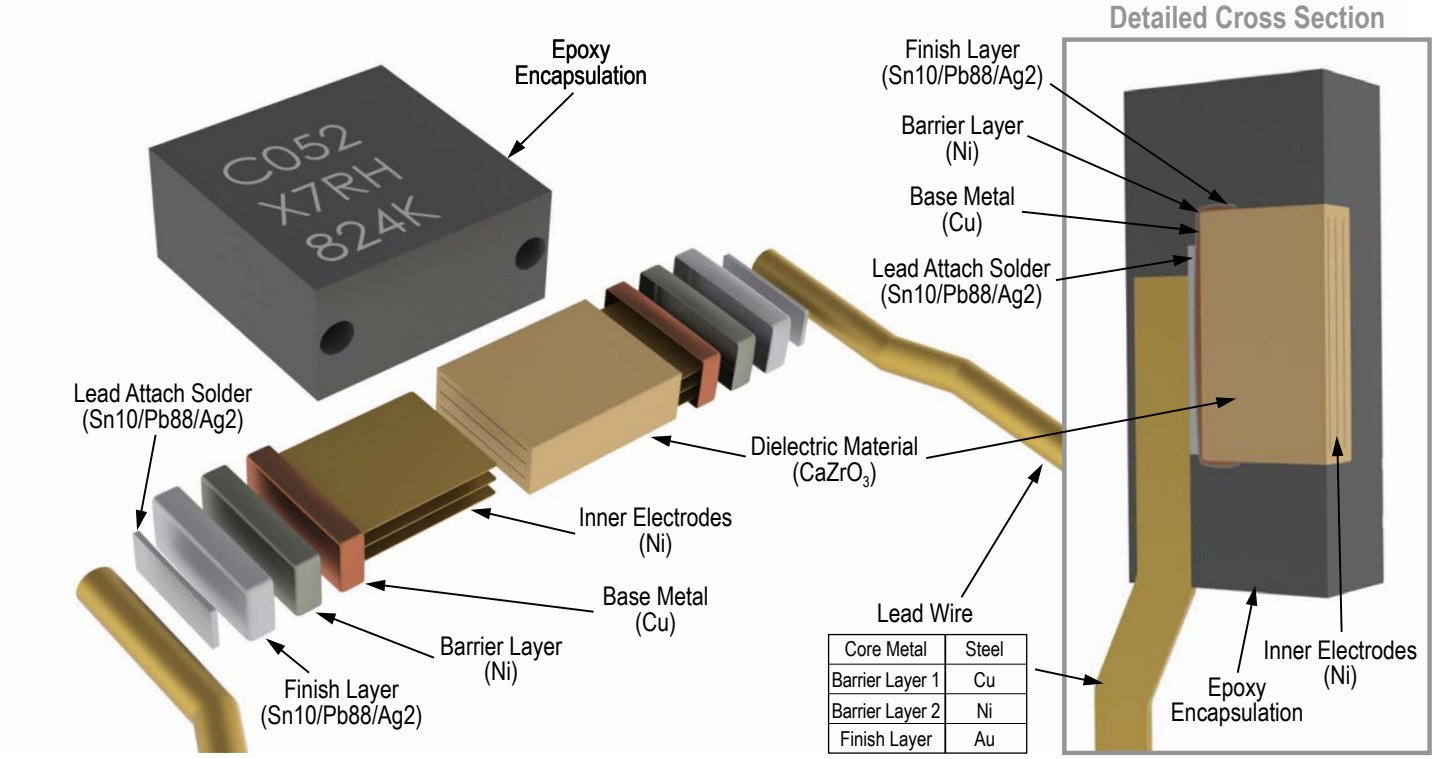
Voltage	DC Voltage	DC+AC Voltage	AC Voltage	Pulse Voltage (1)	Pulse Voltage (2)
Positional Measurement					

Operating Temperature and Self-Generating Heat:
The surface temperature of a capacitor should be kept below the upper limit of its rated operating temperature range. Be sure to take into account the heat generated by the capacitor itself. When the capacitor is used in a high-frequency current, pulse current or similar current, it may self-generate heat due to dielectric loss. Temperature rise due to self-generated heating should not exceed 20°C (while operated at an atmosphere temperature of 25°C).

FAILURE TO FOLLOW THE ABOVE CAUTIONS MAY RESULT, WORST CASE, IN A SHORT CIRCUIT AND CAUSE FUMING OR PARTIAL DISPERSION WHEN THE PRODUCT IS USED.

