

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

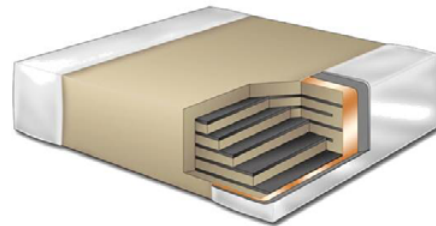
Overview

KEMET's X8L dielectric features a 150°C maximum operating temperature and is considered "general purpose high temperature." These components are fixed, ceramic dielectric capacitors suited for high temperature bypass and decoupling applications or frequency discriminating circuits where Q and stability of capacitance characteristics are not critical. X8L exhibits a predictable change in capacitance with respect to time and voltage and boasts a minimal change in capacitance with reference to ambient temperature up to 125°C. Beyond 125°C X8L displays a wider variation in capacitance. Capacitance change is limited to ±15% from -55°C to +125°C and +15, -40% from 125°C to 150°C.

Driven by the demand for a more robust and reliable component, X8L dielectric capacitors were developed for critical applications where reliability at higher operating temperatures are a concern. These capacitors are widely used in automotive

circuits as well as general high temperature applications. Concerned with flex cracks resulting from excessive tensile and shear stresses produced during board flexure and thermal cycling? These devices are available with KEMET's Flexible termination technology which inhibits the transfer of board stress to the rigid ceramic body, therefore mitigating flex cracks which can result in low IR or short circuit failures. Although flexible termination technology does not eliminate the potential for mechanical damage that may propagate during extreme environmental and handling conditions, it does provide superior flex performance over standard termination systems.

In addition to commercial grade, automotive grade devices are available and meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.



Ordering Information

| C | 1210 | X | 106 | K | 8 | N | A | C | TU |
|---------|--------------------------------------|------------------------------------------|----------------------------------------|---------------------------------|----------------------------------|------------|----------------------|--------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| Ceramic | Case Size (L" x W") | Specification/ Series ¹ | Capacitance Code (pF) | Capacitance Tolerance | Voltage | Dielectric | Failure Rate/ Design | Termination Finish ² | Packaging/Grade (C-Spec) ³ |
| | 0402 0603 0805 1206 1210 | C = Standard X = Flexible Termination | 2 Significant Digits + Number of Zeros | J = ±5% K = ±10% M = ±20% | 8 = 10 V 3 = 25 V 5 = 50 V | N = X8L | A = N/A | C = 100% Matte Sn L = SnPb (5% minimum) | Blank = Bulk TU = 7" Reel Unmarked TM = 7" Reel Marked AUTO = Automotive Grade 7" Reel Unmarked |

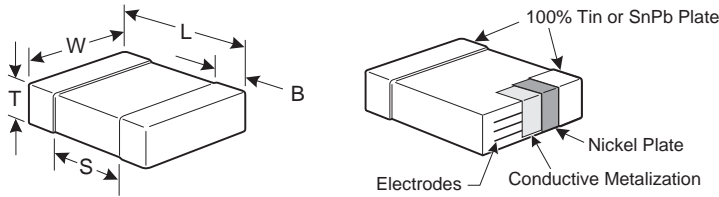
¹ The flexible termination option is not available on EIA 0402 case size product. "C" must be used in the 6th character position when ordering this case size.

² Additional termination finish options may be available. Contact KEMET for details.

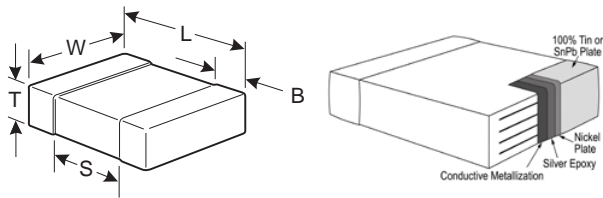
³ SnPb termination finish option is not available on Automotive Grade product.

³ Additional reeling or packaging options may be available. Contact KEMET for details.

Dimensions – Standard Termination – Millimeters (Inches)



| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|---------------|------------------|---------------------------|---------------------------|---------------------------|---------------------------|----------------------|------------------------------|
| 0402 | 1005 | 1.00 (.040) ± 0.05 (.002) | 0.50 (.020) ± 0.05 (.002) | See Table 2 for Thickness | 0.30 (.012) ± 0.10 (.004) | 0.30 (.012) | Solder Reflow Only |
| 0603 | 1608 | 1.60 (.063) ± 0.15 (.006) | 0.80 (.032) ± 0.15 (.006) | | 0.35 (.014) ± 0.15 (.006) | 0.70 (.028) | Solder Wave or Solder Reflow |
| 0805 | 2012 | 2.00 (.079) ± 0.20 (.008) | 1.25 (.049) ± 0.20 (.008) | | 0.50 (0.02) ± 0.25 (.010) | 0.75 (.030) | |
| 1206 | 3216 | 3.20 (.126) ± 0.20 (.008) | 1.60 (.063) ± 0.20 (.008) | | 0.50 (0.02) ± 0.25 (.010) | N/A | Solder Reflow Only |
| 1210 | 3225 | 3.20 (.126) ± 0.20 (.008) | 2.50 (.098) ± 0.20 (.008) | | 0.50 (0.02) ± 0.25 (.010) | | |



Dimensions – Flexible Termination – Millimeters (Inches)

| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|---------------|------------------|---------------------------|---------------------------|---------------------------|---------------------------|----------------------|------------------------------|
| 0603 | 1608 | 1.60 (.064) ± 0.17 (.007) | 0.80 (.032) ± 0.15 (.006) | See Table 2 for Thickness | 0.45 (.018) ± 0.15 (.006) | 0.58 (.023) | Solder Wave or Solder Reflow |
| 0805 | 2012 | 2.00 (.079) ± 0.20 (.008) | 1.25 (.049) ± 0.20 (.008) | | 0.50 (0.02) ± 0.25 (.010) | 0.75 (.030) | |
| 1206 | 3216 | 3.30 (.130) ± 0.40 (.016) | 1.60 (.063) ± 0.20 (.008) | | 0.60 (.024) ± 0.25 (.010) | N/A | Solder Reflow Only |
| 1210 | 3225 | 3.30 (.130) ± 0.40 (.016) | 2.50 (.098) ± 0.20 (.008) | | 0.60 (.024) ± 0.25 (.010) | | |

