Surface Mount Multilayer Ceramic Chip Capacitors (SMD MLCCs)

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

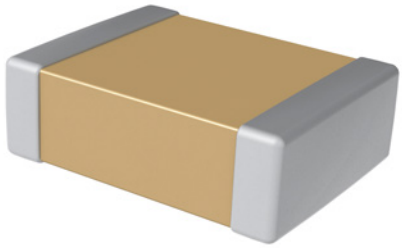
## Overview

KEMET's Floating Electrode (FE-CAP) multilayer ceramic capacitor in X7R dielectric utilizes a cascading internal electrode design configured to form multiple capacitors in series within a single monolithic structure. This unique configuration results in enhanced voltage and ESD performance over standard capacitor designs while allowing for a fail-open condition if mechanically damaged (cracked). If damaged, the device may experience a drop in capacitance but a short is unlikely. The FE-CAP is designed to reduce the likelihood of a low IR or short circuit condition and the chance for a catastrophic and potentially costly failure event.

Driven by the demand for a more robust and reliable component, the FE-CAP was designed for critical applications where higher operating temperatures and mechanical stress are a concern. These capacitors are manufactured in state of the art ISO/TS 16949:2009 certified facilities and are widely used in power supplies (input and output filters) and general electronic applications.

Combined with the stability of an X7R dielectric, the FE-CAP complements KEMET's "Open Mode" devices by providing a fail-safe design optimized for low to mid range capacitance values. These devices exhibit a predictable change in capacitance with respect to time and voltage and boast a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to ±15% from −55°C to +125°C.

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



## Ordering Information

| C | 0805 | S | 104 | K | 5 | R | A | C | TU |
|---|---|---|---|---|---|---|---|---|---|
| Ceramic | Case Size (L" x W") | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (VDC) | Dielectric | Failure Rate/ Design | Termination Finish[1] | Packaging/ Grade (C-Spec) |
| | 0402<br>0603<br>0805<br>1206<br>1210<br>1812 | S = Floating Electrode | Two significant digits and number of zeros | J = ±5%<br>K = ±10%<br>M = ±20% | 9 = 6.3<br>8 = 10<br>4 = 16<br>3 = 25<br>5 = 50<br>1 = 100<br>2 = 200<br>A = 250 | R = X7R | A = N/A | C = 100% Matte Sn<br>L = SnPb (5% Pb minimum) | See "Packaging C-Spec Ordering Options Table" |

*[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)<br>7210 (EIA 0805 and larger case sizes) |
| 7" Reel/Marked | TM |
| 13" Reel/Marked | 7040 (EIA 0603)<br>7215 (EIA 0805 and larger case sizes) |
| Automotive Grade[2] | |
| 7" Reel | AUTO |
| 13" Reel/Unmarked | AUTO7411 (EIA 0603 and smaller case sizes)<br>AUTO7210 (EIA 0805 and larger case sizes) |

*[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] Reeling tape options (Paper or Plastic) are dependent on capacitor case size (L" x W") and thickness dimension. See "Chip Thickness/Tape & Reel Packaging Quantities" and "Tape & Reel Packaging Information".*

*[2] For additional Information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information".*

*[2] All Automotive packaging C-Specs listed exclude the option to laser mark components. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking".*

## Benefits

- −55°C to +125°C operating temperature range
- Floating Electrode/fail open design
- Low to mid capacitance flex mitigation
- Lead (Pb)-free, RoHS and REACH compliant
- EIA 0402, 0603, 0805, 1206, 1210, and 1812 case sizes
- DC voltage ratings of 6.3 V, 10 V, 16 V, 25 V, 50 V, 100 V, 200 V, and 250 V
- Capacitance offerings ranging from 150 pF to 0.22 µF
- Available capacitance tolerances of ±5%, ±10%, and ±20%
- Commercial and Automotive (AEC–Q200) grades available
- Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish allowing for excellent solderability
- SnPb termination finish option available upon request (5% Pb minimum)

## Applications

Typical applications include circuits with a direct battery or power source connection, critical and safety relevant circuits without (integrated) current limitation and any application that is subject to high levels of board flexure or temperature cycling. Examples include raw power input side filtering (power plane/bus), high current applications (automobile battery line) and circuits that cannot be fused to open. Markets include consumer, medical, industrial (power supply), automotive, aerospace and telecom.

## Automotive C-Spec Information

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

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

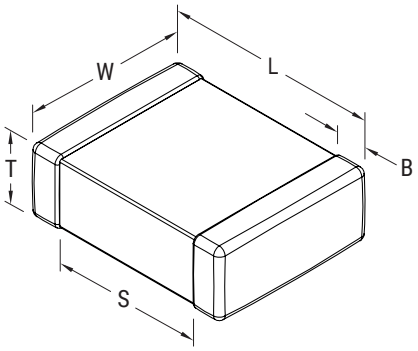
- To ensure that supplier can meet the manufacturability and quality requirements for the purchased parts.
- To provide the evidence that all customer engineering design records and specification requirements are properly understood and fulfilled by the manufacturing organization.
- To demonstrate that the established manufacturing process has the potential to produce the part.

| KEMET Automotive C-Spec | PPAP 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 with customer information included.
○ 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) | 0.50 (0.020) | 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) | 0.70 (0.028) | |
| 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) | 1.50 (0.060) | |
| 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) | 1.50 (0.060) | 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) | 2.30 (0.091) | |

## Qualification/Certification

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

Automotive Grade products meet or exceed the requirements outlined by the Automotive Electronics Council. Details regarding test methods and conditions are referenced in document AEC–Q200, Stress Test Qualification for Passive Components. For additional information regarding the Automotive Electronics Council and AEC–Q200, please visit their website at www.aecouncil.com.