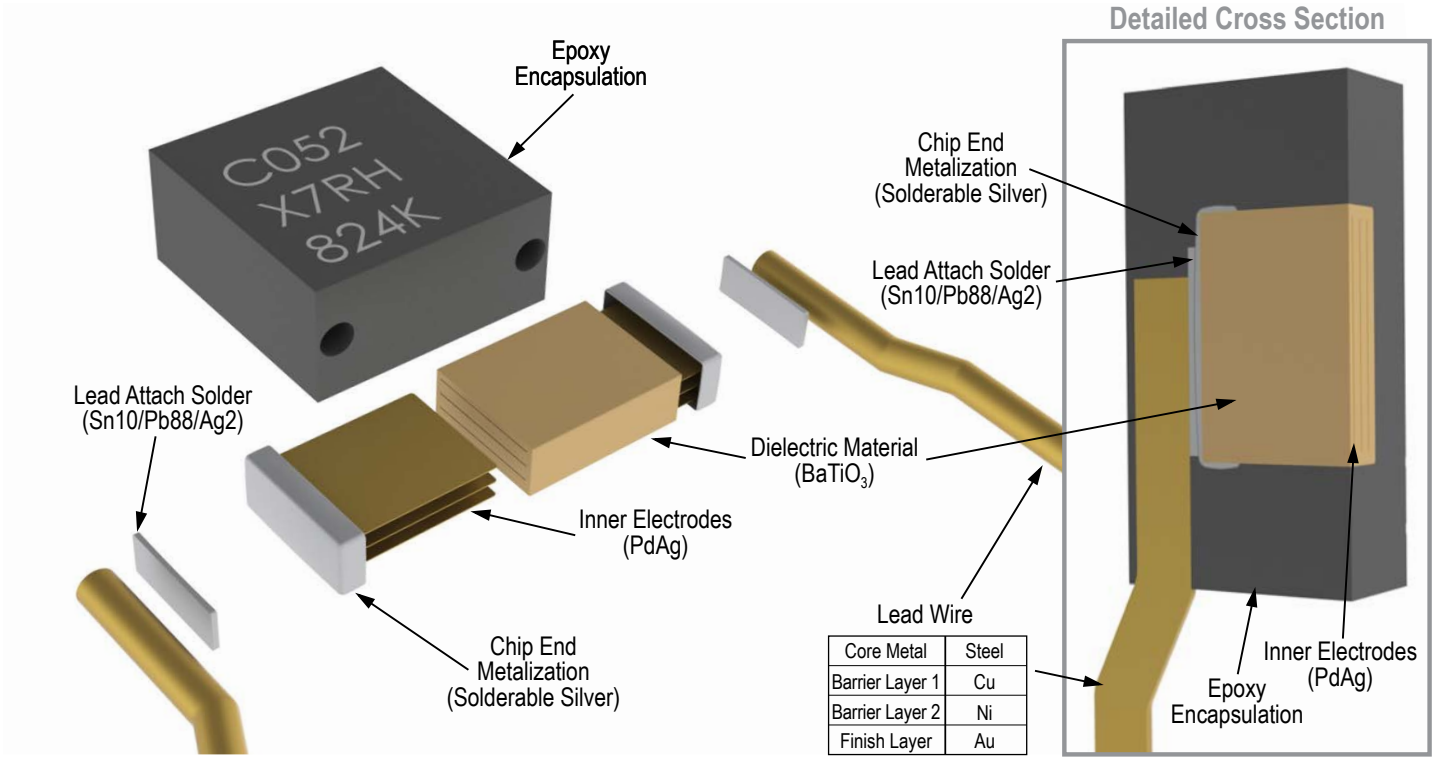
Construction

Base Metal Electrode



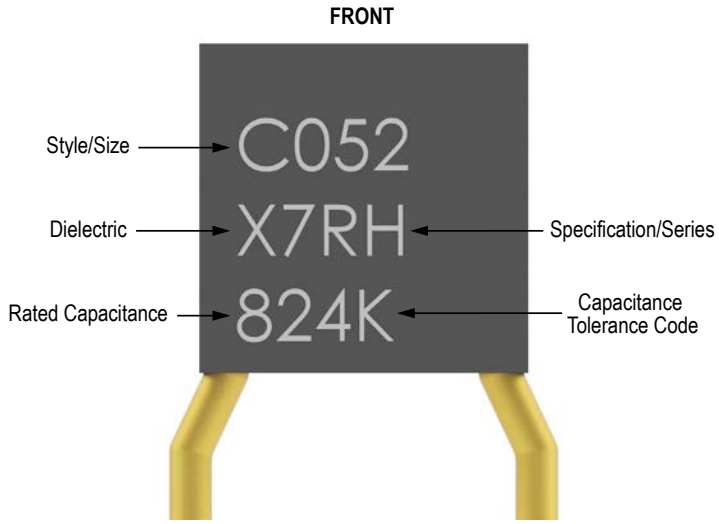
Core Metal	Steel
Barrier Layer 1	Cu
Barrier Layer 2	Ni
Finish Layer	Au

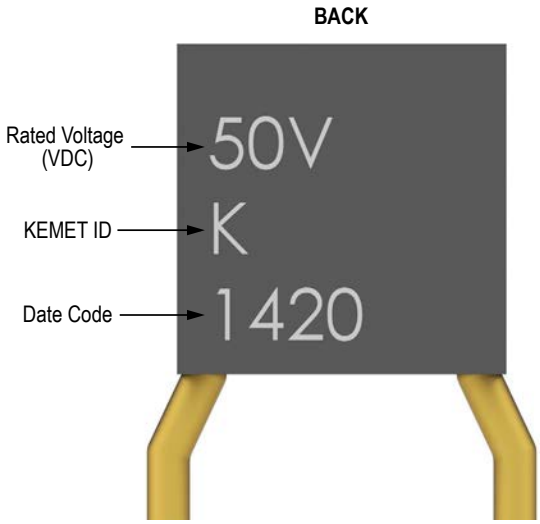
Precious Metal Electrode



Core Metal	Steel
Barrier Layer 1	Cu
Barrier Layer 2	Ni
Finish Layer	Au

Marking





Date Code	
14	20
Manufacturing Year: 14 = 2014	Manufacturing Week: 20 = Week 20 (of mfg. calendar year)

Capacitor Marking (Optional):

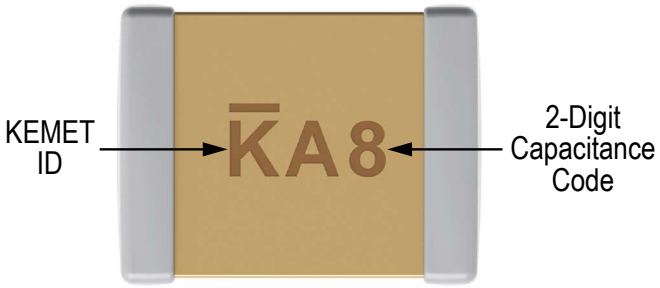
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic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