Benefits

- -55°C to +150°C operating temperature range
- Pb-Free and RoHS Compliant
- EIA 0402, 0603, 0805, 1206, and 1210 case sizes
- DC voltage ratings of 10 V, 25 V, and 50 V
- Capacitance offerings ranging from 0.012 µF to 10 µF
- Available capacitance tolerances of ±5%, ±10%, and ±20%
- Commercial & Automotive (AEC-Q200) grades available
- Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish allowing for excellent solderability
- SnPb termination finish option available upon request (5% minimum)
- Flexible termination option available upon request

Applications

Typical applications include use in extreme environments such as down-hole oil exploration, under-hood automotive, military and aerospace.

Qualification/Certification

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

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

Environmental Compliance

Pb-Free and RoHS compliant (excluding SnPb termination finish option).



RoHS Compliant

Electrical Parameters/Characteristics

| Item | Parameters/Characteristics |
|--------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Operating Temperature Range | -55°C to +150°C |
| Capacitance Change with Reference to +25°C and 0 VDC Applied (TCC) | ±15% (-55°C – 125°C) +15, -40% (125°C – 150°C) |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | 3.0% |
| Dielectric Withstanding Voltage (DWV) | 250% of rated voltage (5 ±1 seconds and charge/discharge not exceeding 50 mA) |
| Dissipation Factor (DF) Maximum Limit @ 25°C | 3.5% (10 V) and 2.5% (25 V and 50 V) |
| Insulation Resistance (IR) Limit @ 25°C | 500 megohm microfarads or 10 GΩ (Rated voltage applied for 120 ±5 seconds @ 25°C) |

Regarding aging rate: Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours.

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

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

1 kHz ±50 Hz and 1.0 ±0.2 Vrms.

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 |
| X8L | > 25 | All | 3.0 | ±20% | 10% of Initial Limit |
| | 25 | | 5.0 | | |
| | 10 | | 7.5 | | |

Insulation Resistance Limit Table (X8L Dielectric)

| EIA Case Size | 1,000 Megohm Microfarads or 100 GΩ | 500 Megohm Microfarads or 10 GΩ |
|---------------|---------------------------------------|------------------------------------|
| 0201 | N/A | ALL |
| 0402 | < .012 μF | ≥ .012 μF |
| 0603 | < .047 μF | ≥ .047 μF |
| 0805 | < .047 μF | ≥ .047 μF |
| 1206 | < 0.22 μF | ≥ 0.22 μF |
| 1210 | < 0.39 μF | ≥ 0.39 μF |
| 1808 | ALL | N/A |
| 1812 | < 2.2 μF | ≥ 2.2 μF |
| 1825 | ALL | N/A |
| 2220 | < 10 μF | ≥ 10 μF |
| 2225 | ALL | N/A |

Table 1 – Capacitance Range/Selection Waterfall (0402 – 1210 Case Sizes)

| Capacitance | Cap Code | Series | | | C0402 | | C0603 | | | C0805 | | | C1206 | | | C1210 | | |
|-------------|----------|-----------------------|---|---|-----------------------------------------------------------------------------------------|----|-------|-------|----|-------|-------|----|-------|-------|----|-------|-------|----|
| | | Voltage Code | | | 8 | 3 | 8 | 3 | 5 | 8 | 3 | 5 | 8 | 3 | 5 | 8 | 3 | 5 |
| | | Voltage DC | | | 10 | 25 | 10 | 25 | 50 | 10 | 25 | 50 | 10 | 25 | 50 | 10 | 25 | 50 |
| | | Capacitance Tolerance | | | Product Availability and Chip Thickness Codes See Table 2 for Chip Thickness Dimensions | | | | | | | | | | | | | |
| 12,000 pF | 123 | J | K | M | BB | BB | | | | | | | | | | | | |
| 15,000 pF | 153 | J | K | M | BB | BB | | | | | | | | | | | | |
| 18,000 pF | 183 | J | K | M | BB | BB | | | | | | | | | | | | |
| 22,000 pF | 223 | J | K | M | BB | BB | | | | | | | | | | | | |
| 27,000 pF | 273 | J | K | M | BB | | | | | | | | | | | | | |
| 33,000 pF | 333 | J | K | M | BB | | | | | | | | | | | | | |
| 39,000 pF | 393 | J | K | M | BB | | | | | | | | | | | | | |
| 47,000 pF | 473 | J | K | M | BB | | CB | CB | CB | | | | | | | | | |
| 56,000 pF | 563 | J | K | M | | | | | | | | | | | | | | |
| 68,000 pF | 683 | J | K | M | | | | | | | | | | | | | | |
| 82,000 pF | 823 | J | K | M | | | | | | | | | | | | | | |
| 0.10 µF | 104 | J | K | M | | | | | | | | | | | | | | |
| 0.12 µF | 124 | J | K | M | | | CB | CB | | | | | | | | | | |
| 0.15 µF | 154 | J | K | M | | | CB | CB | | DG | DG | DG | | | | | | |
| 0.18 µF | 184 | J | K | M | | | CB | | | DG | DG | DG | | | | | | |
| 0.22 µF | 224 | J | K | M | | | CB | | | DD | DD | DG | | | | | | |
| 0.27 µF | 274 | J | K | M | | | | | | DD | DD | | | | | | | |
| 0.33 µF | 334 | J | K | M | | | | | | DD | DD | | | | | | | |
| 0.39 µF | 394 | J | K | M | | | | | | DE | DE | | | | | FD | FD | FD |
| 0.47 µF | 474 | J | K | M | | | | | | DE | DE | | EG | EG | EG | FD | FD | FD |
| 0.56 µF | 564 | J | K | M | | | | | | DG | DH | | | | | FF | FF | FF |
| 0.68 µF | 684 | J | K | M | | | | | | DG | DH | | | | | FG | FG | FG |
| 0.82 µF | 824 | J | K | M | | | | | | DG | | | | | | FL | FL | FL |
| 1.0 µF | 105 | J | K | M | | | | | | DG | | | | | | FM | FM | FM |
| 1.2 µF | 125 | J | K | M | | | | | | | | | ED | ED | | FG | FG | |
| 1.5 µF | 155 | J | K | M | | | | | | | | | EH | EH | | FG | FG | |
| 1.8 µF | 185 | J | K | M | | | | | | | | | EH | EH | | FG | FG | |
| 2.2 µF | 225 | J | K | M | | | | | | | | | EF | EH | | FG | FG | |
| 2.7 µF | 275 | J | K | M | | | | | | | | | EF | | | FG | FG | |
| 3.3 µF | 335 | J | K | M | | | | | | | | | EH | | | FG | FH | |
| 3.9 µF | 395 | J | K | M | | | | | | | | | EH | | | FM | FM | |
| 4.7 µF | 475 | J | K | M | | | | | | | | | EH | | | FG | FK | |
| 5.6 µF | 565 | J | K | M | | | | | | | | | EH | | | FG | FS | |
| 6.8 µF | 685 | J | K | M | | | | | | | | | | | | FM | | |
| 8.2 µF | 825 | J | K | M | | | | | | | | | | | | FK | | |
| 10 µF | 106 | J | K | M | | | | | | | | | | | | FS | | |
| Capacitance | Cap Code | Voltage DC | | | 10 | 25 | 10 | 25 | 50 | 10 | 25 | 50 | 10 | 25 | 50 | 10 | 25 | 50 |
| | | Voltage Code | | | 8 | 3 | 8 | 3 | 5 | 8 | 3 | 5 | 8 | 3 | 5 | 8 | 3 | 5 |
| | | Series | | | C0402 | | | C0603 | | | C0805 | | | C1206 | | | C1210 | |

