

# HV Series, Radial, Conformally Coated, High Temperature 200°C, 500 – 4,000 VDC (Industrial Grade)

## Overview

KEMET's High Voltage and High Temperature 200°C HV Series radial conformally coated ceramic 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, EV charging stations and defense applications.

Available in C0G and X7R dielectrics, these devices are well suited for timing, resonant, bypass, and decoupling applications.

## Benefits

- Operating temperature range of -55°C to +200°C
- High shock and vibration capability
- Capacitance range from 270 pF – 2.2 µF in X7R
- Capacitance range from 12 pF – 0.047 µF in C0G
- DC voltage ratings of 500 V, 1 kV, 2 kV, 3 kV, 4 kV
- High thermal stability
- Encapsulation meets flammability standard UL 94 V-0
- High-temperature solder meets EIA RS-198, Method 302, Condition B



## Applications

- Downhole exploration and mining
- Aerospace engine compartments
- Electric ballast
- Measuring equipment
- Inverter power supply

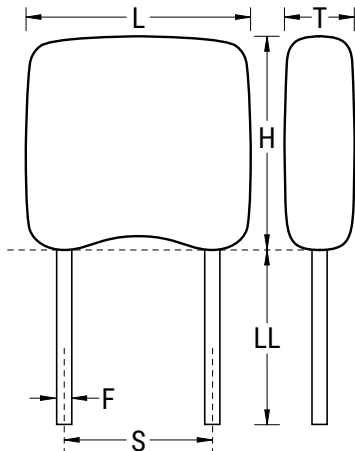
## Ordering Information

10	HV	12	N	472	K	N	M	
Voltage	Series	Style/Size	Dielectric	Capacitance Code (pF)	Capacitance Tolerance <sup>1</sup>	Lead Wire Barrier Layer <sup>2</sup>	Test Level	Packaging
05 = 500 V 10 = 1,000 V 20 = 2,000 V 30 = 3,000 V 40 = 4,000 V	HV	10 11 12 13 14 15 16	B, W = X7R type N = COG (NP0)	Two significant digits and number of zeros	J = ±5% K = ±10% M = ±20%	N = Nickel C = Copper	Blank = No screening M = MIL-PRF-49467 Group A Screening	Blank = Waffle Tray

<sup>1</sup> Additional capacitance tolerance offerings may be available. Contact KEMET for details.

<sup>2</sup> Please refer to the Construction section in the datasheet.

## Dimensions – Inches (Millimeters)



Series	Style/Size	Length (L)	Height (H)	Thickness (T)	Lead Spacing ±0.030 (S)	Lead Diameter (F)	Lead Length Minimum (LL)
HV	10	0.250 (6.35)	0.220 (5.59)	0.150 (3.81)	0.170 (4.32)	0.025 +0.004/-0.002 (0.635 +0.102/-0.051)	0.125 (3.175)
	11	0.320 (8.13)	0.300 (7.62)	0.250 (6.35)	0.200 (5.08)		
	12	0.420 (10.67)	0.400 (10.16)	0.250 (6.35)	0.300 (7.62)		
	13	0.520 (13.21)	0.500 (12.7)	0.300 (7.62)	0.400 (10.16)		
	14	0.620 (15.75)	0.500 (12.7)	0.300 (7.62)	0.500 (12.7)		
	15	0.720 (18.29)	0.700 (17.78)	0.300 (7.62)	0.600 (15.24)		
	16	0.820 (20.83)	0.700 (17.78)	0.350 (8.89)	0.700 (17.78)		

## Environmental Compliance

RoHS exemptions 7a & 7c-II apply to HV series parts that have nickel barrier layer leads.

All other parts are Not RoHS Compliant.