## Environmental Compliance

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

## Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|---|---|
| Operating Temperature Range | −55°C to +125°C |
| Capacitance Change with Reference to +25°C and 0 Vdc Applied (TCC) | ±15% |
| [1]Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| [2]Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5±1 seconds and charge/discharge not exceeding 50mA) |
| [3]Dissipation Factor (DF) Maximum Limit at 25°C | 5%(6.3V & 10V), 3.5%(16V & 25V) and 2.5%(50V to 250V) |
| [4]Insulation Resistance (IR) Minimum Limit at 25°C | See Insulation Resistance Limit Table (Rated voltage applied for 120±5 seconds at 25°C) |

[1] *Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours.*
[2] *DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.*
[3] *Capacitance and dissipation factor (DF) measured under the following conditions:*
*1kHz ± 50Hz and 1.0 ± 0.2 Vrms if capacitance ≤10µF*
*120Hz ± 10Hz and 0.5 ± 0.1 Vrms if capacitance >10µF*
[4] *To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ limit. Select the lower of the two limits.*
*Note: When measuring capacitance it is important to ensure the set voltage level is held constant. The HP4284 & Agilent E4980 have a feature known as Automatic Level Control (ALC). The ALC feature should be switched to "ON".*

## Post Environmental Limits

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

## Insulation Resistance Limit Table (X7R Dielectric)

| EIA Case Size | 1,000 Megohm Microfarads or 100 GΩ | 500 Megohm Microfarads or 10 GΩ |
|---|---|---|
| 0201 | N/A | ALL |
| 0402 | < 0.012 µF | ≥ 0.012 µF |
| 0603 | < 0.047 µF | ≥ 0.047 µF |
| 0805 | < 0.15 µF | ≥ 0.15 µF |
| 1206 | < 0.47 µF | ≥ 0.47 µF |
| 1210 | < 0.39 µF | ≥ 0.39 µF |
| 1808 | ALL | N/A |
| 1812 | < 2.2 µF | ≥ 2.2 µF |
| 1825 | ALL | N/A |
| 2220 | < 10 µF | ≥ 10 µF |
| 2225 | ALL | N/A |

# Table 1A – Capacitance Range/Selection Waterfall (0402 – 0805 Case Sizes)

| Capacitance | Cap Code | Case Size/ Series | | | C0402S | | | | | C0603S | | | | | | | C0805S | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Voltage Code | | | 9 | 8 | 4 | 3 | 5 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A |
| | | Rated Voltage (VDC) | | | 6.3 | 10 | 16 | 25 | 50 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 |
| | | Capacitance Tolerance | | | Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions | | | | | | | | | | | | | | | | | | | |
| 150 pF | 151 | J | K | M | BB | BB | BB | BB | BB | | | | | | | | | | | | | | | |
| 180 pF | 181 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 220 pF | 221 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 270 pF | 271 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 330 pF | 331 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 390 pF | 391 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 470 pF | 471 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 560 pF | 561 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 680 pF | 681 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 820 pF | 821 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 1,000 pF | 102 | J | K | M | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 1,200 pF | 122 | J | K | M | | | | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 1,500 pF | 152 | J | K | M | | | | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 1,800 pF | 182 | J | K | M | | | | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 2,200 pF | 222 | J | K | M | | | | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 2,700 pF | 272 | J | K | M | | | | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 3,300 pF | 332 | J | K | M | | | | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 3,900 pF | 392 | J | K | M | | | | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 4,700 pF | 472 | J | K | M | | | | | | CF | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN | DN | DN |
| 5,600 pF | 562 | J | K | M | | | | | | CF | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DN | DN | DN | DN |
| 6,800 pF | 682 | J | K | M | | | | | | CF | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DN | DN | DN | DN |
| 8,200 pF | 822 | J | K | M | | | | | | CF | CF | CF | CF | CF | CF | | DN | DN | DN | DN | DN | DN | DN | DN |
| 10,000 pF | 103 | J | K | M | | | | | | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DN | DN | DN |
| 12,000 pF | 123 | J | K | M | | | | | | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DN | DN | DN |
| 15,000 pF | 153 | J | K | M | | | | | | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DP | | |
| 18,000 pF | 183 | J | K | M | | | | | | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DP | | |
| 22,000 pF | 223 | J | K | M | | | | | | CF | CF | CF | CF | CF | | | DN | DN | DN | DN | DN | DP | | |
| 27,000 pF | 273 | J | K | M | | | | | | | | | | | | | DN | DN | DN | DN | DN | DN | | |
| 33,000 pF | 333 | J | K | M | | | | | | | | | | | | | DN | DN | DN | DN | DN | DN | | |
| 39,000 pF | 393 | J | K | M | | | | | | | | | | | | | DN | DN | DN | DN | DN | DN | | |
| 47,000 pF | 473 | J | K | M | | | | | | | | | | | | | DN | DN | DN | DN | DN | DN | | |
| 56,000 pF | 563 | J | K | M | | | | | | | | | | | | | DP | DP | DP | DP | DP | DG | | |
| 68,000 pF | 683 | J | K | M | | | | | | | | | | | | | DP | DP | DP | DP | DP | DG | | |
| 82,000 pF | 823 | J | K | M | | | | | | | | | | | | | DG | DG | DG | DG | DG | DG | | |
| 0.10 µF | 104 | J | K | M | | | | | | | | | | | | | DG | DG | DG | DG | DG | DG | | |
| 0.12 µF | 124 | J | K | M | | | | | | | | | | | | | DG | DG | DG | DG | DG | | | |
| 0.15 µF | 154 | J | K | M | | | | | | | | | | | | | DG | DG | DG | DG | DG | | | |
| 0.18 µF | 184 | J | K | M | | | | | | | | | | | | | DG | DG | DG | DG | DG | | | |
| 0.22 µF | 224 | J | K | M | | | | | | | | | | | | | DG | DG | DG | DG | DG | | | |
| 0.27 µF | 274 | J | K | M | | | | | | | | | | | | | DG | DG | DG | DG | | | | |
| 0.33 µF | 334 | J | K | M | | | | | | | | | | | | | DG | DG | DG | DG | | | | |
| Capacitance | Cap Code | Rated Voltage (VDC) | | | 6.3 | 10 | 16 | 25 | 50 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 |
| | | Voltage Code | | | 9 | 8 | 4 | 3 | 5 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A |
| | | Case Size/ Series | | | C0402S | | | | | C0603S | | | | | | | C0805S | | | | | | | |