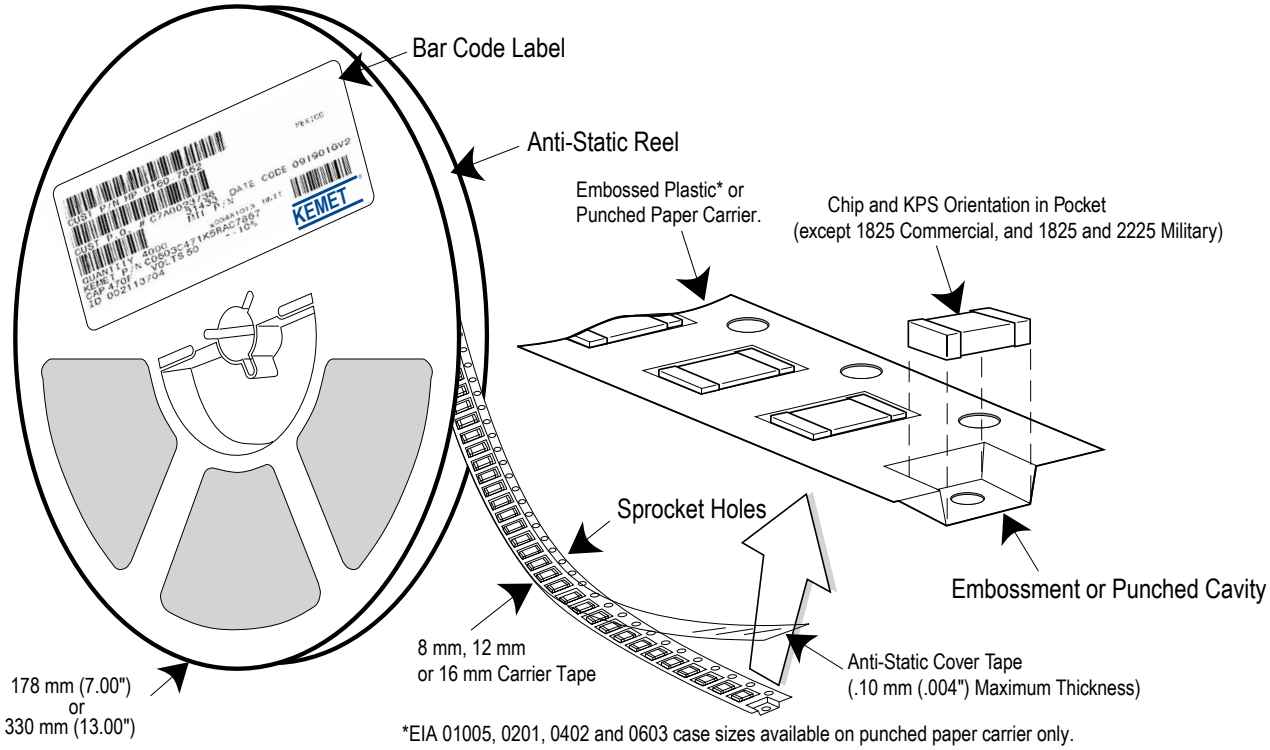


Capacitor Marking (Optional) cont'd

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

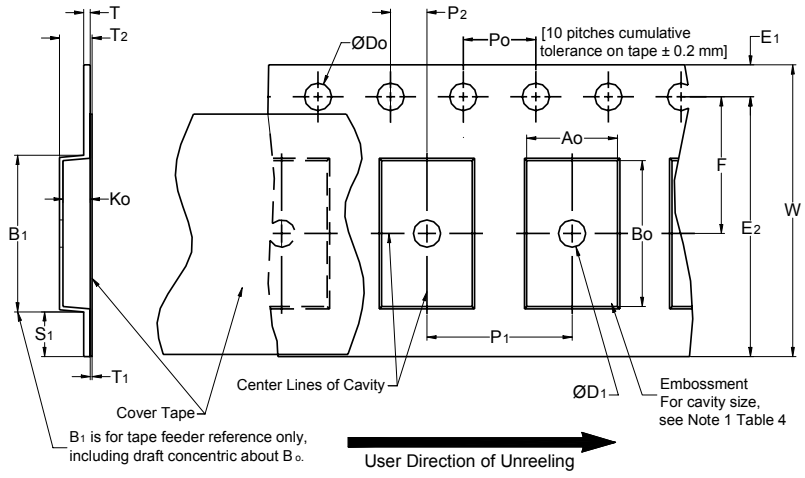


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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