**Table 1A – HV 200°C Series X7R Waterfall**

Style		HV10			HV11			HV12			HV13			
Voltage		500	1k	2k	500	1k	2k	500	1k	2k	500	1k	2k	3k
Capacitance	Capacitance Code													
270 pF	271	X	X	X										
330 pF	331	X	X	X										
390 pF	391	X	X	X										
470 pF	471	X	X	X										
560 pF	561	X	X	X	X	X	X							
681 pF	681	X	X	X	X	X	X							
820 pF	821	X	X	X	X	X	X							
1,000 pF	102	X	X	X	X	X	X				X	X	X	X
1,200 pF	122	X	X	X	X	X	X	X	X	X	X	X	X	X
1,500 pF	152	X	X	X	X	X	X	X	X	X	X	X	X	X
1,800 pF	182	X	X	X	X	X	X	X	X	X	X	X	X	X
2,200 pF	222	X	X		X	X	X	X	X	X	X	X	X	X
2,700 pF	272	X	X		X	X	X	X	X	X	X	X	X	X
3,300 pF	332	X	X		X	X	X	X	X	X	X	X	X	X
3,900 pF	392	X	X		X	X	X	X	X	X	X	X	X	X
4,700 pF	472	X	X		X	X	X	X	X	X	X	X	X	X
5,600 pF	562	X	X		X	X	X	X	X	X	X	X	X	X
6,800 pF	682	X	X		X	X	X	X	X	X	X	X	X	X
8,200 pF	822	X	X		X	X	X	X	X	X	X	X	X	X
0.01 µF	103	X	X		X	X	X	X	X	X	X	X	X	X
0.012 µF	123	X			X	X	X	X	X	X	X	X	X	X
0.015 µF	153	X			X	X	X	X	X	X	X	X	X	X
0.018 µF	183	X			X	X		X	X	X	X	X	X	X
0.022 µF	223	X			X	X		X	X	X	X	X	X	X
0.027 µF	273	X			X	X		X	X	X	X	X	X	X
0.033 µF	333	X			X	X		X	X	X	X	X	X	X
0.039 µF	393				X	X		X	X		X	X	X	
0.047 µF	473				X	X		X	X		X	X	X	
0.056 µF	563				X	X		X	X		X	X	X	
0.068 µF	683				X	X		X	X		X	X	X	
0.082 µF	823				X	X		X	X		X	X	X	
0.1 µF	104				X			X	X		X	X		
0.12 µF	124				X			X	X		X	X		
0.15 µF	154				X			X	X		X	X		
0.18 µF	184				X			X	X		X	X		
0.22 µF	224				X			X			X	X		
0.27 µF	274				X			X			X	X		
0.33 µF	334							X			X	X		
0.39 µF	394										X	X		
0.47 µF	474										X			
0.56 µF	564										X			
0.68 µF	684										X			
0.82 µF	824										X			
0.1 µF	105										X			
0.033 µF	333													
0.039 µF	393													
0.047 µF	473													
0.056 µF	563													
0.068 µF	683													
0.082 µF	823													
0.1 µF	104													
<b>Voltage</b>		<b>500</b>	<b>1k</b>	<b>2k</b>	<b>500</b>	<b>1k</b>	<b>2k</b>	<b>500</b>	<b>1k</b>	<b>2k</b>	<b>500</b>	<b>1k</b>	<b>2k</b>	<b>3k</b>
<b>Style</b>		<b>HV10</b>			<b>HV11</b>			<b>HV12</b>			<b>HV13</b>			

**Table 1A – HV 200°C Series X7R Waterfall cont.**

Style		HV14					HV15					HV16				
Voltage		500	1k	2k	3k	4k	500	1k	2k	3k	4k	500	1k	2k	3k	4k
Capacitance	Capacitance Code															
1,800 pf	182															
2,200 pf	222	X	X	X	X	X										
2,700 pf	272	X	X	X	X	X	X	X	X	X						
3,300 pf	332	X	X	X	X	X	X	X	X	X						
3,900 pf	392	X	X	X	X	X	X	X	X	X						
4,700 pf	472	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5,600 pf	562	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
6,800 pf	682	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8,200 pf	822	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
0.01 µF	103	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
0.012 µF	123	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
0.015 µF	153	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
0.018 µF	183	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
0.022 µF	223	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
0.027 µF	273	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
0.033 µF	333	X	X	X	X		X	X	X	X	X	X	X	X	X	X
0.039 µF	393	X	X	X	X		X	X	X	X		X	X	X	X	X
0.047 µF	473	X	X	X	X		X	X	X	X		X	X	X	X	X
0.056 µF	563	X	X	X	X		X	X	X	X		X	X	X	X	
0.068 µF	683	X	X	X			X	X	X	X		X	X	X	X	
0.082 µF	823	X	X	X			X	X	X	X		X	X	X	X	
0.1 µF	104	X	X	X			X	X	X	X		X	X	X	X	
0.12 µF	124	X	X				X	X	X			X	X	X		
0.15 µF	154	X	X				X	X	X			X	X	X		
0.18 µF	184	X	X				X	X	X			X	X	X		
0.22 µF	224	X	X				X	X				X	X			
0.27 µF	274	X	X				X	X				X	X			
0.33 µF	334	X	X				X	X				X	X			
0.39 µF	394	X	X				X	X				X	X			
0.47 µF	474	X	X				X	X				X	X			
0.56 µF	564	X					X	X				X	X			
0.68 µF	684	X					X	X				X	X			
0.82 µF	824	X					X	X				X	X			
1 µF	105	X					X	X				X	X			
1.2 µF	125						X					X				
1.5 µF	155						X					X				
1.8 µF	185						X					X				
2.2 µF	225											X				
Voltage		500	1k	2k	3k	4k	500	1k	2k	3k	4k	500	1k	2k	3k	4k
Style		HV14					HV15					HV16				

