Radial Through-Hole Multilayer Ceramic Capacitors

# Goldmax, 300, Radial, Conformally Coated, X8L Dielectric, 25 – 50 VDC (Commercial and Automotive Grade)

## Overview

KEMET's Goldmax conformally coated radial through-hole ceramic capacitors in X8L dielectric feature a +150°C maximum operating temperature and is considered "general purpose high temperature". These components are fixed, ceramic dielectric capacitors that are 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.

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

These devices meet the flame test requirements outlined in UL Standard 94V–0.

## Benefits

- Radial through-hole form factor
- Conformally coated
- Operating temperature range of -55°C to +150°C
- Lead (Pb)-Free, RoHS and REACH compliant

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## Ordering Information

| C | 320 | C | 475 | K | 3 | N | 5 | T | A | 7301 |
|---|---|---|---|---|---|---|---|---|---|---|
| Ceramic | Style/Size | Specification/ Series | Capacitance Code (pF) | Capacitance Tolerance[1] | Rated Voltage (VDC) | Dielectric | Design | Lead Finish | Failure Rate | Packaging (C-Spec) |
| | 315 316 317 318 320 321 322 323 324 325 326 327 328 | C = Standard | First two digits represent significant figures. Third digit specifies number of zeros. | J = ±5% K = ±10% M = ±20% | 3 = 25 5 = 50 | N = X8L | 5 = Multilayer | T = 100% Matte Sn H = SnPb (60/40) | A = N/A | See "Packaging C-Spec Ordering Options Table" below |

[1] *Additional capacitance tolerance offerings may be available. Contact KEMET for details.*

*For overmolding applications please contact your KEMET representative.*



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## Benefits cont'd

- DC voltage ratings of 25 and 50 V
- Capacitance offerings ranging from 0.15 µF up to 4.7 µF
- Available capacitance tolerances of ±5%, ±10% & ±20%
- Commercial and Automotive (AEC–Q200) grades available
- Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated lead finish allowing for excellent solderability
- SnPb-plated lead finish option available upon request (60/40)
- Encapsulation meets flammability standard UL 94V–0

## Applications

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

## Application Notes

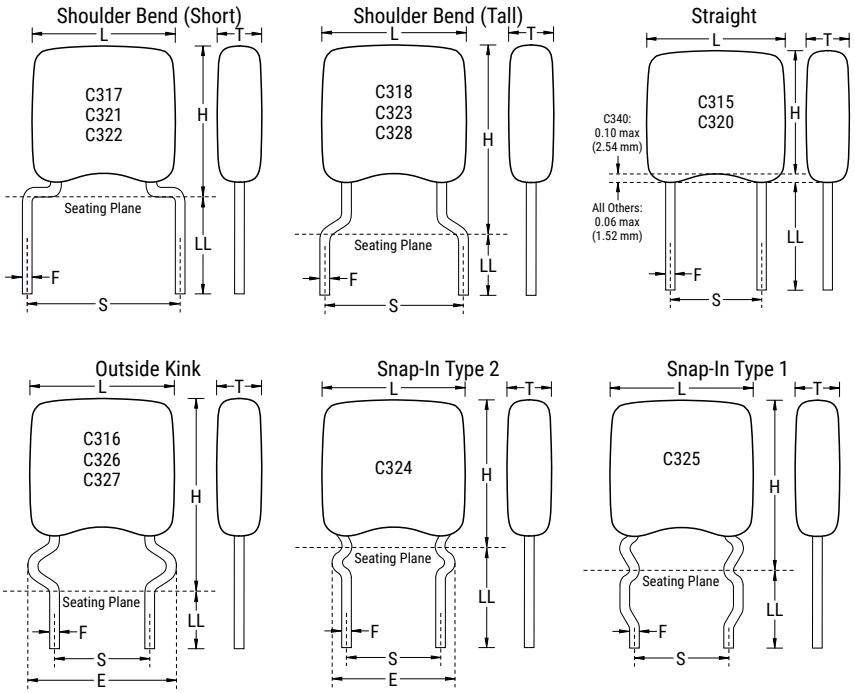
These devices are not recommended for use in overmold applications and/or processes.

