

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

Overview

KPS HV (KEMET Power Solutions, High Voltage), Large Case (≥ 1515), SM Series capacitors in C0G dielectric are designed to meet robust performance standards required in higher reliability industrial applications. Utilizing lead-frame technology, SM Series devices isolate the multilayer ceramic chip component from the printed circuit board providing advanced mechanical and thermal stress performance. Isolation of the chip component also addresses concerns for audible, microphonic noise that may occur when a bias voltage is applied. Although this technology does not eliminate the potential for mechanical damage that may propagate during extreme environmental and handling conditions, it does demonstrate superior performance over non-isolating systems. Available in both formed "L" and "J" lead configurations, SM Series devices

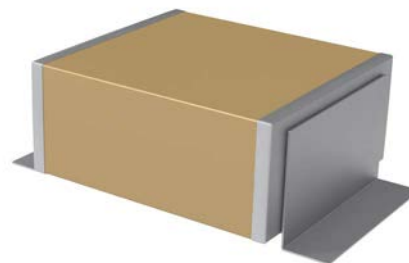
offer up to 10 mm of board flex capability and exhibit lower ESR, ESL and higher current discharge capability when compared to other dielectric solutions.

Combined with the stability of an C0G dielectric, KEMET's High Voltage SM Series devices exhibit no change in capacitance with respect to time and voltage and boasts a negligible change in capacitance with reference to ambient temperature. Capacitance change is limited to ± 30 ppm/°C from -55°C to $+125^{\circ}\text{C}$.

KEMET's Industrial Grade products offer additional screening options for higher reliability applications. Both Group A and Group B testing/inspection options per MIL-PRF-49467 are available for the SM Series.

Benefits

- -55°C to $+125^{\circ}\text{C}$ operating temperature range
- Large Case Sizes (≥ 1515)
- Formed "L" or "J" leadframe configurations.
- Group A and B screening per MIL-PRF-49467 available
- Reliable and robust leadframe termination system
- DC voltage ratings of 500 V, 1 KV, 2 KV, 3 KV, 4 KV, 5 KV, 7.5 KV, and 10 KV
- Capacitance offerings ranging from 10 pF up to 0.39 μF



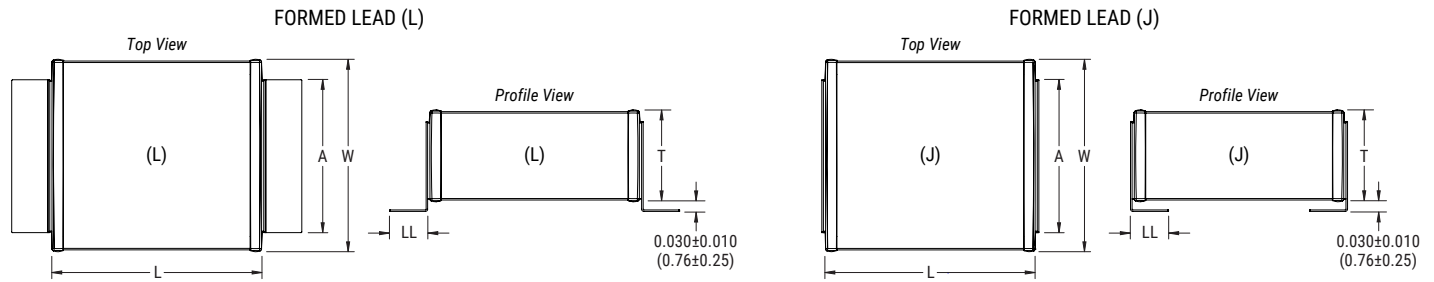
Ordering Information

SM20		N	472	J	501	B	M
Style/Size		Dielectric	Capacitance Code (pF)	Capacitance Tolerance	Rated Voltage (VDC)	Lead Configuration ¹	Testing/ Inspection Option ²
SM20	SM30	N = C0G	Two significant digits and number of zeros	J = $\pm 5\%$ K = $\pm 10\%$ M = $\pm 20\%$	501 = 500	A = Formed "L" B = Formed "J"	Blank = None M = Group A per MIL-PRF-49467
SM21	SM31				102 = 1,000		
SM22	SM33				202 = 2,000		
SM23	SM34				302 = 3,000		
SM24	SM35				402 = 4,000		
SM25	SM36				502 = 5,000		
SM26					752 = 7,500 103 = 10,000		