Table 2 – Chip Thickness/Packaging Quantities

| Thickness Code | Case Size | Thickness ± Range (mm) | Paper Quantity | | Plastic Quantity | |
|----------------|-----------|------------------------|----------------|----------|------------------|----------|
| | | | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| BB | 0402 | 0.50 ± 0.05 | 10,000 | 50,000 | 0 | 0 |
| CB | 0603 | 0.80 ± 0.07 | 4,000 | 10,000 | 0 | 0 |
| DD | 0805 | 0.90 ± 0.10 | 4,000 | 10,000 | 0 | 0 |
| DE | 0805 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| DG | 0805 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| DH | 0805 | 1.25 ± 0.20 | 0 | 0 | 2,500 | 10,000 |
| ED | 1206 | 1.00 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| EF | 1206 | 1.20 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| EG | 1206 | 1.60 ± 0.15 | 0 | 0 | 2,000 | 8,000 |
| EH | 1206 | 1.60 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FD | 1210 | 0.95 ± 0.10 | 0 | 0 | 4,000 | 10,000 |
| FF | 1210 | 1.10 ± 0.10 | 0 | 0 | 2,500 | 10,000 |
| FG | 1210 | 1.25 ± 0.15 | 0 | 0 | 2,500 | 10,000 |
| FL | 1210 | 1.40 ± 0.15 | 0 | 0 | 2,000 | 8,000 |
| FH | 1210 | 1.55 ± 0.15 | 0 | 0 | 2,000 | 8,000 |
| FM | 1210 | 1.70 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FK | 1210 | 2.10 ± 0.20 | 0 | 0 | 2,000 | 8,000 |
| FS | 1210 | 2.50 ± 0.20 | 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 3A – Land Pattern Design Recommendations per IPC-7351 – Standard Termination

| EIA Size Code | Metric Size Code | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | |
|-------------------|------------------|------------------------------------------------------|------|------|------|------|--------------------------------------------------------|------|------|------|------|-------------------------------------------------------|------|------|------|------|
| | | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0402 | 1005 | 0.50 | 0.72 | 0.72 | 2.20 | 1.20 | 0.45 | 0.62 | 0.62 | 1.90 | 1.00 | 0.40 | 0.52 | 0.52 | 1.60 | 0.80 |
| 0603 | 1608 | 0.90 | 1.15 | 1.10 | 4.00 | 2.10 | 0.80 | 0.95 | 1.00 | 3.10 | 1.50 | 0.60 | 0.75 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.75 | 0.95 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.35 | 1.90 | 5.60 | 2.90 | 1.50 | 1.15 | 1.80 | 4.70 | 2.30 | 1.40 | 0.95 | 1.70 | 4.00 | 2.00 |
| 1210 | 3225 | 1.60 | 1.35 | 2.80 | 5.65 | 3.80 | 1.50 | 1.15 | 2.70 | 4.70 | 3.20 | 1.40 | 0.95 | 2.60 | 4.00 | 2.90 |
| 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 |

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).

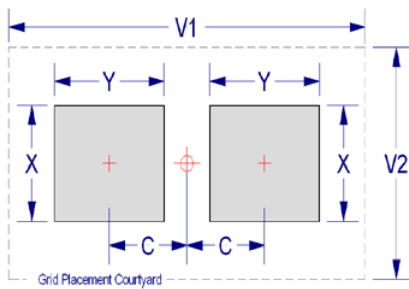
Table 3B – Land Pattern Design Recommendations per IPC–7351 – Flexible Termination

