

HS Series, Radial, Conformally Coated, 500 – 5,000 VDC (Space Grade)

Overview

KEMET's HS Series ceramic capacitors are designed with COG and X7R dielectrics which feature a 125°C maximum operating temperature and are screened to MIL-PRF-49467. These devices are made using robust designs and screened to MIL-PRF-49467 Group A to meet the demands of higher reliability applications. These devices are ideal for high voltage power supplies, DC/DC conversion and well suited for timing, resonant, bypass, and decoupling applications.

These high voltage capacitors are widely used in industries related to semiconductors, telecommunications, test/diagnostic equipment and power/grid.

The HS Series is part of KEMET's Harsh Environment PME (Precious Metal Electrode) portfolio which is ideal for industrial and high reliability applications.

Benefits

- Operating temperature range of -55°C to +125°C
- Capacitance range from 180 pF – 5.6 µF in X7R
- Capacitance range from 12 pF – 0.15 µF in COG
- DC voltage ratings of 500 V, 1 kV, 2 kV, 3 kV, 4 kV, 5 kV
- High thermal stability



Applications

- Aerospace engine compartments
- Switch mode power supplies
- DC/DC Converters
- Measuring equipment
- Inverters
- High voltage coupling

Ordering Information

| 10 | HS | 24 | | B | 102 | K | C | F |
|--|--------|--|----------------------------------|---------------------------------|--|------------------------------------|---|-----------------------------------|
| Voltage | Series | Style/Size | | Dielectric | Capacitance Code (pF) | Capacitance Tolerance ¹ | Test Level ³ | Voltage Conditioning ³ |
| 05 = 500V 10 = 1000V 20 = 2000V 30 = 3000V 40 = 4000V 50 = 5000V 75 = 7500V 100 = 10,000V | HS | 20 21 22 23 24 25 26 | 30 31 33 34 35 36 | N = BP COG (NP0) B = X7R | Two significant digits and number of zeros | J = ±5% K = ±10% M = ±20% | Blank = Standard Screening C = CSAM (optional) | F = Burn In (optional) |

¹ Additional capacitance tolerance offerings may be available. Contact KEMET for details. J= ±5% It is only applicable for COG dielectric

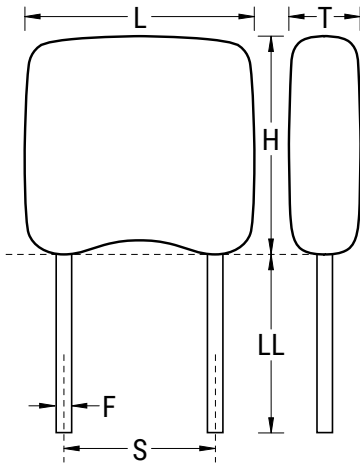
² Please refer to the Construction section in the datasheet.

³ CSAM must be included if burn-in option is selected.

Environmental Compliance

Industrial PME (precious metal electrode) part types are not RoHS compliant.

Dimensions – Inches (Millimeters)



| Series | Style/ Size | Length Maximum (L) | Height Maximum (H) | Thickness Maximum (T) | Lead Spacing ± 0.030 (S) | Lead Diameter (F) | Lead Length Minimum (LL) |
|--------|----------------|--------------------------|--------------------------|-----------------------------|---------------------------------|--|-----------------------------|
| HS | 20 | 0.250 (6.35) | 0.220 (5.59) | 0.200 (5.08) | 0.170 (4.32) | 0.025 +0.004/-0.002 (0.635 +0.102/-0.051) | 1.25 (31.75) |
| | 21 | 0.320 (8.13) | 0.280 (7.11) | 0.250 (6.35) | 0.220 (5.59) | | |
| | 22 | 0.370 (9.40) | 0.300 (7.62) | 0.250 (6.35) | 0.250 (6.35) | | |
| | 23 | 0.470 (11.94) | 0.400 (10.16) | 0.270 (6.89) | 0.375 (9.53) | | |
| | 24 | 0.570 (14.48) | 0.500 (12.70) | 0.270 (6.89) | 0.475 (12.07) | | |
| | 25 | 0.670 (17.02) | 0.600 (15.24) | 0.270 (6.89) | 0.575 (14.61) | | |
| | 26 | 0.770 (19.56) | 0.720 (18.29) | 0.270 (6.89) | 0.675 (17.15) | | |
| | 30 | 0.450 (11.43) | 0.220 (5.59) | 0.200 (5.08) | 0.300 (7.62) | | |
| | 31 | 0.550 (13.97) | 0.280 (7.11) | 0.250 (6.35) | 0.400 (10.16) | | |
| | 33 | 0.850 (21.59) | 0.400 (10.16) | 0.270 (6.89) | 0.700 (17.78) | | |
| | 34 | 1.050 (26.67) | 0.500 (12.70) | 0.270 (6.89) | 0.975 (24.76) | | |
| | 35 | 1.250 (31.75) | 0.600 (15.24) | 0.270 (6.89) | 1.175 (29.84) | | |
| 36 | 1.450 (36.83) | 0.720 (18.29) | 0.270 (6.89) | 1.375 (34.92) | | | |