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

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

Dimensions – Inches (Millimeters)



Style/ Size	L Length	W Width	T Thickness Maximum	A Lead Width Maximum	LL Lead Length (Formed "L")	LL Lead Length (Formed "J")
SM20	0.150±0.015 (3.81±0.38)	0.150±0.015 (3.81±0.38)	0.130 (3.30)	0.100 (2.54)	0.100±0.020 (2.54±0.51)	0.040±0.010 (1.02±0.25)
SM21	0.200±0.020 (5.08±0.51)	0.200±0.020 (5.08±0.51)	0.180 (4.57)			
SM22	0.250±0.020 (6.35±0.51)	0.200±0.020 (5.08±0.51)				
SM23	0.350±0.030 (8.89±0.76)	0.300±0.030 (7.62±0.76)	0.220 (5.59)	0.200 (5.08)		0.100±0.020 (2.54±0.51)
SM24	0.450±0.030 (11.43±0.76)	0.400±0.030 (10.20±0.76)		0.300 (7.62)		
SM25	0.550±0.030 (14.00±0.76)	0.500±0.030 (12.70±0.76)		0.400 (10.20)		
SM26	0.650±0.030 (16.50±0.76)	0.600±0.030 (15.20±0.76)		0.500 (12.70)		
SM30	0.300±0.030 (7.62±0.76)	0.150±0.015 (3.81±0.38)	0.140 (3.55)	0.100 (2.54)		
SM31	0.400±0.030 (10.20±0.76)	0.200±0.020 (5.08±0.51)	0.130 (3.30)			
SM33	0.700±0.030 (17.08±0.76)	0.300±0.030 (7.62±0.76)	0.180 (4.57)	0.200 (5.08)		
SM34	0.900±0.030 (22.90±0.76)	0.400±0.030 (10.20±0.76)	0.220 (5.59)	0.300 (7.62)		
SM35	1.100±0.030 (27.90±0.76)	0.500±0.030 (12.70±0.76)		0.400 (10.2)		
SM36	1.350±0.030 (33.00±0.76)	0.600±0.030 (15.20±0.76)		0.500 (12.7)		

Benefits cont'd

- Advanced protection against thermal and mechanical stress
- Provides up to 10 mm of board flex capability
- Reduces audible, microphonic noise
- Low ESR and ESL
- Non-polar device, minimizing installation concerns
- Silver plated copper alloy leadframe termination system

Applications

Typical applications include switch mode power supplies (input filters, resonators, tank circuits, snubber circuits, output filters), high voltage coupling and DC blocking, voltage multiplier circuits, DC/DC converters and coupling capacitors in Ćuk converters, noise reduction (piezoelectric/mechanical), circuits with a direct battery or power source connection, critical and safety relevant circuits without (integrated) current limitation and any application that is subject to high levels of board flexure or temperature cycling. Markets include power supply, LCD fluorescent backlight ballasts, HID lighting, telecom equipment, industrial and medical equipment/control and Military.

Qualification/Certification

Industrial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 3, Performance & Reliability.

Environmental Compliance

RoHS Compliant with Exemption(s).

Electrical Parameters/Characteristics

Item	Parameters/Characteristics
Operating Temperature Range	-55°C to +125°C
Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC)	±30 ppm/°C
Aging Rate (Maximum % Capacitance Loss/Decade Hour)	0%
Dielectric Withstanding Voltage (DWV)	150% of rated voltage for voltage rating of ≤ 1,250 VDC 120% of rated voltage for voltage rating of > 1,250 VDC (5±1 seconds and charge/discharge not exceeding 50 mA)
Dissipation Factor (DF) Maximum Limit at 25°C	0.15%
Insulation Resistance (IR) Limit at 25°C	1,000 megohm microfarads or 100 GΩ (Rated voltage DC applied for 120±5 seconds at 25°C for voltage rating of ≤ 500 VDC) (500 VDC applied for 120±5 seconds at 25°C for voltage rating of > 500 VDC)

To obtain IR limit, divide MQ-μF value by the capacitance and compare to GΩ limit. Select the lower of the two limits.