## Packaging C-Spec Ordering Options Table

| Packaging Type[1] | Packaging/Grade Ordering Code (C-Spec) |
|---|---|
| Commercial Grade | |
| Bulk Bag | Not required (Blank) |
| 12" Tape & Reel (16.0±0.5 mm lead length) | 7301 |
| 12" Tape & Reel (18.0 mm minimum lead length) | 7303 |
| Ammo Pack (16.0±0.5 mm lead length) | 7305 |
| Ammo Pack (18.0 mm minimum lead length) | 7317 |
| Automotive Grade | |
| Bulk Bag Automotive Grade | 9170 |
| 12" Tape & Reel (16.0±0.5 mm lead length) | 9170 7301 |
| 12" Tape & Reel (18.0 mm minimum lead length) | 9170 7303 |
| Ammo Pack (16.0±0.5 mm lead length) | 9170 7305 |
| Ammo Pack (18.0 mm minimum lead length) | 9170 7317 |

[1] *Bulk bag option is required for Size/Style C321 and C331.*

## Dimensions – Inches (Millimeters)




** May be supplied in a "Shoulder Bend" or "Straight" Lead configuration. Please see Capacitance Range Waterfall section of this document to determine lead configuration availability by capacitance value.*

| Series | Style / Size | S Lead Spacing ± 0.030 (0.78) | L Length Maximum | H Height Maximum | T Thickness Maximum | F Lead Diameter +0.004 (0.10), −0.001 (0.025) | LL Lead Length Minimum |
|---|---|---|---|---|---|---|---|
| C31X | 315 | 0.100 (2.54) | 0.150 (3.81) | 0.120 (3.14) | 0.100 (2.54) | 0.020 (0.51) | 0.276 (7.00) |
| | 316 | | 0.150 (3.81) | 0.230 (5.08) | 0.100 (2.54) | | 0.200 (5.08) |
| C32X | 324 | | 0.200 (5.08) | 0.230 (5.84) | 0.125 (3.18)[1] | | 0.276 (7.00) |
| | 320 | | 0.200 (5.08) | 0.230 (5.84) | 0.125 (3.18)[1] | | 0.276 (7.00) |
| | 326 | | 0.200 (5.08) | 0.300 (7.62) | 0.125 (3.18)[1] | | 0.200 (5.08) |
| C31X | 317 | 0.200 (5.08) | 0.150 (3.81) | 0.200 (5.08) | 0.100 (2.54) | | 0.276 (7.00) |
| | 318 | | 0.150 (3.81) | 0.235 (5.97) | 0.100 (2.54) | | 0.276 (7.00) |
| C32X | 321 | 0.250 (6.35) | 0.200 (5.08) | 0.260 (6.60) | 0.125 (3.18)[1] | | 0.276 (7.00) |
| | 322 | 0.200 (5.08) | 0.200 (5.08) | 0.260 (6.60) | 0.125 (3.18)[1] | | 0.276 (7.00) |
| | 323 | | 0.200 (5.08) | 0.300 (7.62) | 0.125 (3.18)[1] | | 0.276 (7.00) |
| | 325 | | 0.200 (5.08) | 0.300 (7.62) | 0.125 (3.18)[1] | | 0.276 (7.00) |
| | 328 | | 0.200 (5.08) | 0.300 (7.62) | 0.125 (3.18)[1] | | 0.276 (7.00) |
| | 327 | | 0.200 (5.08) | 0.320 (8.13) | 0.125 (3.18)[1] | | 0.200 (5.08) |

*[1] Thickness maximum (T) = 0.160" (4.07 mm) for capacitance values greater than or equal to 4.7 µF*

## Automotive C-Spec Information

KEMET Automotive Grade products meet or exceed the requirements outlined by the Automotive Electronics Council. The details regarding test methods and conditions are referenced in the 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, "9170." 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's 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 |
| 9170 | 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 record 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 (Product Part Approval Process) Level | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| KEMET assigned[1] | ● | ● | ● | ● | ● |
| 9170 | ○ | | ○ | | |

*[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
○ Product family PPAP only

## Qualification/Certification

Commercial Grade products are subject to internal qualification. Details regarding test methods and conditions are referenced in Table 2, 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

Lead (Pb)-free, REACH and RoHS compliant without exemptions when ordered with a 100% tin (Sn) wire lead finish. Product ordered with tin/ lead (Sn60/Pb40) wire lead finish do not meet RoHS criteria.

| Series | Termination Finish (Wire Lead) | RoHS Compliant | RoHS Exemption Code | REACH Compliant[1] | Halogen Free |
|---|---|---|---|---|---|
| 300 (C3XX) | 100% Matte Sn | Yes | n/a | Yes | Yes |
| | Sn60/Pb40 | No | n/a | Yes | Yes |

[1] *REACH compliance indicates product does not contain Substance/s of Very High Concern (SVHC*