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

| Capacitance | Cap Code | Case Size/ Series | | | C1206S | | | | | | | | C1210S | | | | | | | | C1812S | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Voltage Code | | | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 3 | 5 | 1 | 2 | A |
| | | Rated Voltage (VDC) | | | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 25 | 50 | 100 | 200 | 250 |
| | | Capacitance Tolerance | | | Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions | | | | | | | | | | | | | | | | | | | | |
| 1,000 pF | 102 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | | | | | | | | | | | | | |
| 1,200 pF | 122 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | | | | | | | | | | | | | |
| 1,500 pF | 152 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | | | | | | | | | | | | | |
| 1,800 pF | 182 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | | | | | | | | | | | | | |
| 2,200 pF | 222 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | | | | | |
| 2,700 pF | 272 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | | | | | |
| 3,300 pF | 332 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | | | | | |
| 3,900 pF | 392 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | | | | | |
| 4,700 pF | 472 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | | | | | |
| 5,600 pF | 562 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | | | | | |
| 6,800 pF | 682 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | GB |
| 8,200 pF | 822 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | GB |
| 10,000 pF | 103 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | GB |
| 12,000 pF | 123 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | GB |
| 15,000 pF | 153 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | GB |
| 18,000 pF | 183 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | GB |
| 22,000 pF | 223 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | GB |
| 27,000 pF | 273 | J | K | M | EB | EB | EB | EB | EB | EB | EB | EB | FB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | GB |
| 33,000 pF | 333 | J | K | M | EB | EB | EB | EB | EB | EB | | | FB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | GB |
| 39,000 pF | 393 | J | K | M | EB | EB | EB | EB | EB | EC | | | FB | FB | FB | FB | FB | FB | FB | FB | GB | GB | GB | GB | GB |
| 47,000 pF | 473 | J | K | M | EB | EB | EB | EB | EB | EC | | | FB | FB | FB | FB | FB | FB | FC | FC | GB | GB | GB | GB | GB |
| 56,000 pF | 563 | J | K | M | EB | EB | EB | EB | EB | EB | | | FB | FB | FB | FB | FB | FB | FC | FC | GB | GB | GB | GB | GB |
| 68,000 pF | 683 | J | K | M | EB | EB | EB | EB | EB | EH | | | FB | FB | FB | FB | FB | FB | | | GB | GB | GB | GB | GB |
| 82,000 pF | 823 | J | K | M | EB | EB | EB | EB | EB | EH | | | FB | FB | FB | FB | FB | FC | | | GB | GB | GB | GB | GB |
| 0.10 µF | 104 | J | K | M | EB | EB | EB | EB | EB | EH | | | FB | FB | FB | FB | FB | FC | | | GB | GB | GB | | |
| 0.12 µF | 124 | J | K | M | EC | EC | EC | EC | EC | EH | | | FB | FB | FB | FB | FB | | | | GB | GB | GB | | |
| 0.15 µF | 154 | J | K | M | EH | EH | EH | EH | EH | EH | | | FC | FC | FC | FC | FC | | | | GB | GB | GB | | |
| 0.18 µF | 184 | J | K | M | EH | EH | EH | EH | EH | EH | | | FC | FC | FC | FC | FC | | | | GB | GB | GK | | |
| 0.22 µF | 224 | J | K | M | EH | EH | EH | EH | EH | EH | | | FC | FC | FC | FC | FC | | | | GB | GB | GK | | |
| 0.27 µF | 274 | J | K | M | EH | EH | EH | EH | EH | EH | | | FM | FM | FM | FM | | | | | GK | GK | GK | | |
| 0.33 µF | 334 | J | K | M | EH | EH | EH | EH | EH | EH | | | FM | FM | FM | FM | | | | | GK | GK | GK | | |
| 0.39 µF | 394 | J | K | M | EH | EH | EH | EH | EH | EH | | | FM | FM | FM | FM | | | | | GK | GK | GK | | |
| 0.47 µF | 474 | J | K | M | EH | EH | EH | EH | EH | | | | FM | FM | FM | FM | | | | | GK | GK | GK | | |
| 0.56 µF | 564 | J | K | M | EH | EH | EH | EH | EH | | | | FM | FM | FM | FM | | | | | GK | GK | GK | | |
| 0.68 µF | 684 | J | K | M | EH | EH | EH | EH | EH | | | | FM | FM | FM | FM | | | | | GK | GK | GK | | |
| 0.82 µF | 824 | J | K | M | EH | EH | EH | EH | | | | | FM | FM | FM | FM | | | | | GK | GK | GK | | |
| 1.00 µF | 105 | J | K | M | EH | EH | EH | EH | | | | | FM | FM | FM | FM | | | | | GK | GK | GK | | |
| 1.20 µF | 125 | J | K | M | | | | | | | | | FM | FM | FM | FM | | | | | GK | GK | | | |
| 1.50 µF | 155 | J | K | M | | | | | | | | | FM | FM | FM | FM | | | | | GK | GK | | | |
| 1.80 µF | 185 | J | K | M | | | | | | | | | FM | FM | FM | FM | | | | | GK | GK | | | |
| 2.20 µF | 225 | J | K | M | | | | | | | | | FM | FM | FM | FM | | | | | GK | GK | | | |
| 2.70 µF | 275 | J | K | M | | | | | | | | | | | | | | | | | GK | | | | |
| 2.30 µF | 335 | J | K | M | | | | | | | | | | | | | | | | | GK | | | | |
| Capacitance | Cap Code | Rated Voltage (VDC) | | | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 6.3 | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 25 | 50 | 100 | 200 | 250 |
| | | Voltage Code | | | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 9 | 8 | 4 | 3 | 5 | 1 | 2 | A | 3 | 5 | 1 | 2 | A |
| | | Case Size/ Series | | | C1206S | | | | | | | | C1210S | | | | | | | | C1812S | | | | |