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

1 MHz ±100 kHz and 1.0 Vrms ±0.2 V if capacitance ≤ 100 pF

1 kHz ±50 Hz and 1.0 Vrms ±0.2 V if capacitance > 100 pF

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

Post Environmental Limits

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

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

Style/Size	SM33							SM34							SM35							Capacitance Tolerance			
Dimensions – inches (mm)																									
Length	0.700 ± 0.030 (17.08 ± 0.76)							0.900 ± 0.030 (22.90 ± 0.76)							1.100 ± 0.030 (27.90 ± 0.76)										
Width	0.300 ± 0.030 (7.62 ± 0.76)							0.400 ± 0.030 (10.20 ± 0.76)							0.500 ± 0.030 (12.70 ± 0.76)										
Thickness Maximum	0.180 (4.57)							0.220 (5.59)							0.220 (5.59)										
Lead Width Maximum	0.200 (5.08)							0.300 (7.62)							0.400 (10.2)										
Lead Length "L"	0.100 ± 0.020 (2.54 ± 0.51)							0.100 ± 0.020 (2.54 ± 0.51)							0.100 ± 0.020 (2.54 ± 0.51)										
Lead Length "J"	0.100 ± 0.020 (2.54 ± 0.51)							0.100 ± 0.020 (2.54 ± 0.51)							0.100 ± 0.020 (2.54 ± 0.51)										
COG Dielectric																									
Voltage Code	501	102	202	302	402	502	752	501	102	202	302	402	502	752	103	501	102	202	302	402	502	752	103	Capacitance Tolerance	
Voltage DC	500	1 K	2 K	3 K	4 K	5 K	7.5 K	500	1 K	2 K	3 K	4 K	5 K	7.5 K	10 K	500	1 K	2 K	3 K	4 K	5 K	7.5 K	10 K		
Capacitance	Capacitance Code																								
27 pF						270	270																	470	
33 pF						330	330																		
39 pF						390	390								390	390									
47 pF						470	470					470	470	470	470										
56 pF						560	560			560	560	560	560	560	560										
68 pF						680	680	680	680	680	680	680	680	680	680										
82 pF	820	820	820	820	820	820	820	820	820	820	820	820	820	820	820										
100 pF	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101										
120 pF	121	121	121	121	121	121	121	121	121	121	121	121	121	121	121										
150 pF	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151		
180 pF	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181		
220 pF	221	221	221	221	221	221	221	221	221	221	221	221	221	221	221	221	221	221	221	221	221	221	221		
270 pF	271	271	271	271	271	271	271	271	271	271	271	271	271	271	271	271	271	271	271	271	271	271	271		
330 pF	331	331	331	331	331	331	331	331	331	331	331	331	331	331	331	331	331	331	331	331	331	331	331		
390 pF	391	391	391	391	391	391	391	391	391	391	391	391	391	391	391	391	391	391	391	391	391	391	391		
470 pF	471	471	471	471	471	471	471	471	471	471	471	471	471	471	471	471	471	471	471	471	471	471	471		
560 pF	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561	561		
680 pF	681	681	681	681	681	681	681	681	681	681	681	681	681	681	681	681	681	681	681	681	681	681	681		
820 pF	821	821	821	821	821	821	821	821	821	821	821	821	821	821	821	821	821	821	821	821	821	821	821		
1,000 pF	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102		
1,200 pF	122	122	122	122	122	122		122	122	122	122	122	122	122		122	122	122	122	122	122	122	122		
1,500 pF	152	152	152	152	152	152		152	152	152	152	152	152	152		152	152	152	152	152	152	152	152		
1,800 pF	182	182	182	182	182	182		182	182	182	182	182	182	182		182	182	182	182	182	182	182	182		
2,200 pF	222	222	222	222	222	222		222	222	222	222	222	222	222		222	222	222	222	222	222	222	222		
2,700 pF	272	272	272	272	272	272		272	272	272	272	272	272	272		272	272	272	272	272	272	272	272		
3,300 pF	332	332	332	332				332	332	332	332					332	332	332	332	332	332	332	332		
3,900 pF	392	392	392	392				392	392	392	392					392	392	392	392	392	392	392	392		
4,700 pF	472	472	472	472				472	472	472	472					472	472	472	472						
5,600 pF	562	562	562	562				562	562	562	562					562	562	562	562						
6,800 pF	682	682	682	682				682	682	682	682					682	682	682	682						
8,200 pF	822	822	822					822	822	822	822					822	822	822	822						
0.01 µF	103	103	103					103	103	103	103					103	103	103	103						
0.012 µF	123	123	123					123	123	123	123					123	123	123	123						
0.015 µF	153	153	153					153	153	153	153					153	153	153	153						
0.018 µF	183	183	183					183	183	183						183	183	183	183						
0.022 µF	223	223						223	223	223						223	223	223	223						
0.027 µF	273	273						273	273							273	273	273							
0.033 µF	333	333						333	333							333	333	333							
0.039 µF	393	393						393	393							393	393	393							
0.047 µF	473	473						473	473							473	473	473							
0.056 µF	563							563	563							563	563								
0.068 µF	683							683								683	683								
0.082 µF	823							823								823	823								
0.1 µF	104							104								104	104								
0.12 µF								124								124	124								
0.15 µF								154								154	154								
0.18 µF																184									
0.22 µF																224									
0.27 µF																274									