**Table 1B – HV 200°C Series COG Waterfall**

Style		HV10			HV11				HV12				HV13			
Voltage		500	1k	2k	500	1k	2k	3k	500	1k	2k	3k	500	1k	2k	3k
Capacitance	Capacitance Code															
12 pf	120	X	X	X												
15 pf	150	X	X	X												
18 pf	180	X	X	X									X	X	X	X
22 pf	220	X	X	X	X	X	X	X					X	X	X	X
27 pf	270	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
33 pf	330	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
39 pf	390	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
47 pf	470	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
56 pf	560	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
68 pf	680	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
82 pf	820	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
100 pf	101	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
120 pf	121	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
150 pf	151	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
180 pf	181	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
220 pf	221	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
270 pf	271	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
330 pf	331	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
390 pf	391	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
470 pf	471	X	X		X	X	X	X	X	X	X	X	X	X	X	X
560 pf	561	X	X		X	X	X	X	X	X	X	X	X	X	X	X
680 pf	681	X	X		X	X	X	X	X	X	X	X	X	X	X	X
820 pf	821	X	X		X	X	X	X	X	X	X	X	X	X	X	X
1,000 pf	102	X	X		X	X	X	X	X	X	X	X	X	X	X	X
1,200 pf	122	X	X		X	X	X		X	X	X	X	X	X	X	X
1,500 pf	152	X	X		X	X	X		X	X	X	X	X	X	X	X
1,800 pf	182	X			X	X	X		X	X	X		X	X	X	X
2,200 pf	222	X			X	X	X		X	X	X		X	X	X	X
2,700 pf	272	X			X	X	X		X	X	X		X	X	X	X
3,300 pf	332				X	X			X	X	X		X	X	X	X
3,900 pf	392				X	X			X	X	X		X	X	X	X
4,700 pf	472				X	X			X	X	X		X	X	X	X
5,600 pf	562				X	X			X	X			X	X	X	
6,800 pf	682				X				X	X			X	X	X	
8,200 pf	822				X				X				X	X		
0.01 µF	103				X				X				X	X		
0.012 µF	123												X	X		
0.015 µF	153												X	X		
Voltage		500	1k	2k	500	1k	2k	3k	500	1k	2k	3k	500	1k	2k	3k
Style		HV10			HV11				HV12				HV13			