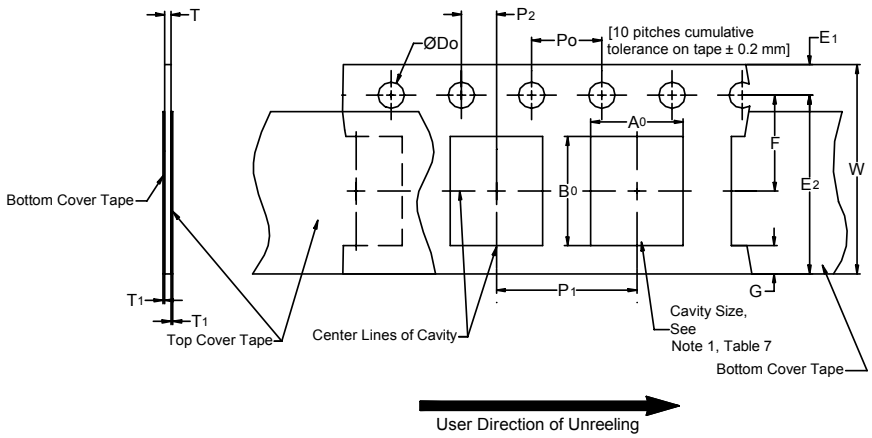


Table 7 – Punched (Paper) Carrier Tape Dimensions

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

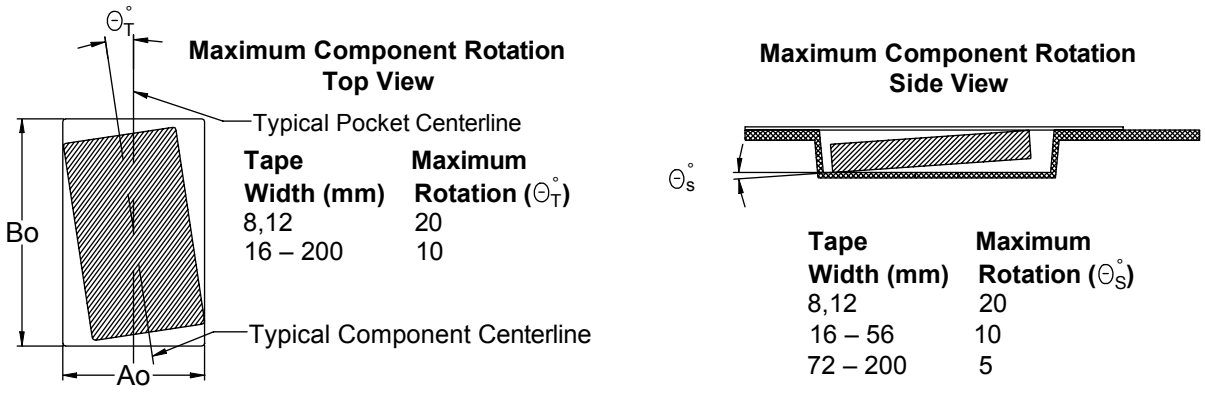


Figure 4 – Maximum Lateral Movement

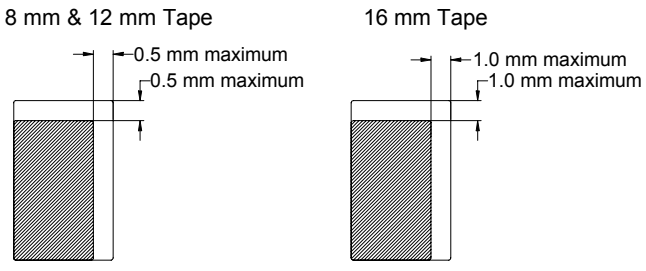


Figure 5 – Bending Radius

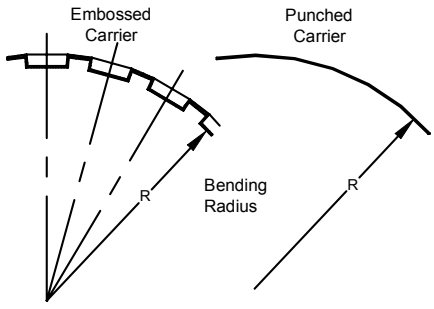
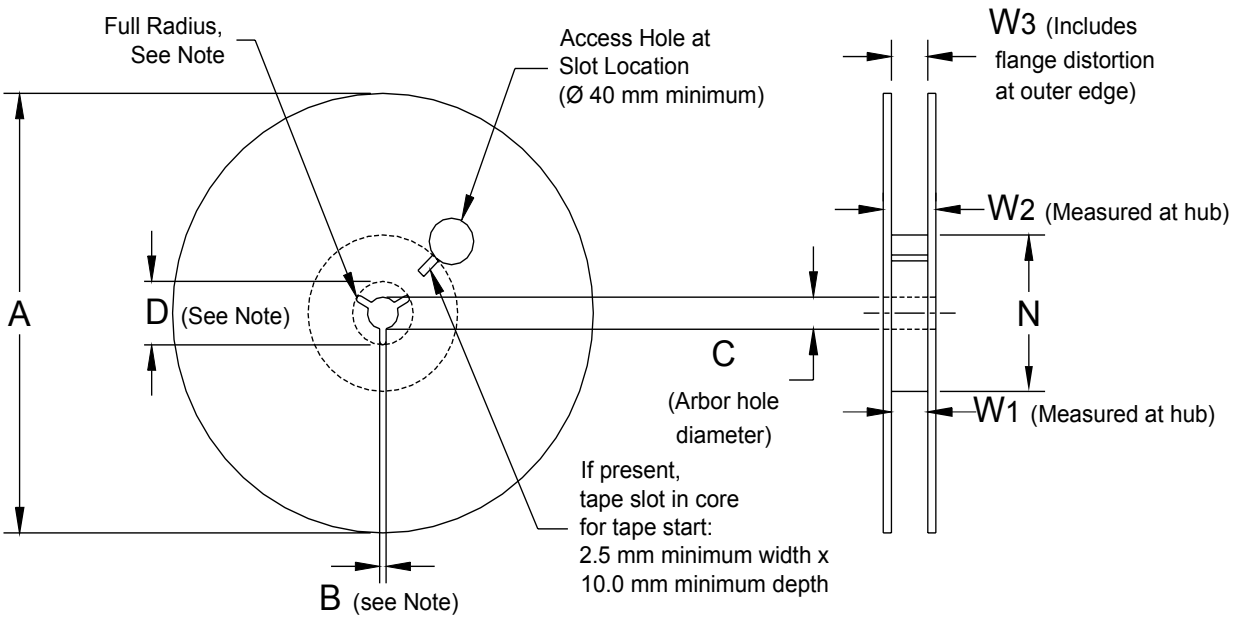