## Table 2A – Chip Thickness/Tape & Reel Packaging Quantities

| Thickness Code | Case Size | Thickness ± Range (mm) | Paper Quantity | | Plastic Quantity | |
|---|---|---|---|---|---|---|
| | | | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| CJ | 0603 | 0.80 ± 0.15 | 4,000 | 15,000 | 0 | 0 |
| DR | 0805 | 0.78 ± 0.20 | 0 | 0 | 4,000 | 10,000 |
| DD | 0805 | 0.90 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EQ | 1206 | 0.78 ± 0.20 | 0 | 0 | 4,000 | 10,000 |
| ER | 1206 | 0.90 ± 0.20 | 0 | 0 | 4,000 | 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 |
| FX | 1210 | 0.95 ± 0.20 | 0 | 0 | 4,000 | 10,000 |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| GB | 1812 | 1.00 ± 0.10 | 0 | 0 | 1,000 | 4,000 |
| GK | 1812 | 1.60 ± 0.20 | 0 | 0 | 1,000 | 4,000 |
| **Thickness Code** | **Case Size** | **Thickness ± Range (mm)** | **7" Reel** | **13" Reel** | **7" Reel** | **13" Reel** |
| | | | **Paper Quantity** | | **Plastic Quantity** | |

*Package quantity based on finished chip thickness specifications.*

## Table 2B – Bulk Packaging Quantities

| Packaging Type | | Loose Packaging | |
|---|---|---|---|
| | | Bulk Bag (default) | |
| Packaging C-Spec[1] | | N/A[2] | |
| Case Size | | Packaging Quantities (pieces/unit packaging) | |
| EIA (in) | Metric (mm) | Minimum | Maximum |
| 0402 | 1005 | 1 | 50,000 |
| 0603 | 1608 | | |
| 0805 | 2012 | | |
| 1206 | 3216 | | |
| 1210 | 3225 | | |
| 1808 | 4520 | | 20,000 |
| 1812 | 4532 | | |
| 1825 | 4564 | | |
| 2220 | 5650 | | |
| 2225 | 5664 | | |

[1] *The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial Grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for Automotive Grade products.*

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

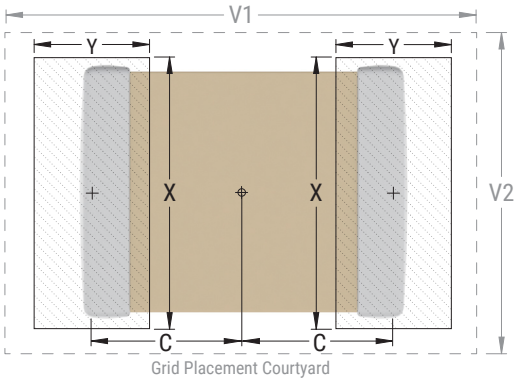
[1] *Only for capacitance values ≥ 22 µF*

***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:**

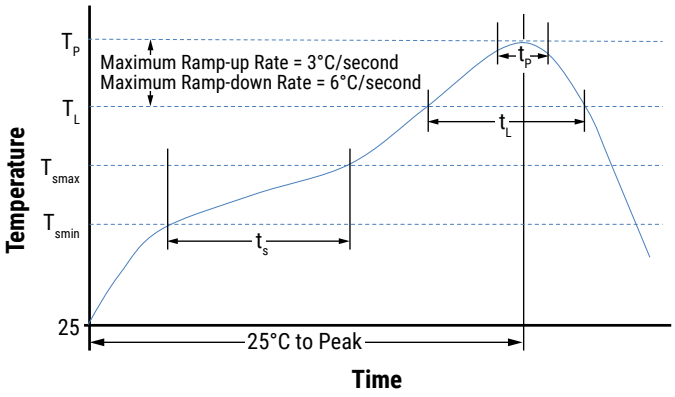
- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- All other EIA case sizes are limited to solder reflow only

**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.*



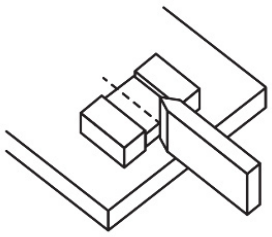
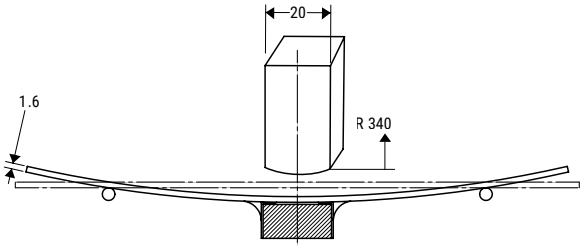
## X7R Performance and Reliability: SMD Test Methods and Conditions

| Test | Reference | Test Condition | Limits |
|---|---|---|---|
| Visual and Mechanical | KEMET Internal | No defects that may affect performance (10X) | Dimensions according KEMET Spec Sheet |
| Capacitance (Cap) | KEMET Internal | C ≤ 10 µF 1 kHz ±50 Hz and 1.0 ±0.2 $V_{rms}$ or 0.5 ±0.2 $V_{rms}$*<br>C > 10 µF 120 Hz ±10 Hz and 0.5 ±0.1 $V_{rms}$<br>* See part number specification sheet for voltage<br>Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours. Please refer to a part number specification sheet for details | Within Tolerance |
| Dissipation Factor (DF) | KEMET Internal | C ≤ 10 µF<br>Frequency: 1 kHz ±50 Hz<br>Voltage*: 1.0 ±0.2 $V_{rms}$<br>C > 10 µF<br>Frequency: 120 Hz ±10 Hz<br>Voltage: 0.5 ±0.1 $V_{rms}$<br><br>* See part number specification sheet for voltage | Within Specification<br>Maximum Limit at 25°C<br>5% (6.3V & 10V)<br>3.5% (16V & 25V)<br>2.5% (50V to 250V) |
| Insulation Resistance (IR) | KEMET Internal | Apply rated voltage for 120 seconds at 25°C | Within Specification<br>Minimum Limit at 25°C<br>To obtain IR limit, divide MΩ-µF value by the capacitance and compare to GΩ limit. Select the lower of the two limits. |

**Insulation Resistance (IR) Limits Table**

| 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 |
| 1805 | ALL | N/A |
| 1808 | ALL | N/A |
| 1812 | < 2.2 µF | ≥ 2.2 µF |
| 1825 | ALL | N/A |
| 2220 | < 10 µF | ≥ 10 µF |
| 2225 | ALL | N/A |