Table 1B – HS COG Waterfall

| Style/Size | | HS20 | | | HS21 | | | HS22 | | | HS23 | | | | HS24 | | | | | HS25 | | | | | HS26 | | | | | | | |
|-------------|----------|---------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|-----|------|------|------|------|------|-----|------|------|------|------|------|
| | | Voltage | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Capacitance | Cap Code | 500 | 1000 | 2000 | 500 | 1000 | 2000 | 500 | 1000 | 2000 | 500 | 1000 | 2000 | 3000 | 500 | 1000 | 2000 | 3000 | 4000 | 5000 | 500 | 1000 | 2000 | 3000 | 4000 | 5000 | 500 | 1000 | 2000 | 3000 | 4000 | 5000 |
| 12 pF | 120 | X | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 pF | 150 | X | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 18 pF | 180 | X | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 22 pF | 220 | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | | | | | | |
| 27 pF | 270 | X | X | X | X | 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 | X | X | X | X | | | | | | | | | | | | |
| 39 pF | 390 | X | X | X | X | 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 | X | X | X | X | | | | | | | | | | | | |
| 56 pF | 560 | X | X | X | X | X | X | X | X | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | 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 | X | X | | | X | X | X | X | | | | | | |
| 1,800 pF | 182 | X | | | X | X | X | X | X | X | X | 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 | 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 | X | X | X | | | X | X | X | X | | | | | | |
| 3,300 pF | 332 | | | | X | | | X | X | X | X | X | 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 | | | X | X | X | X | | | | | | |
| 4,700 pF | 472 | | | | X | | | 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 | X | | | | | | |
| 6,800 pF | 682 | | | | | | | X | | | X | | | X | X | X | X | X | X | X | | | X | X | X | X | | | | | | |
| 7,500 pF | 752 | | | | | | | | | | 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 | | | | | | |
| 10,000 pF | 103 | | | | | | | | | | X | | | X | X | X | X | X | X | X | | | X | X | X | X | | | | | | |
| 12,000 pF | 123 | | | | | | | | | | X | | | X | | | | | | | | | X | X | | | | | | | | |
| 15,000 pF | 153 | | | | | | | | | | X | | | X | | | | | | | | | X | X | | | | | | | | |
| 18,000 pF | 183 | | | | | | | | | | X | | | X | | | | | | | | | X | | | | | | | | | |
| 22,000 pF | 223 | | | | | | | | | | | | | X | | | | | | | | | X | | | | | | | | | |
| 27,000 pF | 273 | | | | | | | | | | | | | X | | | | | | | | | X | | | | | | | | | |
| 33,000 pF | 333 | | | | | | | | | | | | | X | | | | | | | | | X | | | | | | | | | |
| 39,000 pF | 393 | | | | | | | | | | | | | X | | | | | | | | | X | | | | | | | | | |
| 47,000 pF | 473 | | | | | | | | | | | | | X | | | | | | | | | X | | | | | | | | | |
| 56,000 pF | 563 | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | |
| 68,000 pF | 683 | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | |

Packaging Quantities

| Style | Waffle Pack Quantity | Style | Waffle Pack Quantity |
|-------|----------------------|-------|----------------------|
| HS20 | 28 | HS25 | 28 |
| HS21 | 28 | HS26 | 20 |
| HS22 | 28 | HS33 | 20 |
| HS30 | 28 | HS34 | 4 |
| HS23 | 20 | HS35 | 4 |
| HS31 | 20 | HS36 | 4 |
| HS24 | 20 | - | - |