| EIA Size Code | Metric Size Code | Density Level A: Maximum (Most) Land Protrusion (mm) | | | | | Density Level B: Median (Nominal) Land Protrusion (mm) | | | | | Density Level C: Minimum (Least) Land Protrusion (mm) | | | | |
|---------------|------------------|------------------------------------------------------|------|------|------|------|--------------------------------------------------------|------|------|------|------|-------------------------------------------------------|------|------|------|------|
| | | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 | C | Y | X | V1 | V2 |
| 0603 | 1608 | 0.85 | 1.25 | 1.10 | 4.00 | 2.10 | 0.75 | 1.05 | 1.00 | 3.10 | 1.50 | 0.65 | 0.85 | 0.90 | 2.40 | 1.20 |
| 0805 | 2012 | 1.00 | 1.35 | 1.55 | 4.40 | 2.60 | 0.90 | 1.15 | 1.45 | 3.50 | 2.00 | 0.80 | 0.95 | 1.35 | 2.80 | 1.70 |
| 1206 | 3216 | 1.60 | 1.65 | 1.90 | 5.90 | 2.90 | 1.50 | 1.45 | 1.80 | 5.00 | 2.30 | 1.40 | 1.25 | 1.70 | 4.30 | 2.00 |
| 1210 | 3225 | 1.60 | 1.65 | 2.80 | 5.90 | 3.80 | 1.50 | 1.45 | 2.70 | 5.00 | 3.20 | 1.40 | 1.25 | 2.60 | 4.30 | 2.90 |

Density Level A: For low-density product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.

Density Level B: For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes.

Density Level C: For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC–7351).



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 Soldering Profile:

- KEMET recommends following the guidelines outlined in IPC/JEDEC J–STD–020

Table 4 – Performance & Reliability: Test Methods and Conditions

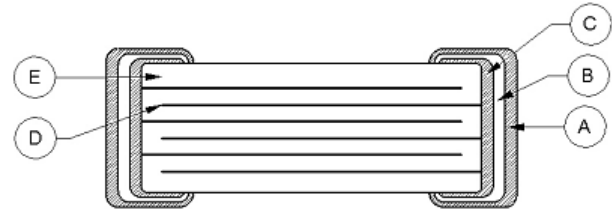
| Stress | Reference | Test or Inspection Method |
|------------------------|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Terminal Strength | JIS-C-6429 | Appendix 1, Note: Force of 1.8 kg for 60 seconds. |
| Board Flex | JIS-C-6429 | Appendix 2, Note: Standard termination system – 2.0 mm (minimum) for all except 3 mm for COG. Flexible termination system – 3.0 mm (minimum). |
| Solderability | J-STD-002 | Magnification 50 X. Conditions: |
| | | a) Method B, 4 hours @ 155°C, dry heat @ 235°C |
| | | b) Method B @ 215°C category 3 |
| | | c) Method D, category 3 @ 260°C |
| Temperature Cycling | JESD22 Method JA-104 | 1,000 cycles (-55°C to +150°C). Measurement at 24 hours +/- 2 hours after test conclusion. |
| Biased Humidity | MIL-STD-202 Method 103 | Load Humidity: 1,000 hours 85°C/85%RH and rated voltage. Add 100K ohm resistor. Measurement at 24 hours +/- 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. |
| Moisture Resistance | MIL-STD-202 Method 106 | 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/+150. Note: Number of cycles required – 300. Maximum transfer time – 20 seconds. Dwell time – 15 minutes. Air – Air. |
| High Temperature Life | MIL-STD-202 Method 108 /EIA-198 | 1,000 hours at 150°C with 2 X rated voltage applied. |
| Storage Life | MIL-STD-202 Method 108 | 150°C, 0 VDC for 1,000 hours. |
| Vibration | MIL-STD-202 Method 204 | 5 g's for 20 min., 12 cycles each of 3 orientations. Note: Use 8" X 5" PCB 0.031" thick 7 secure points on one long side and 2 secure points at corners of opposite sides. Parts mounted within 2" from any secure point. Test from 10 – 2,000 Hz |
| Mechanical Shock | MIL-STD-202 Method 213 | Figure 1 of Method 213, Condition F. |
| Resistance to Solvents | MIL-STD-202 Method 215 | Add aqueous wash chemical, OKEM Clean or equivalent. |

Storage and Handling

Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature– reels may soften or warp and tape peel force may increase. KEMET recommends that maximum storage temperature not exceed 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 – Standard Termination

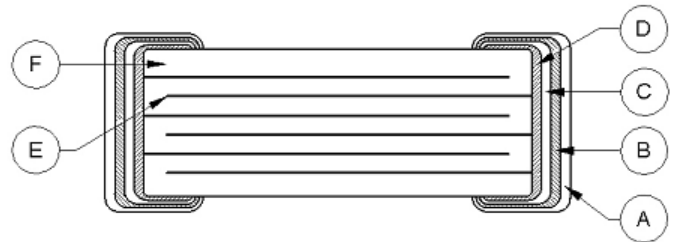
| Reference | Item | | Material | |
|-----------|---------------------|---------------|--------------------|---------------|
| A | Termination System | Finish | 100% Matte Sn | SnPb (5% min) |
| B | | Barrier Layer | Ni | |
| D | | Base Metal | Cu | |
| E | Inner Electrode | | Ni | |
| F | Dielectric Material | | BaTiO ₃ | |



Note: Image is exaggerated in order to clearly identify all components of construction.

Construction – Flexible Termination

| Reference | Item | | Material | |
|-----------|---------------------|---------------|--------------------|---------------|
| A | Termination System | Finish | 100% Matte Sn | SnPb (5% min) |
| B | | Barrier Layer | Ni | |
| C | | Epoxy Layer | Ag | |
| D | Base Metal | | Cu | |
| E | Inner Electrode | | Ni | |
| F | Dielectric Material | | BaTiO ₃ | |

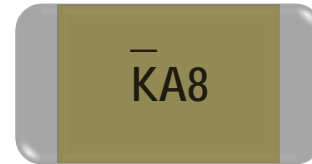


Note: Image is exaggerated in order to clearly identify all components of construction.

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.

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.