## X7R Performance and Reliability: SMD Test Methods and Conditions cont.

<table>
<tr><th>Test</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Temperature Coefficient of Capacitance (TCC)</td><td>KEMET Internal</td><td>C ≤ 10µF<br>Frequency: 1 kHz ±50 Hz<br>Voltage*: 1.0 ±0.2 $V_{rms}$,<br>C > 10µF<br>Frequency: 120 Hz ±10 Hz<br>Voltage: 0.5 ±0.1 $V_{rms}$<br><br>* See part number specification sheet for voltage<br><table><tr><th>Step</th><th>Temperature (°C)</th></tr><tr><td>1</td><td>+25°C</td></tr><tr><td>2</td><td>−55°C</td></tr><tr><td>3</td><td>+25°C (Reference Temperature)</td></tr><tr><td>4</td><td>+125°C</td></tr></table></td><td>Capacitance ±15% over −55°C to +125°C</td></tr>
<tr><td>Dielectric Withstanding Voltage (DWV)</td><td>KEMET Internal</td><td>250% of rated voltage<br>(5 ±1 seconds and charge/discharge not exceeding 50 mA)</td><td>Withstand test voltage without insulation breakdown or damage.</td></tr>
<tr><td>Aging Rate (Maximum % Capacitance Loss/Decade Hour)</td><td>KEMET Internal</td><td>Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours. Please refer to a part number specific datasheet for referee time details.</td><td>Please refer to a part number specification sheet for specific Aging rate</td></tr>
<tr><td>Terminal Strength</td><td>KEMET Internal</td><td>Shear stress test per specific case size, Time: 60±1 seconds<br><table><tr><th>Case Size</th><th>Force</th></tr><tr><td>0201</td><td>2N</td></tr><tr><td>0402</td><td>3N</td></tr><tr><td>0603</td><td>5N</td></tr><tr><td>0805</td><td>9N</td></tr><tr><td>≥1206</td><td>18N</td></tr></table>  </td><td>No evidence of mechanical damage</td></tr>
<tr><td>Board Flex</td><td>AEC-Q200-005</td><td>Standard Termination system 2.0 mm<br>Flexible Termination System 3.0 mm<br>Test time: 60± 5 seconds<br>Ramp time: 1 mm/second<br> 
</td><td>No evidence of mechanical damage</td></tr>
</table>

## X7R Performance and Reliability: SMD Test Methods and Conditions cont.

<table>
<tr><th>Test</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Solderability</td><td>J-STD-002</td><td>Condition: 4 hours ± 15 minutes at 155°C dry bake apply all methods<br>Test 245 ±5°C (SnPb and Pb-Free)</td><td>Visual Inspection.<br>95% coverage on termination.<br>No leaching</td></tr>
<tr><td>Temperature Cycling</td><td>JESD22<br>Method JA-104</td><td>1,000 cycles (−55°C to +125°C)<br>2 – 3 cycles per hour<br>Soak Time 1 or 5 minutes</td><td>Measurement at 24 hours ±4 hours after test conclusion.<br>Cap: ±20% shift<br>DF: Initial Limit<br>IR: Initial Limit</td></tr>
<tr><td>Biased Humidity</td><td>MIL-STD-202<br>Method 103</td><td>Load Humidity:<br>1,000 hours 85°C/85% RH and rated voltage.<br><br>Low Volt Humidity:<br>1,000 hours 85C°/85% RH and 1.5 V.</td><td>Measurement at 24 hours ±4 hours after test conclusion.<br>Within Post Environmental Limits<br>Cap: ±20% shift<br>IR: 10% of Initial Limit<br><br><table><tr><th colspan="2">DF Limits Maximum (%)</th></tr><tr><th>Initial</th><th>Post</th></tr><tr><td>2.5</td><td>3.0</td></tr><tr><td>3.5</td><td>5.0</td></tr><tr><td>5.0</td><td>7.5</td></tr><tr><td>10.0</td><td>20.0</td></tr></table></td></tr>
<tr><td>Thermal Shock</td><td>MIL-STD-202<br>Method 107</td><td>Number of cycles required 5, (−55°C to 125°C)<br>Dwell time 15 minutes.</td><td>Cap:±20% shift<br>DF: Initial Limit<br>IR: Initial Limit<br><br><table><tr><th colspan="2">DF Limits Maximum (%)</th></tr><tr><th>Initial</th><th>Post</th></tr><tr><td>2.5</td><td>3.0</td></tr><tr><td>3.5</td><td>5.0</td></tr><tr><td>5.0</td><td>7.5</td></tr><tr><td>10.0</td><td>20.0</td></tr></table></td></tr>
</table>

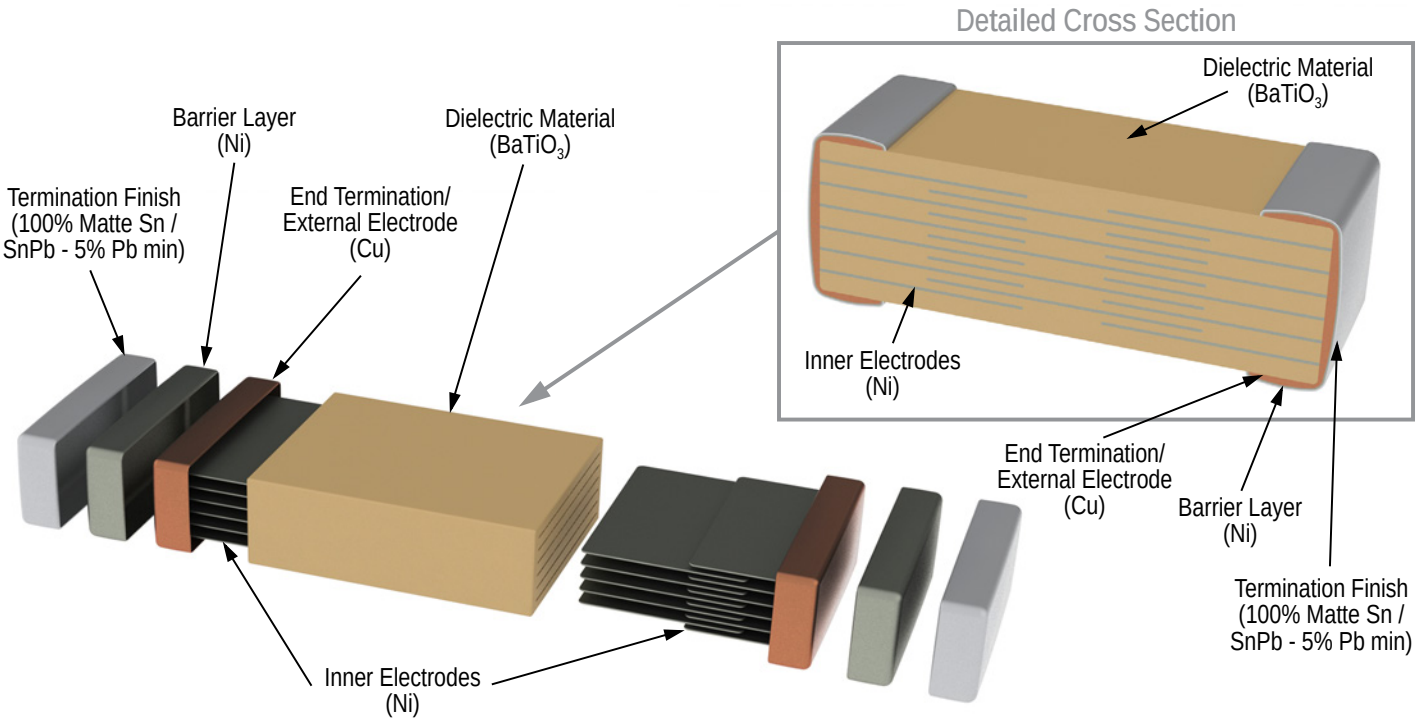
## X7R Performance and Reliability: SMD Test Methods and Conditions cont.