**Table 1B – HV 200°C Series COG Waterfall cont.**

Style		HV14					HV15					HV16				
Voltage		500	1k	2k	3k	4k	500	1k	2k	3k	4k	500	1k	2k	3k	4k
Capacitance	Capacitance Code															
68 pF	680	X	X	X	X	X										
82 pF	820	X	X	X	X	X										
100 pf	101	X	X	X	X	X						X	X	X	X	X
120 pf	121	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
150 pf	151	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
180 pf	181	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
220 pf	221	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
270 pf	271	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
330 pf	331	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
390 pf	391	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
470 pf	471	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
560 pf	561	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
680 pf	681	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
820 pf	821	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1,000 pf	102	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1,200 pf	122	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1,500 pf	152	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1,800 pf	182	X	X	X	X		X	X	X	X	X	X	X	X	X	
2,200 pf	222	X	X	X	X		X	X	X	X	X	X	X	X	X	
2,700 pf	272	X	X	X	X		X	X	X	X	X	X	X	X	X	
3,300 pf	332	X	X	X	X		X	X	X	X		X	X	X	X	
3,900 pf	392	X	X	X			X	X	X	X		X	X	X	X	
4,700 pf	472	X	X	X			X	X	X	X		X	X	X	X	
5,600 pf	562	X	X	X			X	X	X	X		X	X	X	X	
6,800 pf	682	X	X	X			X	X	X	X		X	X	X	X	
8,200 pf	822	X	X	X			X	X	X	X		X	X	X	X	
0.01 µF	103	X	X	X			X	X	X	X		X	X	X	X	
0.012 µF	123	X	X				X	X	X			X	X	X		
0.015 µF	153	X	X				X	X	X			X	X	X		
0.018 µF	183	X	X				X	X	X			X	X	X		
0.022 µF	223	X	X				X	X				X	X	X		
0.027 µF	273						X	X				X	X			
0.033 µF	333						X	X				X	X			
0.039 µF	393						X	X				X	X			
0.047 µF	473						X	X				X	X			
Voltage		500	1k	2k	3k	4k	500	1k	2k	3k	4k	500	1k	2k	3k	4k
Style		HV14					HV15					HV16				

## Packaging Quantities

Style	Waffle Pack Quantity
HV 10	56
HV 11	28
HV 12	28
HV 13	28
HV 14	20
HV 15	20
HV 16	20

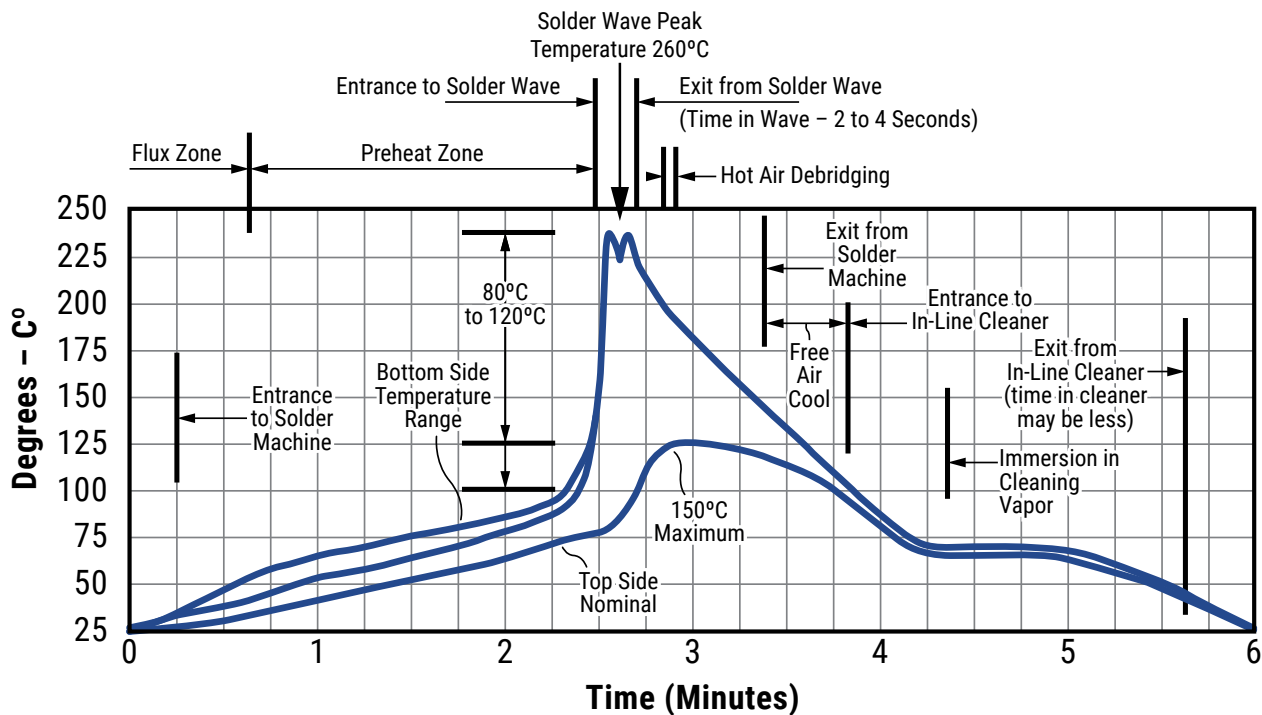
## Soldering Process

### Recommended Soldering Technique:

- Solder Wave
- Hand Soldering (Manual)