Laser marking option is not available on:

- COG, 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.

| Capacitance (pF) For Various Alpha/Numeral Identifiers | | | | | | | | | | |
|--------------------------------------------------------|------------------|-----|----|-----|-------|--------|---------|-----------|------------|-------------|
| Alpha Character | Numeral | | | | | | | | | |
| | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| | Capacitance (pF) | | | | | | | | | |
| A | 0.1 | 10 | 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 | 12 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 |
| D | 0.13 | 13 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 |
| E | 0.15 | 15 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 |
| F | 0.16 | 16 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 |
| G | 0.18 | 18 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 |
| H | 0.2 | 20 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 |
| J | 0.22 | 22 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 |
| K | 0.24 | 24 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 |
| L | 0.27 | 27 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 |
| M | 0.3 | 30 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 |
| N | 0.33 | 33 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 |
| P | 0.36 | 36 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 |
| Q | 0.39 | 39 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 |
| R | 0.43 | 43 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 |
| S | 0.47 | 47 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 |
| T | 0.51 | 51 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 |
| U | 0.56 | 56 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 |
| V | 0.62 | 62 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 |
| W | 0.68 | 68 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 |
| X | 0.75 | 75 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 |
| Y | 0.82 | 82 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 |
| Z | 0.91 | 91 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 |
| a | 0.25 | 25 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 |
| b | 0.35 | 35 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 |
| d | 0.4 | 40 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 |
| e | 0.45 | 45 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 |
| f | 0.5 | 50 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 |
| m | 0.6 | 60 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 |
| n | 0.7 | 70 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 |
| i | 0.8 | 80 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 |
| y | 0.9 | 90 | 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.

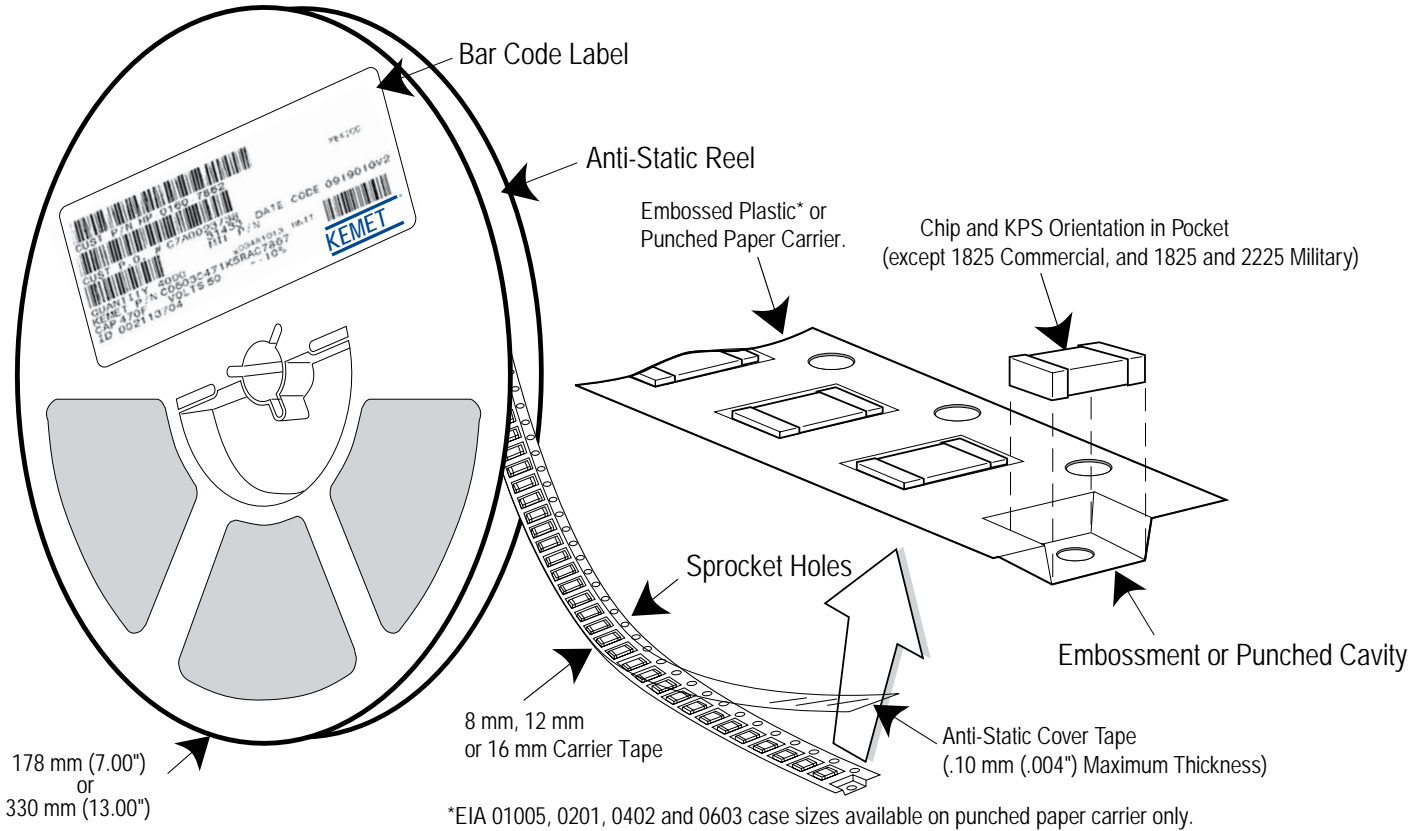


Table 5 – Carrier Tape Configuration – Embossed Plastic & Punched Paper (mm)

| EIA Case Size | Tape Size (W)* | Pitch (P ₁)* |
|-------------------|----------------|--------------------------|
| 01005 – 0402 | 8 | 2 |
| 0603 – 1210 | 8 | 4 |
| 1805 – 1808 | 12 | 4 |
| ≥ 1812 | 12 | 8 |
| KPS 1210 | 12 | 8 |
| KPS 1812 & 2220 | 16 | 12 |
| Array 0508 & 0612 | 8 | 4 |

*Refer to Figures 1 & 2 for W and P₁ carrier tape reference locations.

*Refer to Tables 6 & 7 for tolerance specifications.