<table>
<tr><th>Test</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>High Temperature Life</td><td>MIL-STD-202 Method 108</td><td>1,000 hours at 125°C with 2 X rated voltage applied excluding the following:</td><td>Within Post Environmental Limits<br>Cap: ±20% shift<br>IR: 10% of Initial Limit<br><table><tr><th colspan="2">DF Limits Maximum (%)</th></tr><tr><th>Initial</th><th>Post</th></tr><tr><td>2.5</td><td>3.0</td></tr><tr><td>3.5</td><td>5.0</td></tr><tr><td>5.0</td><td>7.5</td></tr><tr><td>10.0</td><td>20.0</td></tr></table></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. Test from 10 – 2,000 Hz</td><td>Cap: ±20% shift<br>DF: Initial Limit<br>IR: Initial Limit</td></tr>
<tr><td>Resistance to Soldering Heat</td><td>MIL-STD-202 Method 210</td><td>Condition D, 260°C, 10 seconds</td><td>Cap: ±20% shift<br>DF: Initial Limit<br>IR: Initial Limit</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



## Capacitor Marking (Optional)

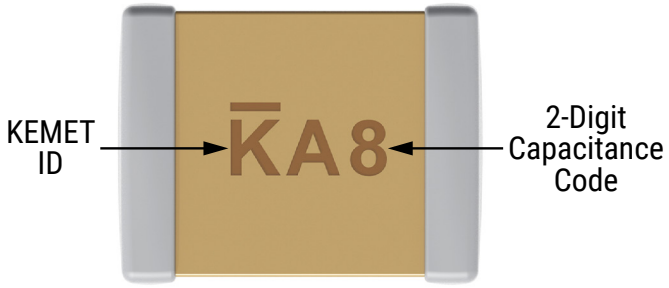
These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic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

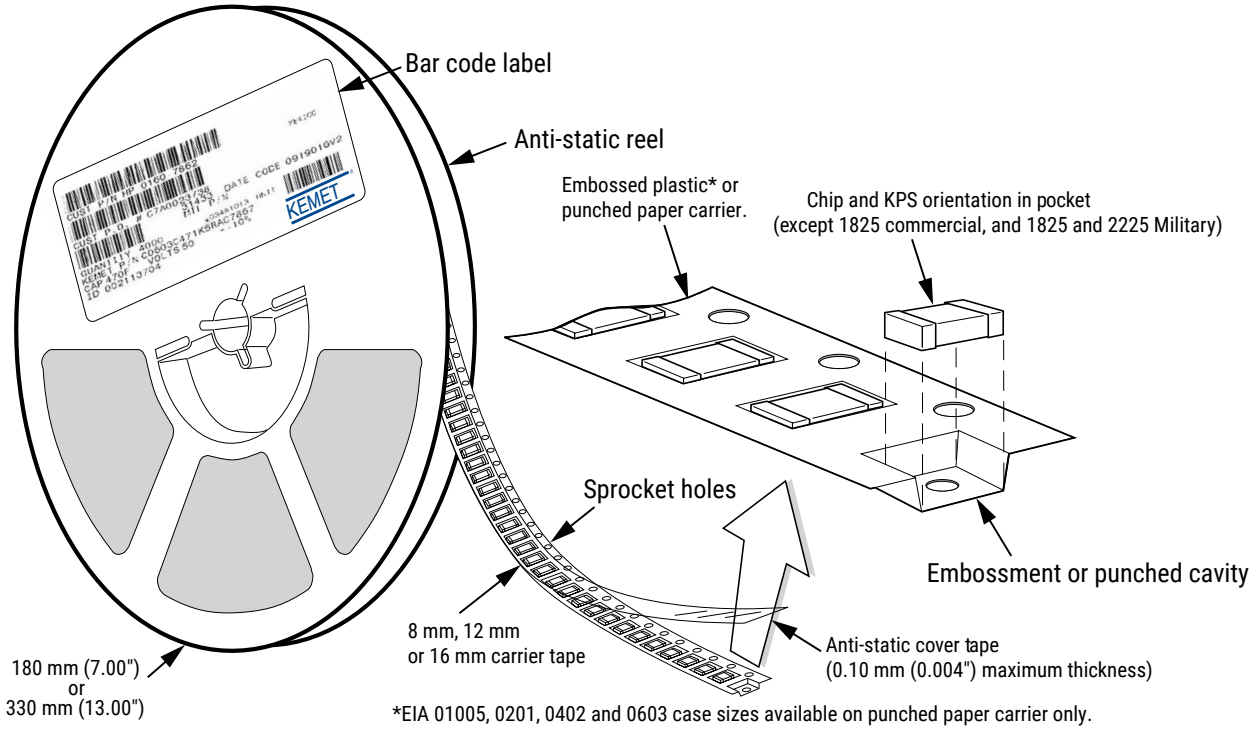


## Capacitor Marking (Optional) cont.

| Capacitance (pF) For Various Alpha/Numeral Identifiers | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Alpha Character | Numeral | | | | | | | | | |
| | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| | Capacitance (pF) | | | | | | | | | |
| A | 0.10 | 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 | 0.20 | 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 | 0.30 | 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 | 0.40 | 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 | 0.50 | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 |
| m | 0.60 | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 |
| n | 0.70 | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 |
| t | 0.80 | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 |
| y | 0.90 | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 |

## Tape & Reel Packaging Information

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.