Figure 6 – Reel Dimensions



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

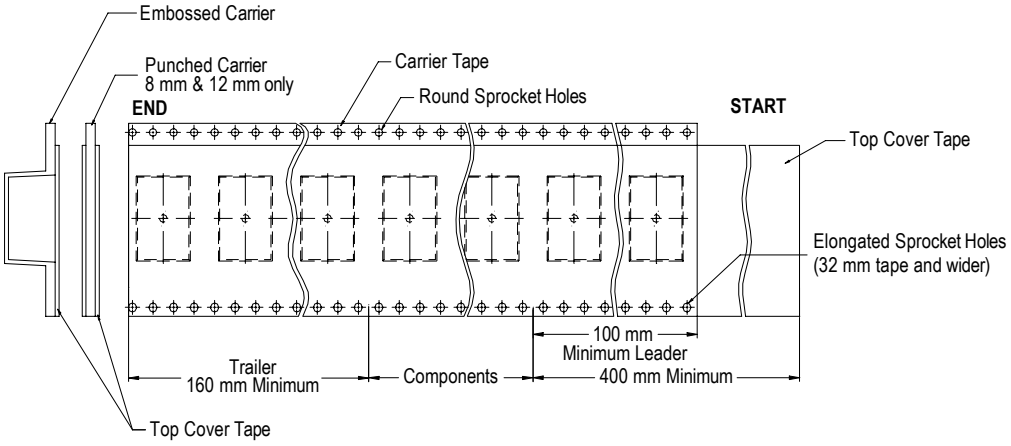
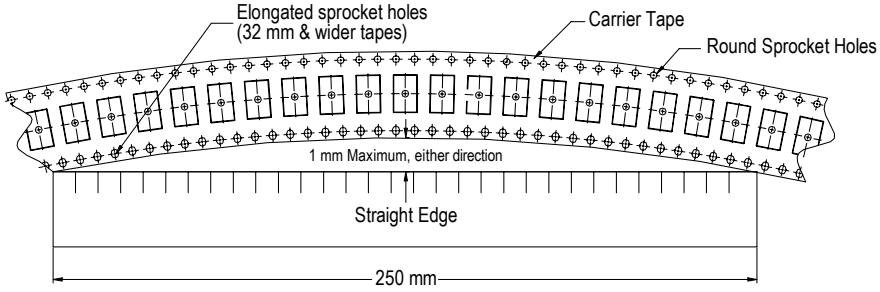


Figure 8 – Maximum Camber



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.

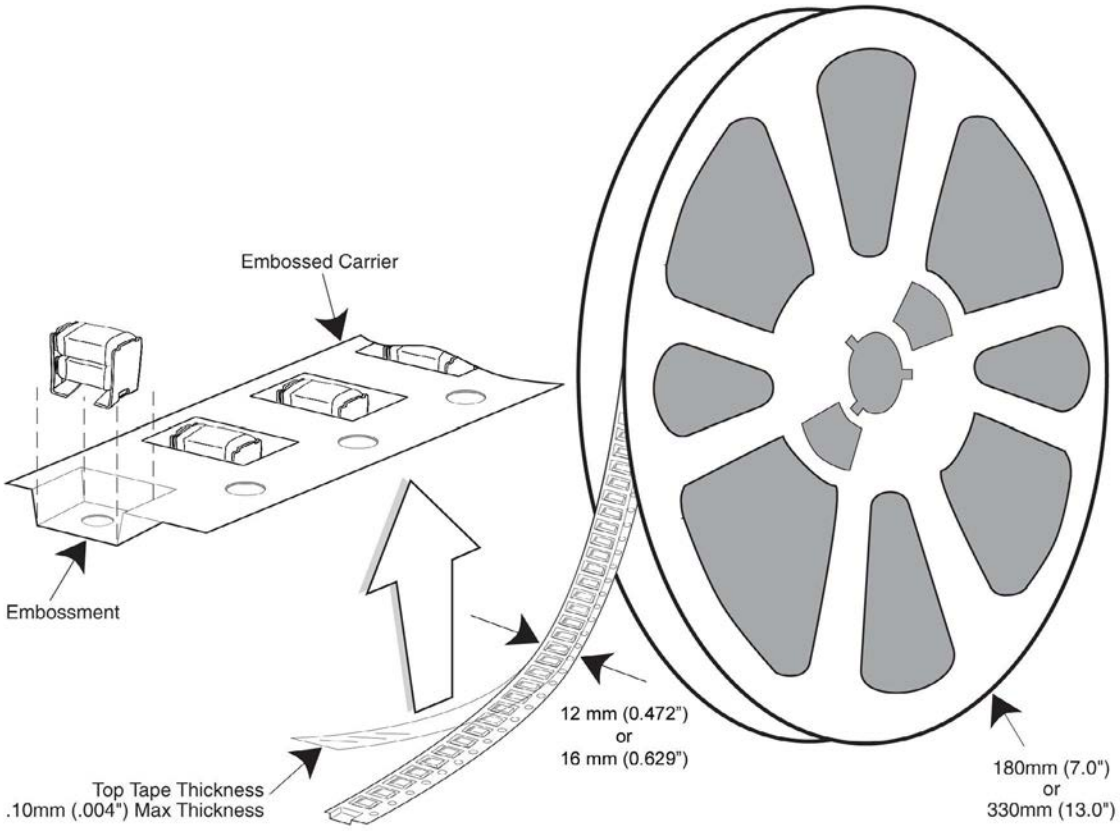


Table 5 – Carrier Tape Configuration – Embossed Plastic (mm)