Figure 1 – Embossed (Plastic) Carrier Tape Dimensions

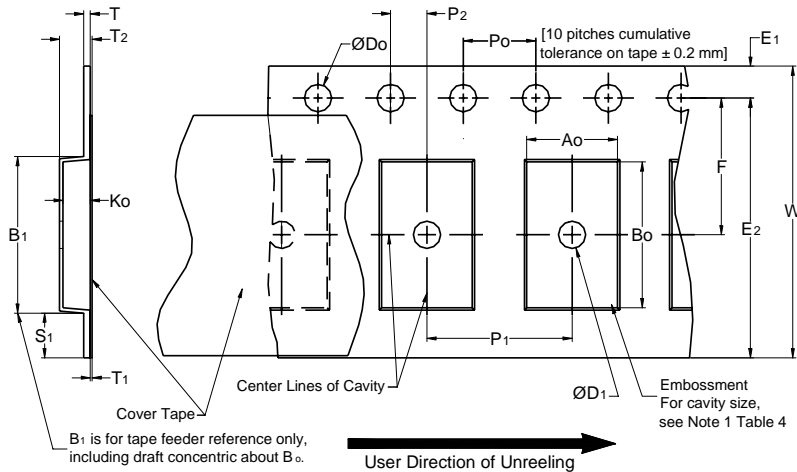


Table 6 – Embossed (Plastic) Carrier Tape Dimensions
 Metric will govern

| 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) & 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) | | |

- The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.
- The tape with or without components shall pass around R without damage (see Figure 6).
- If S₁ < 1.0 mm, there may not be enough area for cover tape to be properly applied (see EIA Standard 481 paragraph 4.3 section b).
- B₁ dimension is a reference dimension for tape feeder clearance only.
- The cavity defined by A₀, B₀ and K₀ shall surround the component with sufficient clearance that:
 - the component does not protrude above the top surface of the carrier tape.
 - the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.
 - 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).
 - 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).
 - for KPS Series product, A₀ and B₀ are measured on a plane 0.3 mm above the bottom of the pocket.
 - see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.

Figure 2 – Punched (Paper) Carrier Tape Dimensions

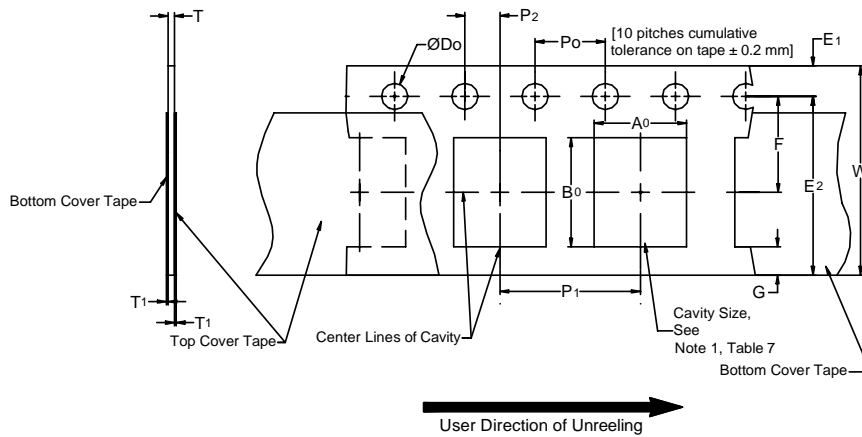


Table 7 – Punched (Paper) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | |
|--------------------------------------------|-----------------------------------------|-----------------------------------|----------------------------------|----------------------------------|-------------------------|-----------------|--------------------|
| Tape Size | D_0 | E_1 | P_0 | P_2 | T_1 Maximum | G Minimum | R Reference Note 2 |
| 8 mm | $1.5 +0.10 -0.0$ (0.059 +0.004 -0.0) | 1.75 ± 0.10 (0.069 ±0.004) | 4.0 ± 0.10 (0.157 ±0.004) | 2.0 ± 0.05 (0.079 ±0.002) | 0.10 (0.004) Maximum | 0.75 (0.030) | 25 (0.984) |
| Variable Dimensions — Millimeters (Inches) | | | | | | | |
| Tape Size | Pitch | E2 Minimum | F | P_1 | T Maximum | W Maximum | $A_0 B_0$ |
| 8 mm | Half (2 mm) | 6.25 (0.246) | 3.5 ± 0.05 (0.138 ±0.002) | 2.0 ± 0.05 (0.079 ±0.002) | 1.1 (0.098) | 8.3 (0.327) | Note 1 |
| 8 mm | Single (4 mm) | | | 4.0 ± 0.10 (0.157 ±0.004) | | | |

- The cavity defined by A_0 , B_0 and T shall surround the component with sufficient clearance that:
 - the component does not protrude beyond either surface of the carrier tape.
 - the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.
 - rotation of the component is limited to 20° maximum (see Figure 3).
 - lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4).
 - see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.
- 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