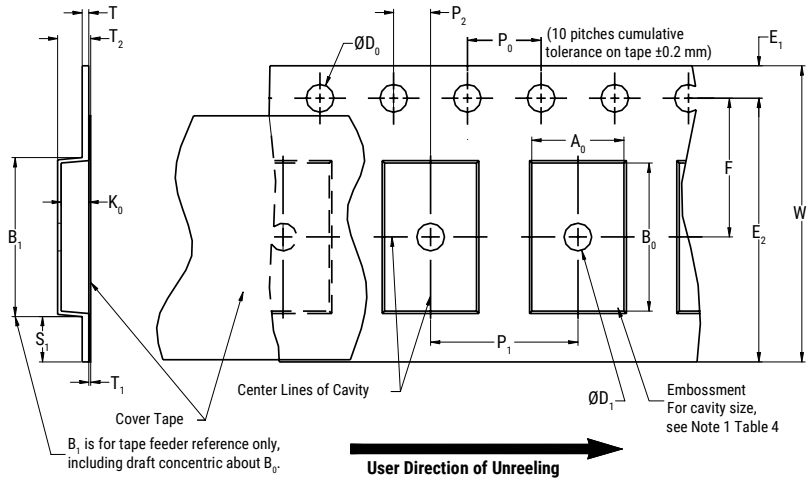



## Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)

| 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 | | | 4 | 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 and 2220 | 16 | 12 | 12 | | |
| Array 0612 | 8 | 4 | 4 | | |

**Refer to Figures 1 and 2 for W and $P_1$ carrier tape reference locations.*
**Refer to Tables 6 and 7 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) and 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 the embossment location and the hole location shall be applied independently 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 a 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.*

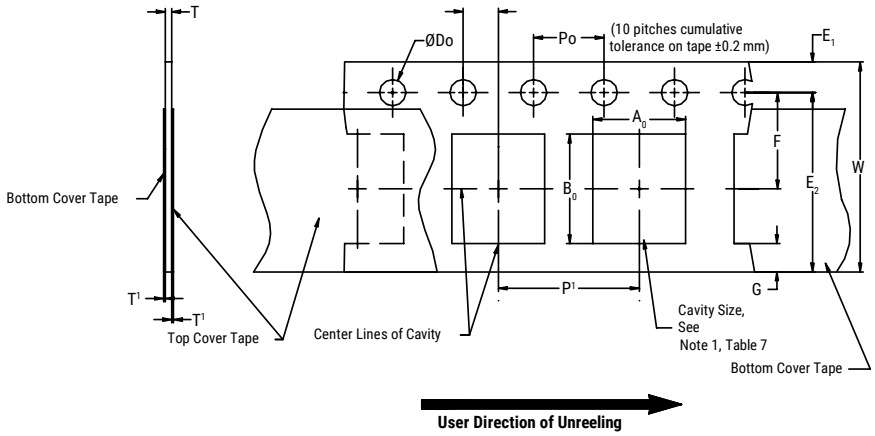
*(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)*

*(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 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 | Single (4 mm) | 6.25 (0.246) | 3.5 ±0.05 (0.138 ±0.002) | 4.0 ±0.10 (0.157 ±0.004) | 1.1 (0.043) | 8.3 (0.327) | Note 1 |

*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.)*

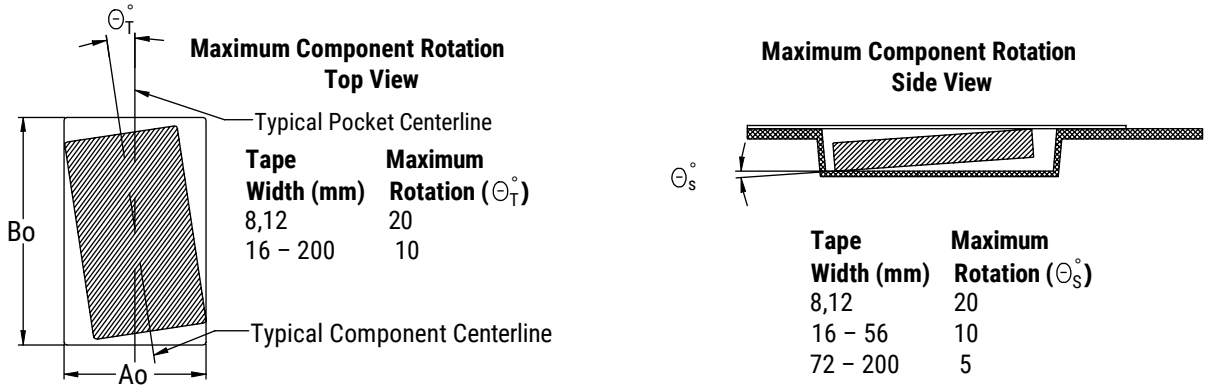
## Packaging Information Performance Notes

**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:

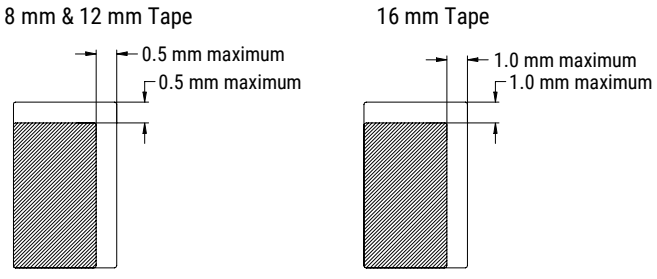
| Tape Width | Peel Strength |
|---|---|
| 8 mm | 0.1 to 1.0 newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 newton (10 to 130 gf) |

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*.