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

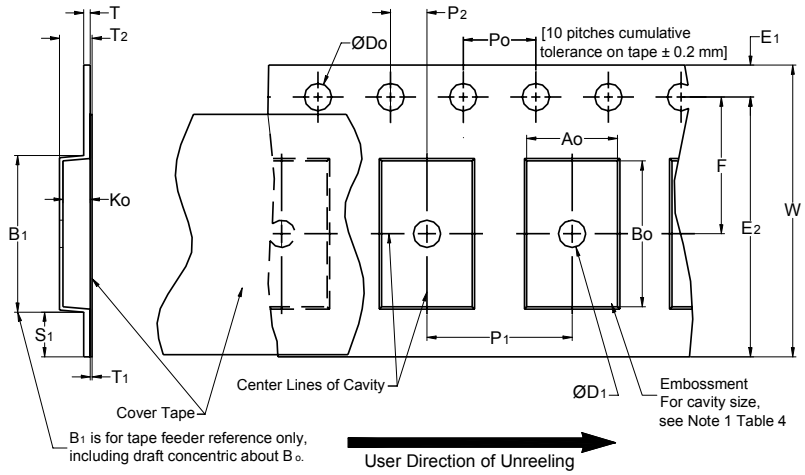


Table 6 – Embossed (Plastic) Carrier Tape Dimensions

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

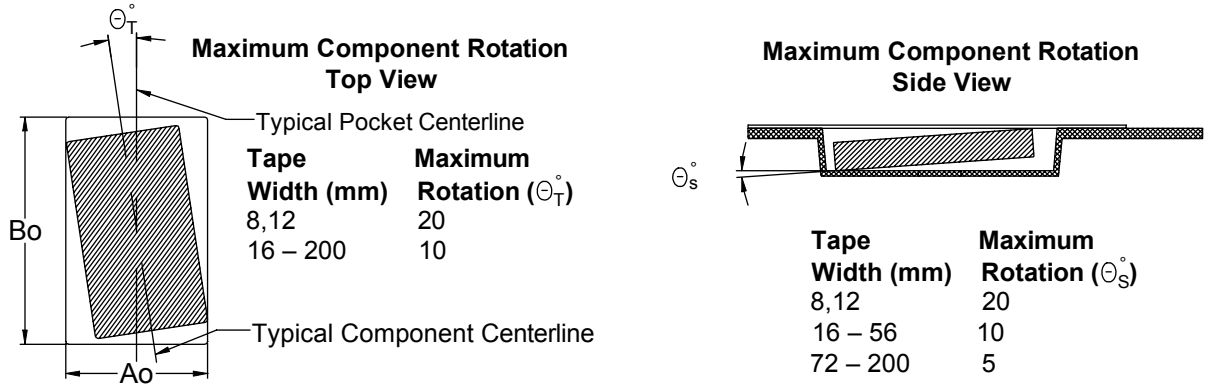


Figure 3 – Maximum Lateral Movement

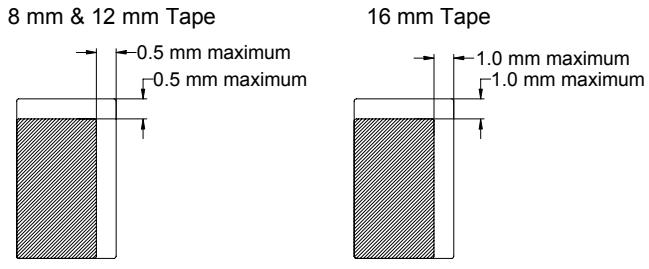


Figure 4 – Bending Radius

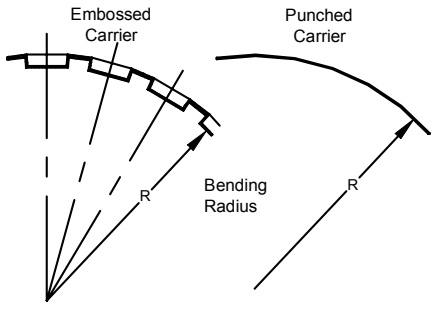
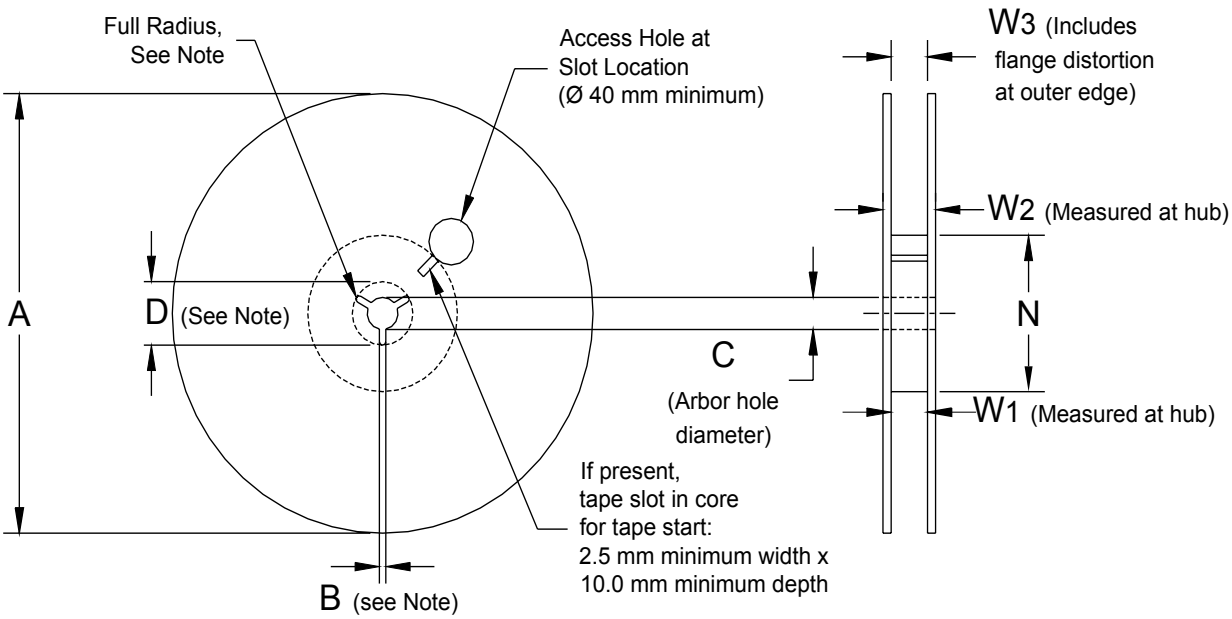