### Recommended Soldering Profile:

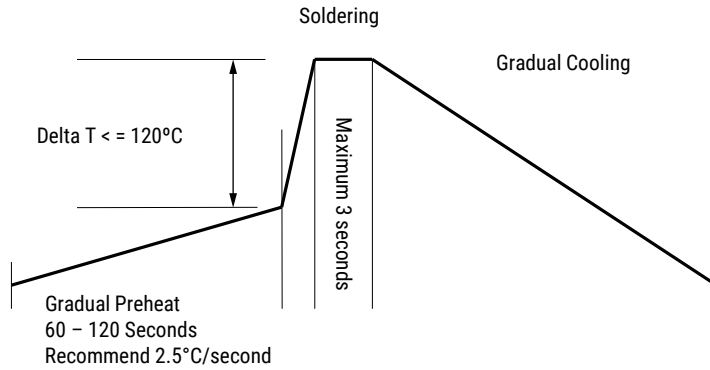
- Optimum Wave Solder Profile



## Soldering Process cont.

- 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	Limits
Visual & Mechanical	KEMET Internal	No defects that may affect performance (10X)	Dimensions according KEMET Spec Sheet
Capacitance (Cap)	"MIL-STD-202 Method 305"	C ≤ 100 pF: 1 MHz ± 100 kHz and 1.0 ± 0.2 Vrms C > 100 pF: 1 kHz ± 100 Hz and 1.0 ± 0.2 Vrms	Dimensions according KEMET Spec Sheet
Dissipation Factor (DF)	KEMET Internal	C ≤ 100 pF: 1 MHz ± 100 kHz and 1.0 ± 0.2 Vrms C > 100 pF: 1 kHz ± 100 Hz and 1.0 ± 0.2 Vrms	X7R: 2.5% COG: 0.15%
Insulation Resistance (IR)	"MIL-STD-202 Method 302"	500 VDC applied for 120 ± 5 seconds at 25°C	Within Specification To obtain IR limit, divide MΩ·μF value by the capacitance and compare to GΩ limit. Select the lower of the two limits. 1,000 MΩ microfarads or 100 GΩ, whichever is less.
Temperature Coefficient of Capacitance (TCC)	KEMET Internal	Capacitance change with reference to +25°C and 0 VDC applied. * See part number specification sheet for voltage	COG: 0 ppm/°C ± 30 ppm/°C X7R: ± 15%