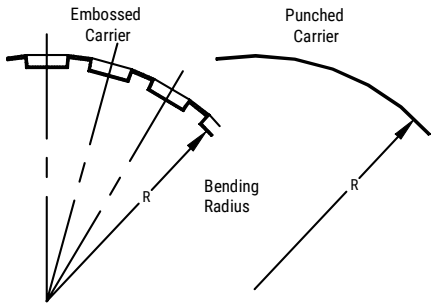
## Figure 3 – Maximum Component Rotation



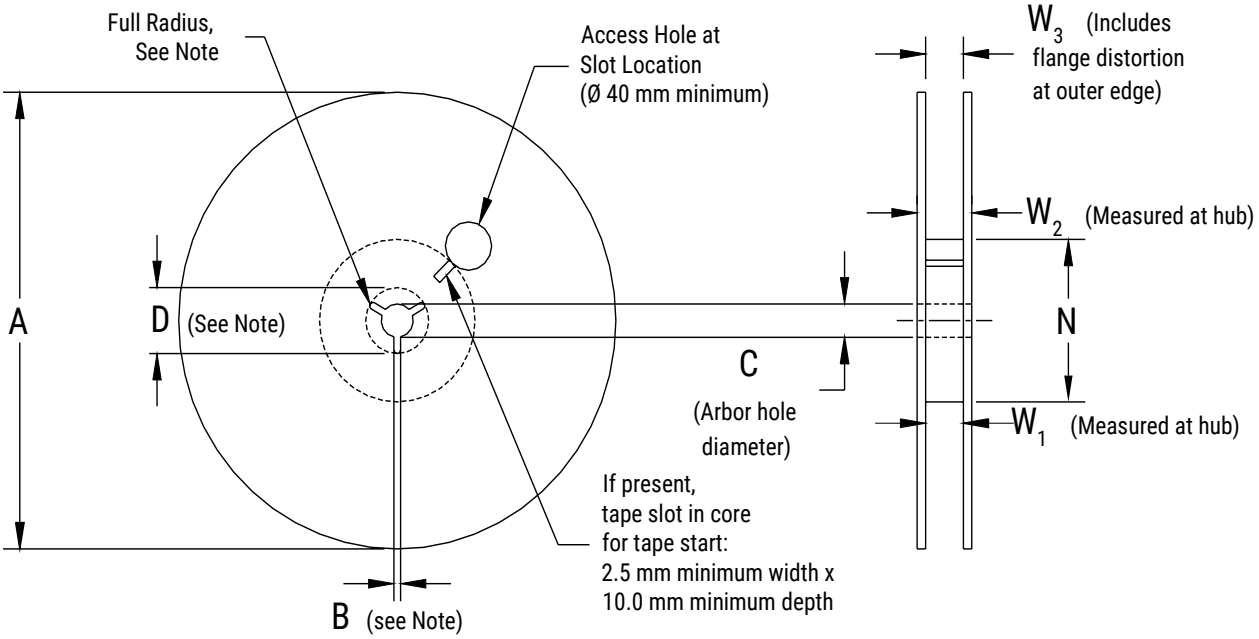

## Figure 4 – Maximum Lateral Movement




## Figure 5 – Bending Radius



## Figure 6 – Reel Dimensions




Note: Drive spokes optional; if used, dimensions B and D shall apply.

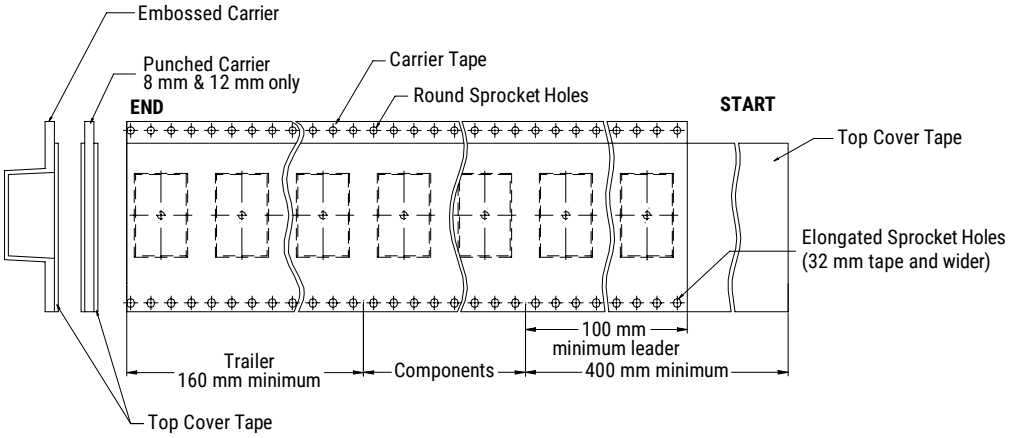
## Table 8 – Reel Dimensions

Metric will govern

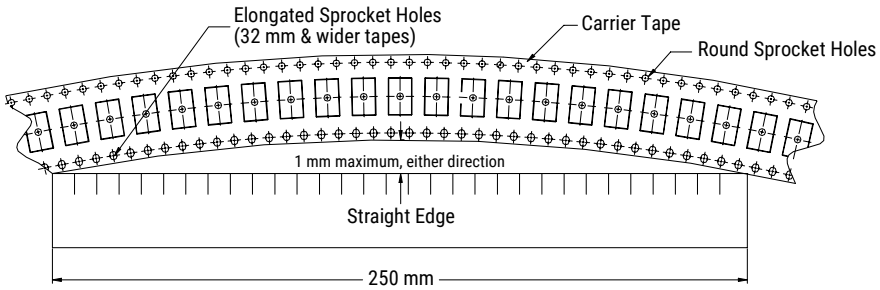
| Constant Dimensions — Millimeters (Inches) | | | | |
|---|---|---|---|---|
| Tape Size | A | B Minimum | C | D Minimum |
| 8 mm | 178 ±0.20 (7.008 ±0.008) or 330 ±0.20 (13.000 ±0.008) | 1.5 (0.059) | 13.0 +0.5/−0.2 (0.521 +0.02/−0.008) | 20.2 (0.795) |
| 12 mm | | | | |
| 16 mm | | | | |

| 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



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