Figure 5 – Reel Dimensions



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

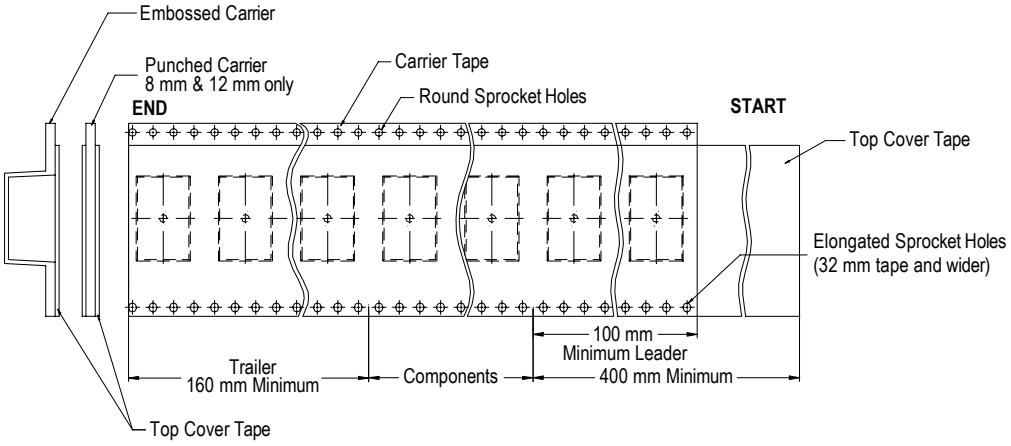
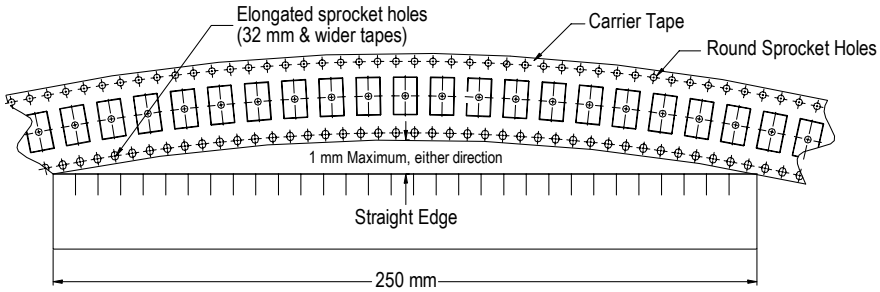


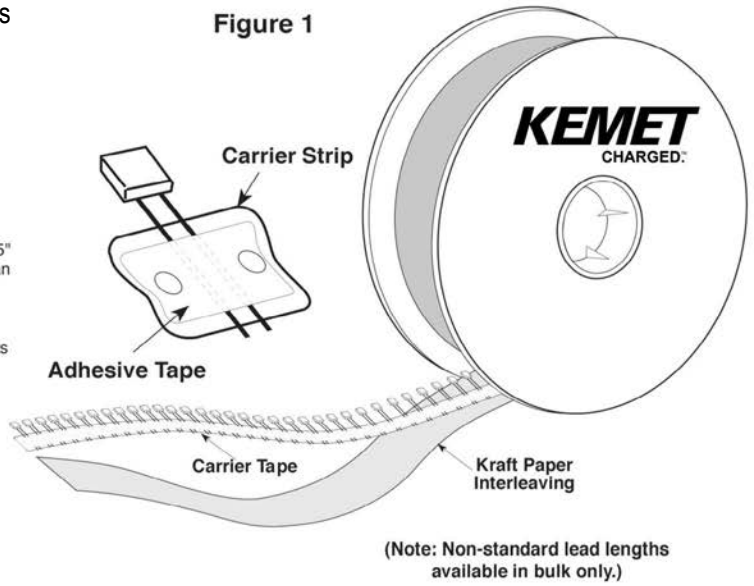
Figure 7 – Maximum Camber



Lead Tape & Reel Packaging Information – Radial Through-Hole Devices

KEMET offers standard reeling of Molded Radial Leaded Capacitors in accordance with EIA standard 468. Parts are taped to a tag board carrier strip, and wound on a reel as shown in Figure 1. Kraft paper interleaving is inserted between the layers of capacitors on the reel.

Figure 1



(Note: Non-standard lead lengths available in bulk only.)