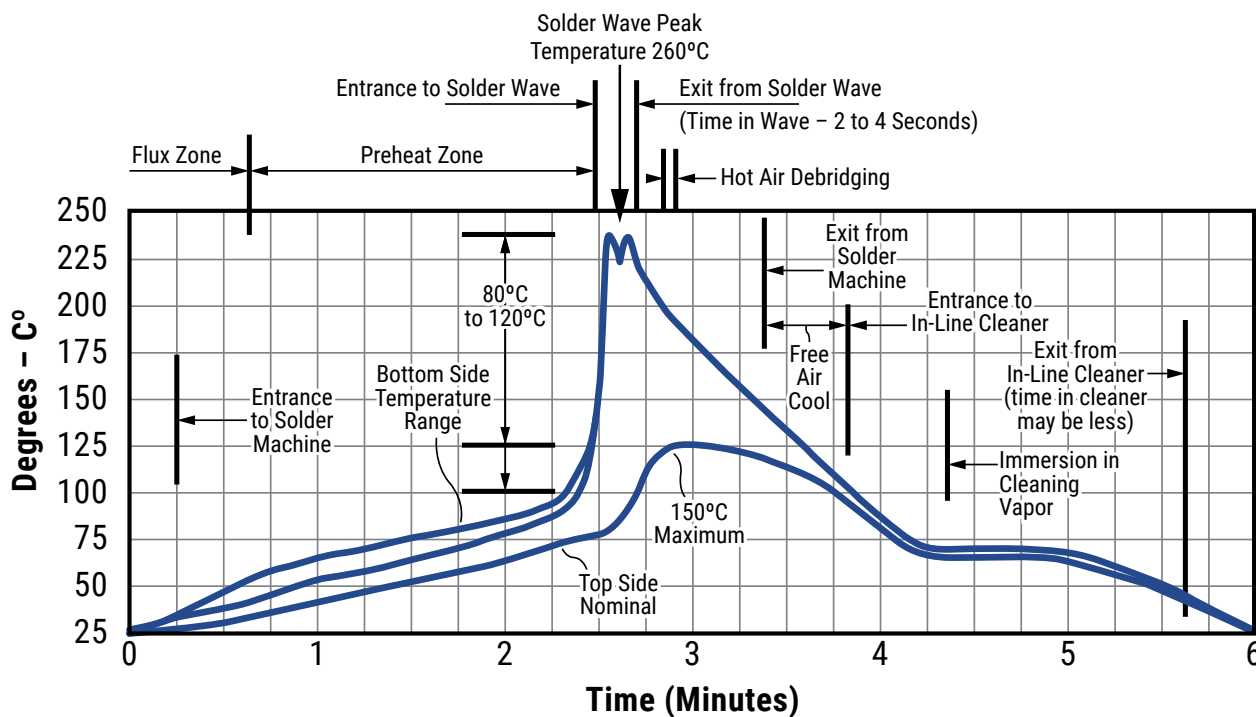
Soldering Process

Recommended Soldering Technique:

- Solder Wave
- Hand Soldering (Manual)

Recommended Soldering Profile:

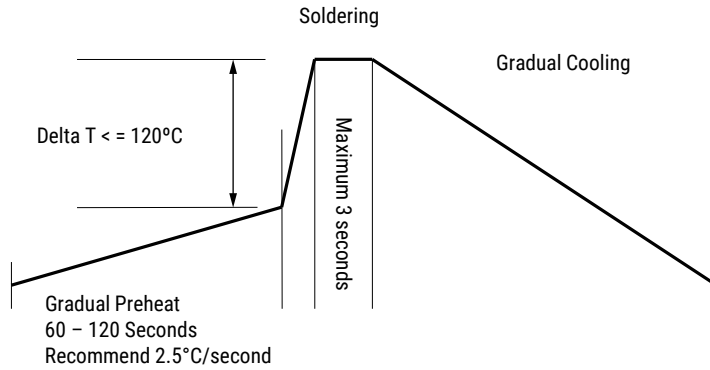
- Optimum Wave Solder Profile



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 and 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 | Test potential: 500 V DC between capacitor element terminals Surge current: limited to 30mA Special condition: If failure at relative humidity of ≥ 50%, IR may be measured again at a relative humidity of less than 50% | 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. At 25°C: 100,000 megohms or 1,000 Megohm-microfarad, whichever is less. At 125°C: 10,000 megohms or 100 Megohm-microfarad, whichever is less. |
| Temperature Coefficient of Capacitance (TCC) | KEMET Internal | COG: 0 ppm/°C ±30 ppm/°C X7R: ±15% | Within Specification |
| Temperature Coefficient of Capacitance at Applied Voltage (TCVC) | KEMET Internal | COG: 0 ppm/°C ±30 ppm/°C X7R: +15%/-70% | COG: Within Specification X7R: Within KEMET Specification limits |