Step	Temperature (°C)
1	+25°C
2	-55°C
3	+25°C (Reference)
4	+125°C



**Table 2 – Performance & Reliability: Test Methods and Conditions cont.**

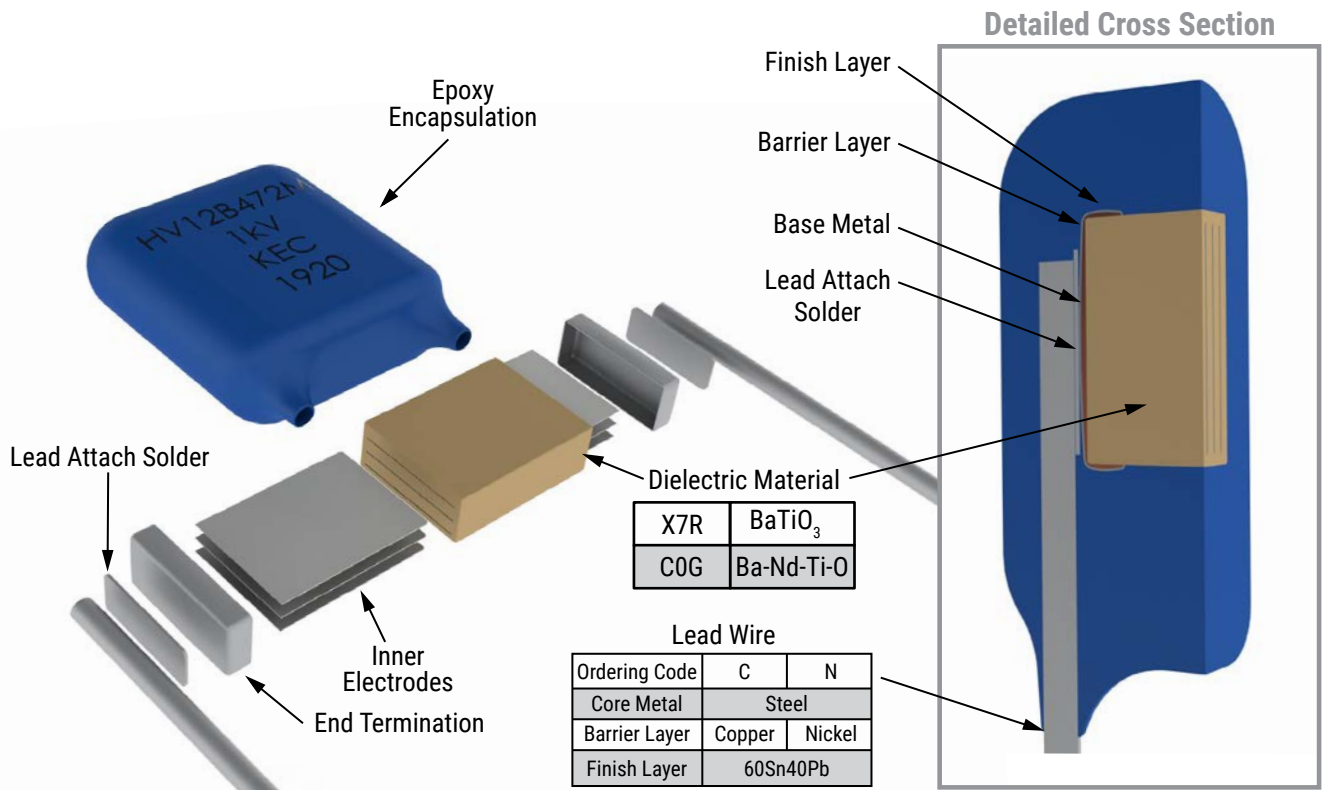
Dielectric Withstanding Voltage (DWV)	KEMET Internal	150% of rated voltage for voltage rating of $500\text{ V} \leq V < 1,000\text{ V}$ 120% of rated voltage for voltage rating of $\geq 1,000\text{ V}$ (5 $\pm$ 1 seconds and charge/discharge not exceeding 50 mA at 25°C)	Withstand test voltage without insulation breakdown or damage.
Aging Rate (Maximum % Capacitance Loss/Decade Hour)	KEMET Internal	Capacitance measurements (including tolerance) are indexed to a referee time of 48 or 1,000 hours. Please refer to a part number specific datasheet for referee time details.	Please refer to a part number specification sheet for specific Aging rate
Terminal Strength	MIL-STD-202 Method 211	Applied force: 5 pounds (2.3 kg)	No evidence of mechanical damage
Solderability	MIL-STD-202 Method 208	Condition: 4 hours $\pm$ 15 minutes at 155°C dry bake apply all methods Test 245 $\pm$ 5°C (SnPb & Pb-Free)	Visual Inspection. 95% coverage on termination. No leaching
Temperature Cycling	JESD22 Method JA-104	1,000 cycles (-55°C to +200°C) 2 - 3 cycles per hour Soak Time: 1 or 5 minutes	Measurement at 24 hours +/- 4 hours after test conclusion. Cap: Initial Limit DF: Initial Limit IR: Initial Limit
Biased Humidity	"MIL-STD-202 Method 103"	Load Humidity: 1,000 hours 85°C/85% RH and rated voltage.  Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V.	Measurement at 24 hours $\pm$ 4 hours after test conclusion. Within Post Environmental Limits  For C0G dielectric: Cap: $\pm$ 0.3% or $\pm$ 0.25 pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5%  For X7R dielectric: Cap: $\pm$ 20% shift IR: 10% of Initial Limit DF Limits Maximum: 3%
High Temperature Life	MIL-STD-202 Method 108	1,000 hours at 200°C with rated voltage applied.	Measurement at 24 hours $\pm$ 4 hours after test conclusion. Within Post Environmental Limits  For C0G dielectric: Cap: $\pm$ 0.3% or $\pm$ 0.25 pF shift IR: 10% of Initial Limit DF Limits Maximum: 0.5%
Storage Life		Unpowered 1,000 hours at 200°C.	For X7R dielectric: Cap: $\pm$ 20% shift IR: 10% of Initial Limit DF Limits Maximum: 3%
Vibration	MIL-STD-202 Method 204	5 g's for 20 minutes, 12 cycles each of 3 orientations. Test from 10 – 2,000 Hz	Cap: Initial Limit DF: Initial Limit IR: Initial Limit
Mechanical Shock	MIL-STD-202 Method 213	100 g's 6 ms Half-sine, Velocity Change 12.3 feet/second (Condition C)	Cap: Initial Limit DF: Initial Limit IR: Initial Limit
Resistance to Solvents	MIL-STD-202 Method 215	Add Aqueous wash chemical OKEMCLEAN (A 6% concentrated Oakite cleaner) or equivalent. Do not use banned solvents	Capacitors shall be visually examined for evidence of mechanical damage and marking.