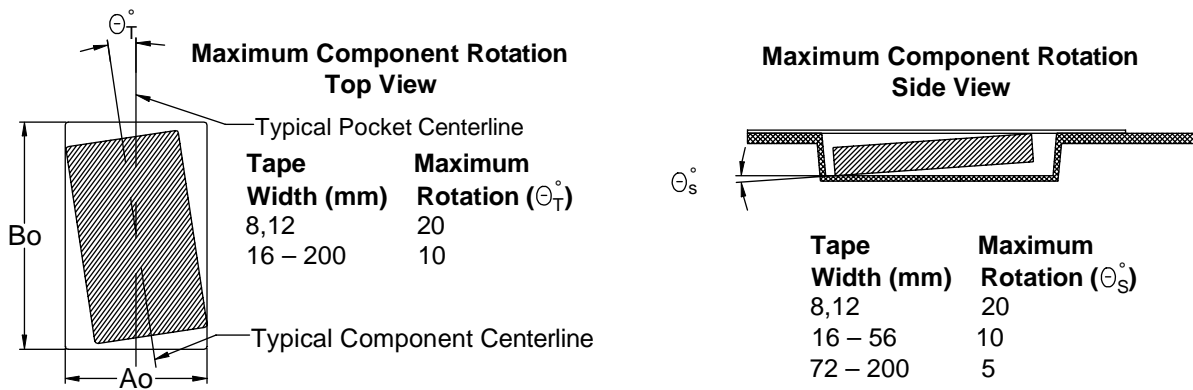


Figure 4 – Maximum Lateral Movement

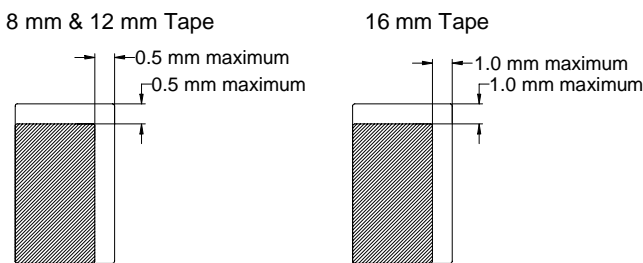


Figure 5 – Bending Radius

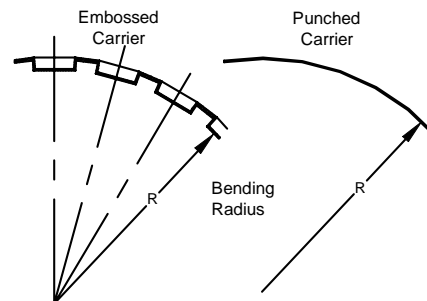
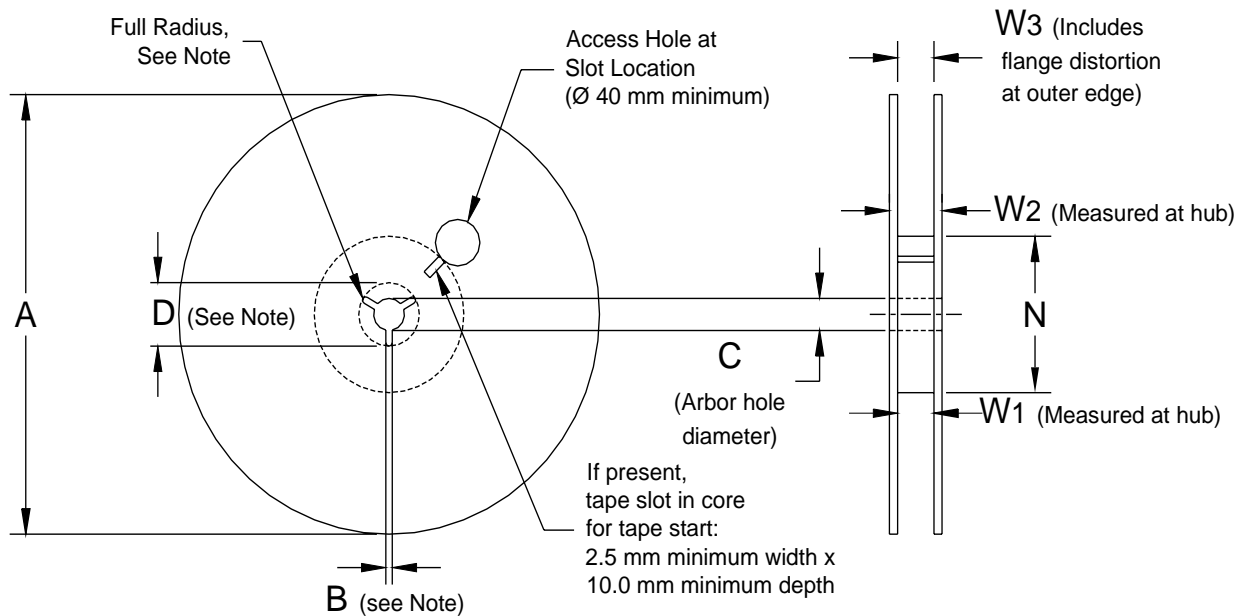


Figure 6 – Reel Dimensions



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

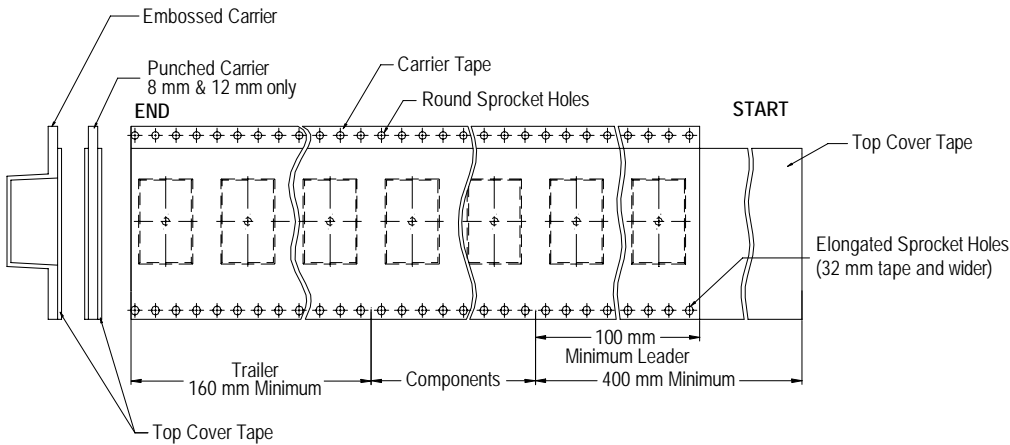


Figure 8 – Maximum Camber

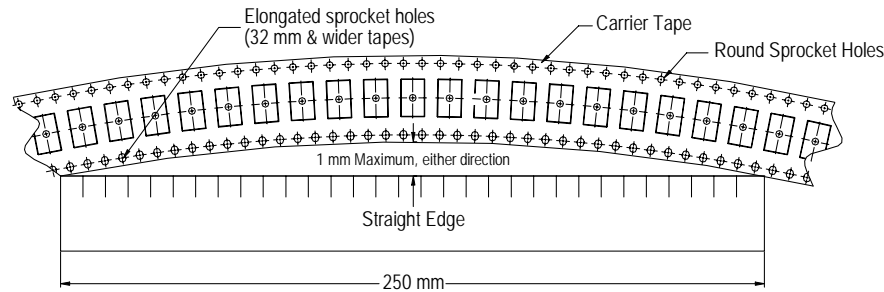


Figure 9 – Bulk Cassette Packaging (Ceramic Chips Only)