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

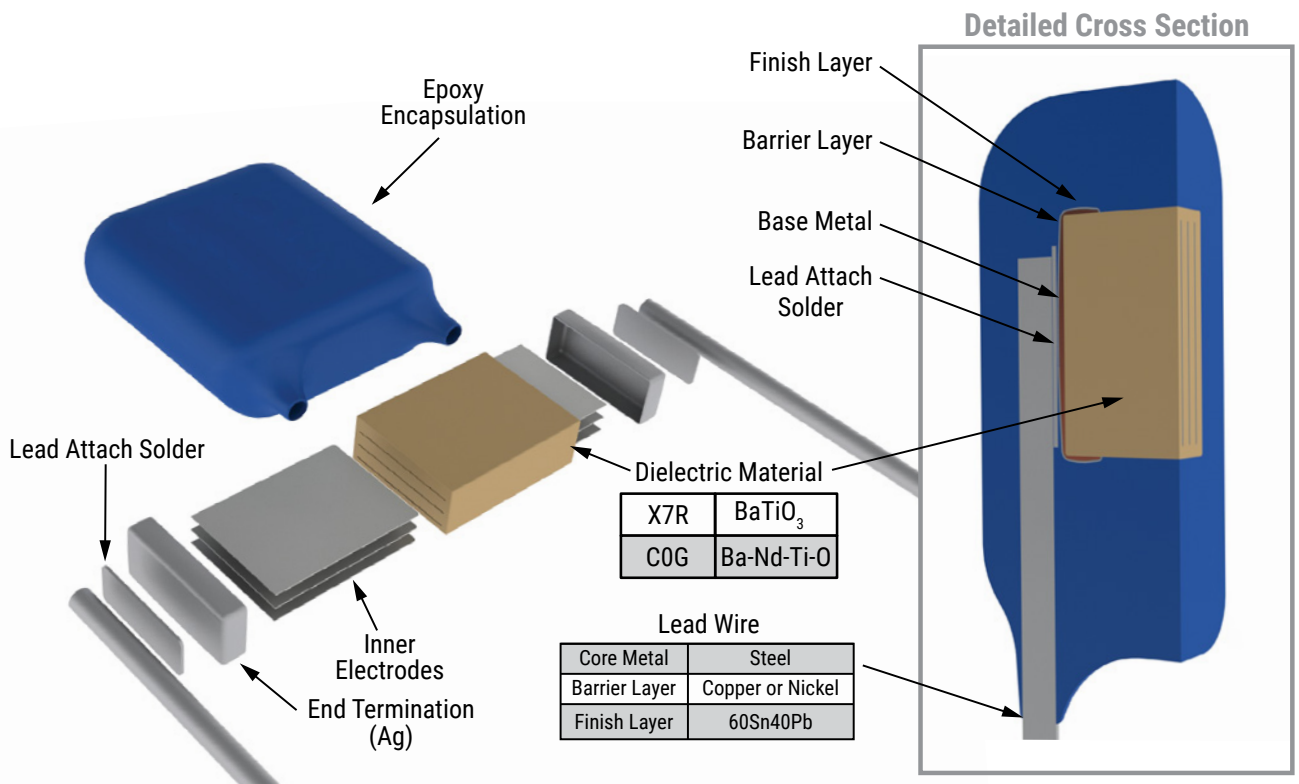
| Stress | Reference | Test or Inspection Method | Limits |
|---|------------------------|--|---|
| Dielectric Withstanding Voltage (DWV) | KEMET Internal | 150% of rated voltage for voltage rating of $500\text{ V} \leq V < 1,000\text{ V}$ 120% of rated voltage for voltage rating of $\geq 1,000\text{ V}$ (5 ± 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 | Visual Inspection. 95% coverage on termination. No leaching |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to $+125^\circ\text{C}$) 2 - 3 cycles per hour Soak Time: 1 or 5 minutes | Measurement at 24 hours \pm 4 hours after test conclusion. Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| Moisture Resistance | MIL-STD-202 Method 106 | Number of cycles required 10, 24 hours per cycle. Steps 7a and 7b not required | Visual examination: No mechanical damage. Marking shall remain legible Measurement at 24 hours \pm 4 hours after test conclusion. Within Post Environmental Limits Cap: X7R: Change not to exceed $\pm 10\%$ of initial measured value Cap: COG: ± 0.5 percent or 5 pF, whichever is greater, of initial measured value IR: 10% of Initial Limit of the initial $+25^\circ\text{C}$ requirement |
| Thermal Shock | MIL-STD-202 Method 107 | Number of cycles required 5, (-55°C to 125°C) Dwell time 15 minutes. | Cap: Initial Limit DF: Initial Limit IR: Initial Limit |
| High Temperature Life | MIL-STD-202 Method 108 | 2,000 hours at $+125^\circ\text{C}$, $+4^\circ\text{C}$, -0°C . With rated voltage, ± 5 percent. | Within Post Environmental Limits Visual examination: No mechanical damage. Marking shall remain legible. IR: (at $+25^\circ\text{C}$): Shall not be less than 30 percent of the value specified IR: (at elevated ambient temperature): Shall not be less than 30 percent of the value specified |
| Storage Life | | 1,000 hours at 125°C , Unpowered | |
| Vibration | MIL-STD-202 Method 204 | 20 g's for 8 hours, 3 orientations. Test from 10 – 2,000 Hz | Cap: X7R: Change not to exceed $\pm 10\%$ of initial measured value Cap: COG: ± 0.5 percent or 5 pF, whichever is greater, of initial measured value DF: Initial Limit IR: Initial Limit |
| Mechanical Shock | MIL-STD-202 Method 213 | 100 g's 6 ms Sawtooth, Velocity Change 9.7 feet/second (Condition I) | 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.