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

Style/Size		SM36							
Dimensions – inches (mm)									
Length	1.350 ± 0.030 (33.00 ± 0.76)								
Width	0.600 ± 0.030 (15.20 ± 0.76)								
Thickness Maximum	0.220 (5.59)								
Lead Width Maximum	0.500 (12.7)								
Lead Length "L"	0.100 ± 0.020 (2.54 ± 0.51)								
Lead Length "J"	0.100 ± 0.020 (2.54 ± 0.51)								
COG Dielectric									
Voltage Code	501	102	202	302	402	502	752	103	Capacitance Tolerance
Voltage DC	500	1K	2K	3K	4K	5K	7.5K	10K	
Capacitance	Capacitance Code								
120 pF					121	121	121		J, K, M, P, Z
150 pF	151	151	151	151	151	151	151		
180 pF	181	181	181	181	181	181	181		
220 pF	221	221	221	221	221	221	221		
270 pF	271	271	271	271	271	271	271		
330 pF	331	331	331	331	331	331	331		
390 pF	391	391	391	391	391	391	391		
470 pF	471	471	471	471	471	471	471		
560 pF	561	561	561	561	561	561	561		
680 pF	681	681	681	681	681	681	681		
820 pF	821	821	821	821	821	821	821		
1,000 pF	102	102	102	102	102	102	102	102	
1,200 pF	122	122	122	122	122	122	122		
1,500 pF	152	152	152	152	152	152	152	152	
1,800 pF	182	182	182	182	182	182	182		
2,200 pF	222	222	222	222	222	222	222		
2,700 pF	272	272	272	272	272	272	272		
3,300 pF	332	332	332	332	332	332	332		
3,900 pF	392	392	392	392	392	392			
4,700 pF	472	472	472	472	472	472			
5,600 pF	562	562	562	562	562	562			
6,800 pF	682	682	682	682	682	682			
8,200 pF	822	822	822	822	822				
0.01 µF	103	103	103	103	103				
0.012 µF	123	123	123	123					
0.015 µF	153	153	153	153					
0.018 µF	183	183	183	183					
0.022 µF	223	223	223	223					
0.027 µF	273	273	273	273					
0.033 µF	333	333	333	333					
0.039 µF	393	393	393						
0.047 µF	473	473	473						
0.056 µF	563	563	563						
0.068 µF	683	683							
0.082 µF	823	823							
0.1 µF	104	104							
0.12 µF	124	124							
0.15 µF	154	154							
0.18 µF	184								
0.22 µF	224								
0.27 µF	274								
0.33 µF	334								
0.39 µF	394								

J, K, M, P, Z

Table 2 – Chip Thickness/Packaging Quantities

Series	Style/Size	Tray Quantity Minimum ¹	Tray Quantity Maximum ¹
SM	SM20	1	50
	SM21		
	SM22		
	SM23		
	SM24		
	SM25		
	SM26		
	SM30		25
	SM31		
	SM33		10
	SM34		
	SM35		
	SM36		

¹ Minimum order value applies. Contact KEMET for details.

Soldering Process

The capacitors and assemblies outlined in this specification sheet are susceptible to thermal shock damage due to their large ceramic mass. Temperature profiles used should provide adequate temperature rise and cool-down time to prevent damage from thermal shock. In general, KEMET recommends against hand soldering for these types of large ceramic devices.