Meets Dimensional Requirements IEC-286 and EIAJ 7201

Unit mm *Reference

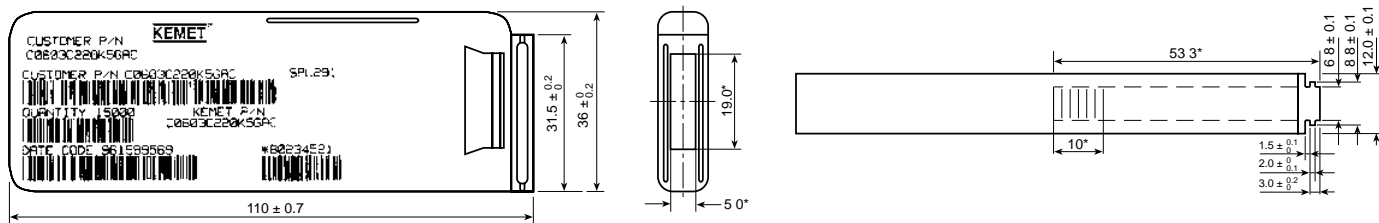


Table 9 – Capacitor Dimensions for Bulk Cassette

Cassette Packaging – Millimeters

| EIA Size Code | Metric Size Code | L Length | W Width | B Bandwidth | S Separation Minimum | T Thickness | Number of Pieces/Cassette |
|---------------|------------------|------------|------------|-------------|----------------------|-------------|---------------------------|
| 0402 | 1005 | 1.0 ± 0.05 | 0.5 ± 0.05 | 0.2 to 0.4 | 0.3 | 0.5 ± 0.05 | 50,000 |
| 0603 | 1608 | 1.6 ± 0.07 | 0.8 ± 0.07 | 0.2 to 0.5 | 0.7 | 0.8 ± 0.07 | 15,000 |

KEMET Corporation World Headquarters

2835 KEMET Way
Simpsonville, SC 29681

Mailing Address:
P.O. Box 5928
Greenville, SC 29606

www.kemet.com
Tel: 864-963-6300
Fax: 864-963-6521

Corporate Offices
Fort Lauderdale, FL
Tel: 954-766-2800

North America

Southeast
Lake Mary, FL
Tel: 407-855-8886

Northeast
Wilmington, MA
Tel: 978-658-1663

Central
Novi, MI
Tel: 248-994-1030

West
Milpitas, CA
Tel: 408-433-9950

Mexico
Guadalajara, Jalisco
Tel: 52-33-3123-2141

Europe

Southern Europe
Paris, France
Tel: 33-1-4646-1006

Sasso Marconi, Italy
Tel: 39-051-939111

Central Europe
Landsberg, Germany
Tel: 49-8191-3350800

Kamen, Germany
Tel: 49-2307-438110

Northern Europe
Bishop's Stortford, United Kingdom
Tel: 44-1279-460122

Espoo, Finland
Tel: 358-9-5406-5000

Asia

Northeast Asia
Hong Kong
Tel: 852-2305-1168

Shenzhen, China
Tel: 86-755-2518-1306

Beijing, China
Tel: 86-10-5829-1711

Shanghai, China
Tel: 86-21-6447-0707

Taipei, Taiwan
Tel: 886-2-27528585

Southeast Asia
Singapore
Tel: 65-6586-1900

Penang, Malaysia
Tel: 60-4-6430200

Bangalore, India
Tel: 91-806-53-76817

Note: KEMET reserves the right to modify minor details of internal and external construction at any time in the interest of product improvement. KEMET does not assume any responsibility for infringement that might result from the use of KEMET Capacitors in potential circuit designs. KEMET is a registered trademark of KEMET Electronics Corporation.

Other KEMET Resources

| Tools | |
|--------------------------------|-----------------------------------------------------------------------------|
| Resource | Location |
| Configure A Part: CapEdge | http://capacitoredge.kemet.com |
| SPICE & FIT Software | http://www.kemet.com/spice |
| Search Our FAQs: KnowledgeEdge | http://www.kemet.com/keask |
| Electrolytic LifeCalculator | http://www.kemet.com:8080/elc |

| Product Information | |
|------------------------------------------------------|-------------------------------------------------------------------------------------------|
| Resource | Location |
| Products | http://www.kemet.com/products |
| Technical Resources (Including Soldering Techniques) | http://www.kemet.com/technicalpapers |
| RoHS Statement | http://www.kemet.com/rohs |
| Quality Documents | http://www.kemet.com/qualitydocuments |

| Product Request | |
|-------------------------|-----------------------------------------------------------------------|
| Resource | Location |
| Sample Request | http://www.kemet.com/sample |
| Engineering Kit Request | http://www.kemet.com/kits |

| Contact | |
|--------------------|-------------------------------------------------------------------------------------|
| Resource | Location |
| Website | www.kemet.com |
| Contact Us | http://www.kemet.com/contact |
| Investor Relations | http://www.kemet.com/ir |
| Call Us | 1-877-MyKEMET |
| Twitter | http://twitter.com/kemetcapacitors |

Disclaimer

All product specifications, statements, information and data (collectively, the "Information") are subject to change without notice.

All Information given herein is believed to be accurate and reliable, but is presented without guarantee, warranty, or responsibility of any kind, expressed or implied.

Statements of suitability for certain applications are based on our knowledge of typical operating conditions for such applications, but are not intended to constitute – and we specifically disclaim – any warranty concerning suitability for a specific customer application or use. This Information is intended for use only by customers who have the requisite experience and capability to determine the correct products for their application. Any technical advice inferred from this Information or otherwise provided by us with reference to the use of our products is given gratis, and we assume no obligation or liability for the advice given or results obtained.

Although we design and manufacture our 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.