## Storage & Handling

The un-mounted storage life of a 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.

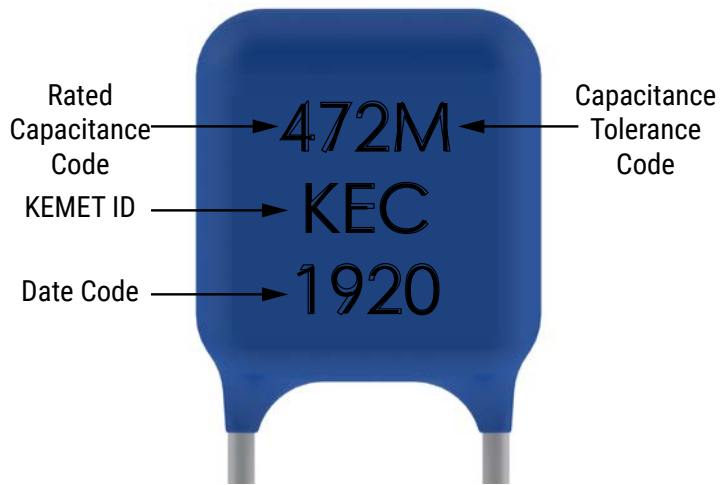
KEMET recommends storing the un-mounted capacitors in their original packaging, in a location away from direct sunlight, and where the temperature and relative humidity do not exceed 40 degrees centigrade and 70% respectively. For optimum solderability, capacitor stock should be used promptly, preferably 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.

## Construction

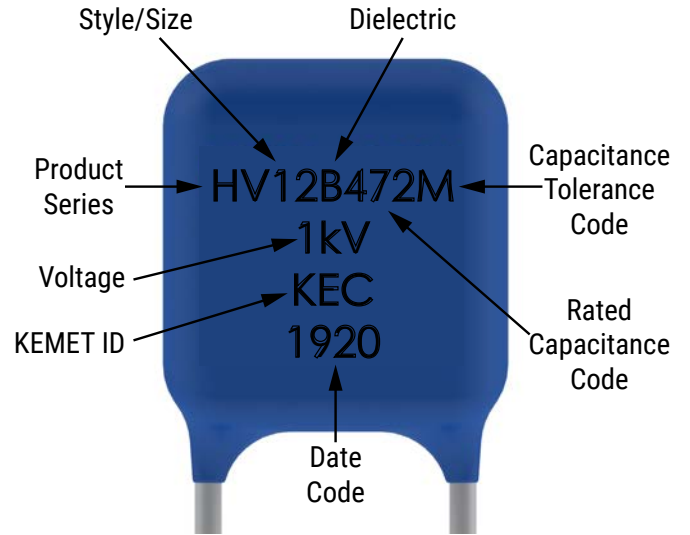


## Marking

**HV10, HV11**



**All Other Sizes**



Date Code	
19	20
Manufacturing Year: 19 = 2019	Manufacturing Week: 20 = Week 20 (of manufacturing calendar year)

## KEMET Electronics Corporation Sales Offices

For a complete list of our global sales offices, please visit [www.kemet.com/sales](http://www.kemet.com/sales).

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