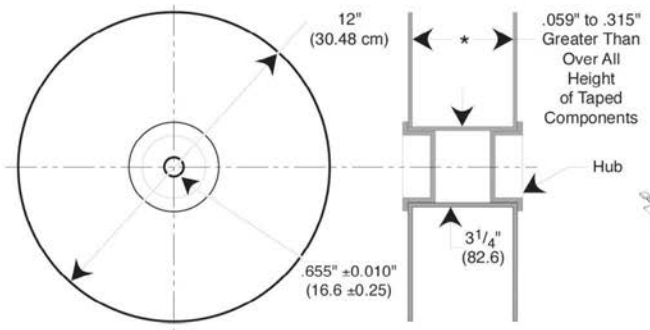


Figure 3: Standard Reel

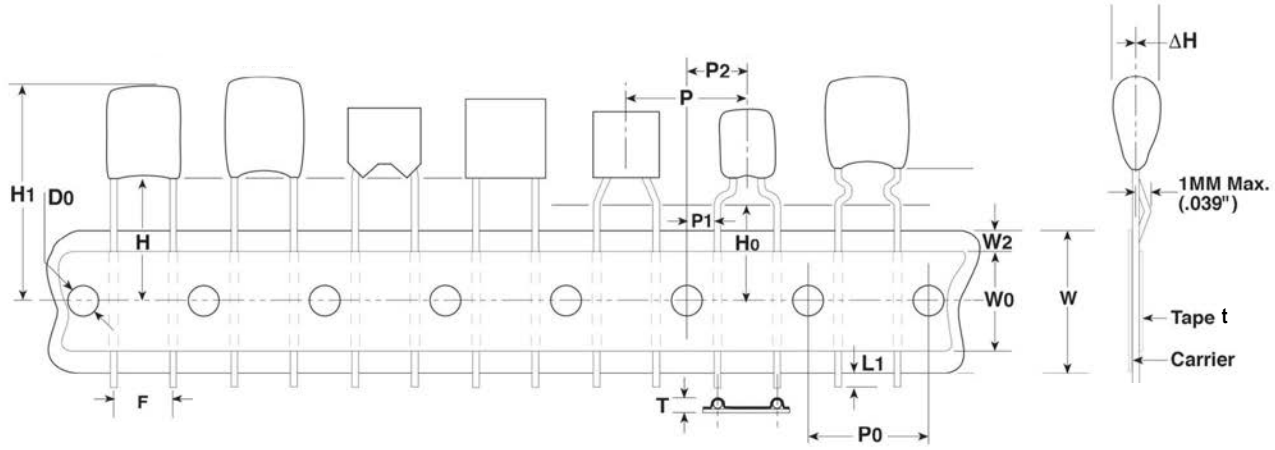


Table 3 – Ceramic Radial Tape and Reel Dimensions

Metric will govern

Constant Dimensions — Millimeters (Inches)										
D_0 ±0.2 (0.008)	P_0 ±0.3 (0.012)	P ±0.3 (0.012)	P_2 ±0.7 (0.028)	ΔH Maximum	L_1 Maximum	t Maximum	T Maximum	W + 1.0/- 0.5 (+0.039/-0.020)	W_0 Minimum	W_2 Maximum
4.00 (0.157)	12.7 (0.500)	12.7 (0.500)	6.35 (0.250)	1.0 (0.039)	1.0 (0.039)	0.9 (0.035)	2.0 (0.079)	18.0 (0.709)	5.0 (0.197)	3.0 (0.118)

Variable Dimensions — Millimeters (Inches)			
F +0.6 (0.024) -0.2 (0.008) Note 1	P_1 ±0.7 (0.028) Note 1	H Minimum Note 2	H_0 ±0.5 (0.630) Note 3
2.54 (0.100)	5.08 (0.200)	18.0 (0.709)	16.0 (0.024)
4.32 (0.170)	3.89 (0.153)		
5.08 (0.200)	3.81 (0.150)		
5.59 (0.220)	3.25 (0.128)		
6.98 (0.275)	2.54 (0.100)		
7.62 (0.300)	2.24 (0.088)		
9.52 (0.375)	7.62 (0.300)		
10.16 (0.400)	7.34 (0.290)		
12.06 (0.475)	6.35 (0.250)		
14.60 (0.575)	5.08 (0.200)		
17.14 (0.675)	3.81 (0.15)		

Symbol Reference Table	
D_0	Sprocket Hole Diameter
P_0	Sprocket Hole Pitch
P	Component Pitch
F	Lead Spacing
P_1	Sprocket Hole Center to Adjacent Component Lead
P_2	Sprocket Hole Center to Component Center
H	Height to Seating Plane (Straight Leads Only)
H_0	Height to Seating Plane (Formed Leads Only)
H_1	Component Height Above Tape Center
ΔH	Component Alignment
L_1	Lead Protrusion
t	Composite Tape Thickness
W	Carrier Tape Width
W_0	Hold-Down Tape Width
W_2	Hold-Down Tape Location

1. Measured at the egress from the carrier tape, on the component side.

2. Straight Lead configuration part types only.

3. Formed (bent) lead configuration part types only.

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Although KEMET designs and manufactures its products to the most stringent quality and safety standards, given the current state of the art, isolated component failures may still occur. Accordingly, customer applications which require a high degree of reliability or safety should employ suitable designs or other safeguards (such as installation of protective circuitry or redundancies) in order to ensure that the failure of an electrical component does not result in a risk of personal injury or property damage.

Although all product–related warnings, cautions and notes must be observed, the customer should not assume that all safety measures are indicted or that other measures may not be required.

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