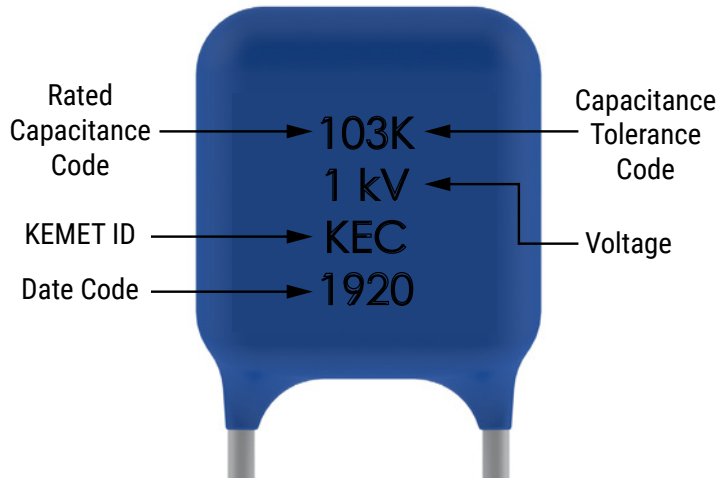
KEMET recommends storing the un-mounted capacitors in their original packaging, in a location away from direct sunlight, and where the temperature and relative humidity do not exceed 40 degrees centigrade and 70% respectively. For optimum solderability, capacitor stock should be used promptly, preferably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

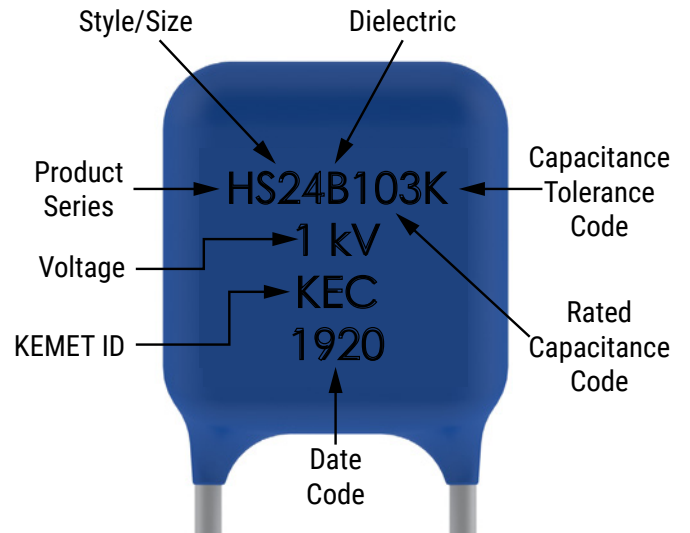


Marking

HS20, HS21



All Other Sizes



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

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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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