Recommended Soldering Technique:

- Solder reflow only

Preheating and Reflow Profile Notes:

Due to differences in the coefficient of thermal expansion for the different materials of construction, it is critical to monitor and control the heating and cooling rates during the soldering process. During the reflow soldering process, the maximum recommended heating and cooling rate (dT/dt) is 4°C/second. To ensure optimal component reliability, KEMET's recommended heating and cooling rate is 2°C/second. After soldering, the capacitors should be air cooled to room temperature before further processing. Forced air cooling is not recommended.

Recommended Reflow Soldering Profile:

Profile Feature	SnPb Assembly
Preheat/Soak	
Temperature Minimum (T_{smin})	100°C
Temperature Maximum (T_{smax})	150°C
Time (t_s) from T_{smin} to T_{smax}	60 – 90 seconds
Ramp-up Rate (T_L to T_p)	2°C/seconds
Liquidous Temperature (T_L)	183°C
Time Above Liquidous (t_L)	95 seconds
Peak Temperature (T_p)	240°C
Time within 5°C of Maximum Peak Temperature (t_p)	5 seconds
Ramp-down Rate (T_p to T_L)	2°C/seconds
Time 25°C to Peak Temperature	3.5 minutes

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

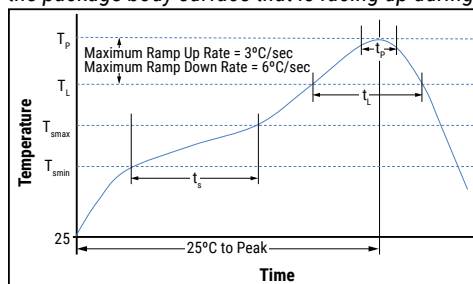


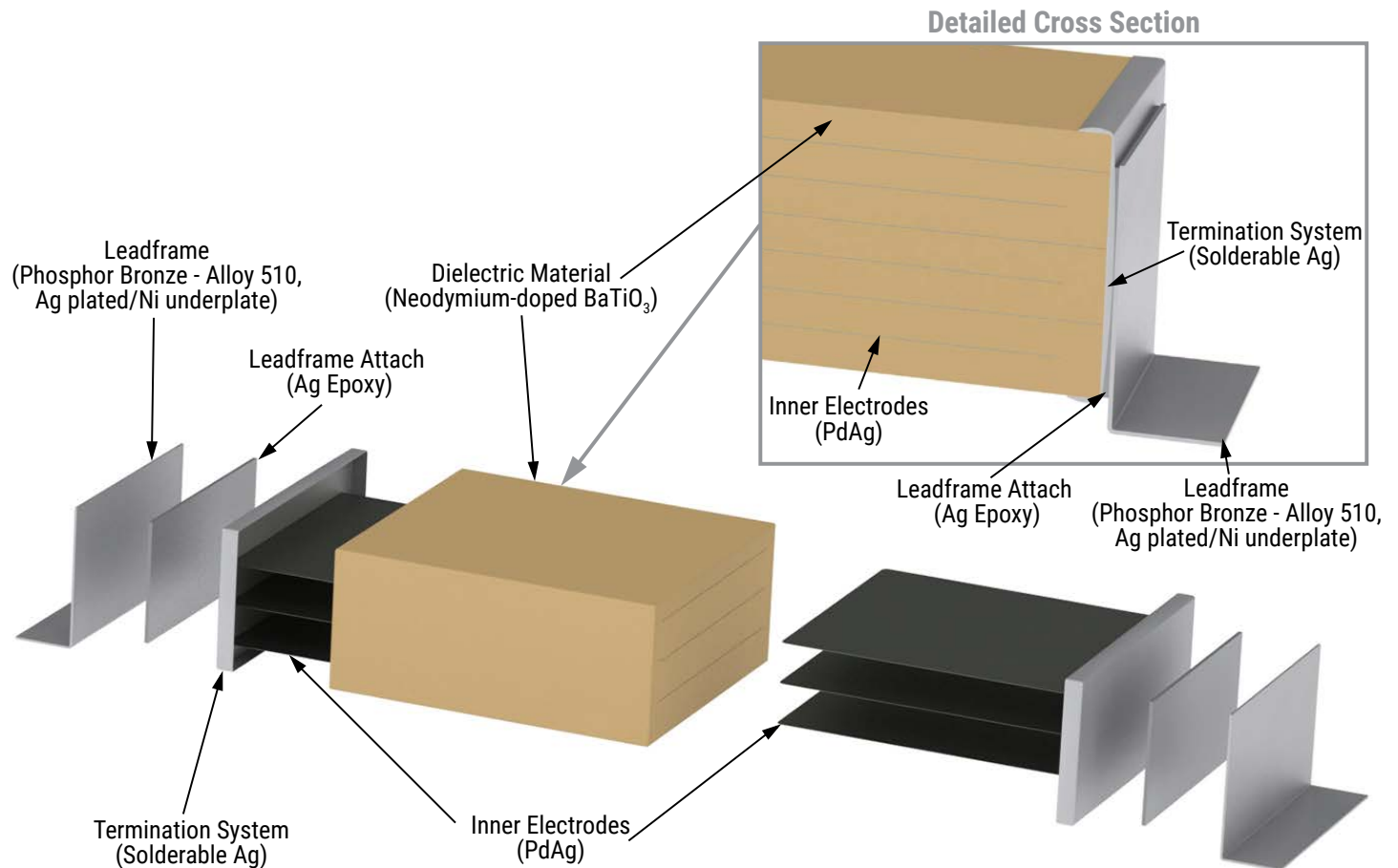
Table 3 – Performance & Reliability: Test Methods and Conditions

Stress	Reference	Test or Inspection Method
Board Flex	JIS-C-6429	Appendix 2, Note: 2 mm (minimum) for all except 3 mm for COG.
Solderability	J-STD-002	Magnification 50 X. Conditions:
		a) Method B, 4 hours at 155°C, dry heat at 235°C
		b) Method B at 215°C category 3
		c) Method D, category 3 at 260°C
		1,000 cycles (-55°C to +125°C). Measurement at 24 hours +/- 2 hours after test conclusion.
Biased Humidity	MIL-STD-202 Method 103	Load Humidity: 1,000 hours 85°C/85% RH and 300 VDC Maximum Add 100 K ohm resistor. Measurement at 24 hours +/- 2 hours after test conclusion.
		Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours +/- 2 hours after test conclusion.
		t = 24 hours/cycle. Steps 7a and 7b not required. Unpowered. Measurement at 24 hours +/- 2 hours after test conclusion.
Thermal Shock	MIL-STD-202 Method 107	-55°C/+125°C. Note: Number of cycles required – 300. Maximum transfer time – 20 seconds. D14 dwell time – 15 minutes. Air – Air.
High Temperature Life	MIL-STD-202 Method 108 /EIA -198	1,000 hours at 125°C (85°C for X5R, Z5U and Y5V) with rated voltage applied.
Storage Life	MIL-STD-202 Method 108	150°C, 0 VDC, for 1,000 hours.
Vibration	MIL-STD-202 Method 204	5 g for 20 minutes, 12 cycles each of 3 orientations. Note: Use 8 "X5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10–2,000 Hz.
Resistance to Soldering Heat	MIL-STD-202 Method 210	Condition B. No preheat of samples. Note: single wave solder – procedure 2.
Terminal Strength	MIL-STD-202 Method 211	Conditions A (2.3 kg or 5 lbs).
Mechanical Shock	MIL-STD-202 Method 213	Figure 1 of Method 213, Condition F.
Resistance to Solvents	MIL-STD-202 Method 215	Add aqueous wash chemical, OKEM Clean or equivalent.

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature—reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 40°C and maximum storage humidity not exceed 70% relative humidity. Temperature fluctuations should be minimized to avoid condensation on the parts and atmospheres should be free of chlorine and sulfur bearing compounds. For optimized solderability chip stock should be used promptly, preferably within 1.5 years of receipt.

Construction



Product Marking

Product marking is an extra-cost option. These devices will be supplied unmarked unless otherwise specified and/or requested. For more detailed information regarding marked product and how to request this option, please contact KEMET.

KEMET Electronic Corporation Sales Offices

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Disclaimer

All product specifications, statements, information and data (collectively, the "Information") in this datasheet are subject to change. The customer is responsible for checking and verifying the extent to which the Information contained in this publication is applicable to an order at the time the order is placed.

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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 indicated or that other measures may not be required.

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