## 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%(−55ºC to +125ºC) +15%, −40% (+125°C to +150°C) |
| Aging Rate (Maximum % Cap Loss/Decade Hour): | 3.0% |
| Dielectric Withstanding Voltage: | 250% of rated voltage<br>(5±1 seconds and charge/discharge not exceeding 50 mA at +25°C) |
| Dissipation Factor (DF) Maximum Limit at +25ºC: | 2.5% |
| Insulation Resistance (IR) Limit at +25°C: | 1,000 megohm microfarads or 100 GΩ<br>(Rated voltage applied for 120±5 seconds at +25°C) |

*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 MHz ±100 kHz and 1.0 $V_{rms}$ ±0.2 V if capacitance ≤ 1,000 pF*

*1 kHz ±50 Hz and 1.0 $V_{rms}$ ±0.2 V if capacitance > 1,000 pF*

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

## Post Environmental Limits

| High Temperature Life, Biased Humidity and Storage Life | | | | | |
|---|---|---|---|---|---|
| Dielectric | Rated DC Voltage | Capacitance Value | DF (%) | Capacitance Shift | IR |
| X8L | 25 | All | 5.0 | ±20% | 10% of initial limit |
| | 50 | | 3.0 | | |

## Table 1A - C31X Style/Size (0.100" & 0.200" Lead Spacing), Capacitance Range Waterfall

| C315, C316, C317, C318 Style/Size (0.100" & 0.200" Lead Spacing) | | | |
|---|---|---|---|
| **Rated Voltage (VDC)** | | **25** | **50** |
| **Voltage Code** | | **3** | **5** |
| **Capacitance** | **Capacitance Tolerance** | **Capacitance Code (Available Capacitance)** | |
| 0.15µF | J = ±5%<br>K = ±10%<br>M = ±20% | 154 | 154 |
| 0.18µF | | 184 | 184 |
| 0.22µF | | 224 | 224 |
| 0.27µF | | 274 | |
| 0.33µF | | 334 | |
| 0.39µF | | 394 | |
| 0.47µF | | 474 | |
| 0.56µF | | 564 | |
| 0.68µF | | 684 | |
| **Rated Voltage (VDC)** | | **25** | **50** |
| **Voltage Code** | | **3** | **5** |

## Table 1B - C32X Style/Size (0.100" & 0.200" Lead Spacing), Capacitance Range Waterfall

| C320, C322, C323, C326, C328 Style/Size (0.100" & 0.200" Lead Spacing) | | | |
|---|---|---|---|
| **Rated Voltage (VDC)** | | **25** | **50** |
| **Voltage Code** | | **3** | **5** |
| **Capacitance** | **Capacitance Tolerance** | **Capacitance Code (Available Capacitance)** | |
| 0.15µF | J = ±5%<br>K = ±10%<br>M = ±20% | 154 | 154 |
| 0.18µF | | 184 | 184 |
| 0.22µF | | 224 | 224 |
| 0.27µF | | 274 | |
| 0.33µF | | 334 | |
| 0.39µF | | 394 | 394 |
| 0.47µF | | 474 | 474 |
| 0.56µF | | 564 | 564 |
| 0.68µF | | 684 | 684 |
| 0.82µF | | 824 | 824 |
| 1.0µF | | 105 | 105 |
| 1.2µF | | 125 | |
| 1.5µF | | 155 | |
| 1.8µF | | 185 | |
| 2.2µF | | 225 | |
| 2.7µF | | 275 | |
| 3.3µF | | 335 | |
| 3.9µF | | 395 | |
| 4.7µF | | 475 | |
| **Rated Voltage (VDC)** | | **25** | **50** |
| **Voltage Code** | | **3** | **5** |

# Table 1C - C32X Style/Size (0.100" & 0.200" Lead Spacing), Capacitance Range Waterfall

| C321, C324, C325, C327 Style/Size (0.100" & 0.200" Lead Spacing) | | | |
|---|---|---|---|
| **Rated Voltage (VDC)** | | **25** | **50** |
| **Voltage Code** | | **3** | **5** |
| **Capacitance** | **Capacitance Tolerance** | **Capacitance Code (Available Capacitance)** | |
| 0.39µF | J = ±5%<br>K = ±10%<br>M = ±20% | 394 | 394 |
| 0.47µF | | 474 | 474 |
| 0.56µF | | 564 | 564 |
| 0.68µF | | 684 | 684 |
| 0.82µF | | 824 | 824 |
| 1.0µF | | 105 | 105 |
| 1.2µF | | 125 | |
| 1.5µF | | 155 | |
| 1.8µF | | 185 | |
| 2.2µF | | 225 | |
| 2.7µF | | 275 | |
| 3.3µF | | 335 | |
| 3.9µF | | 395 | |
| 4.7µF | | 475 | |
| **Rated Voltage (VDC)** | | **25** | **50** |
| **Voltage Code** | | **3** | **5** |

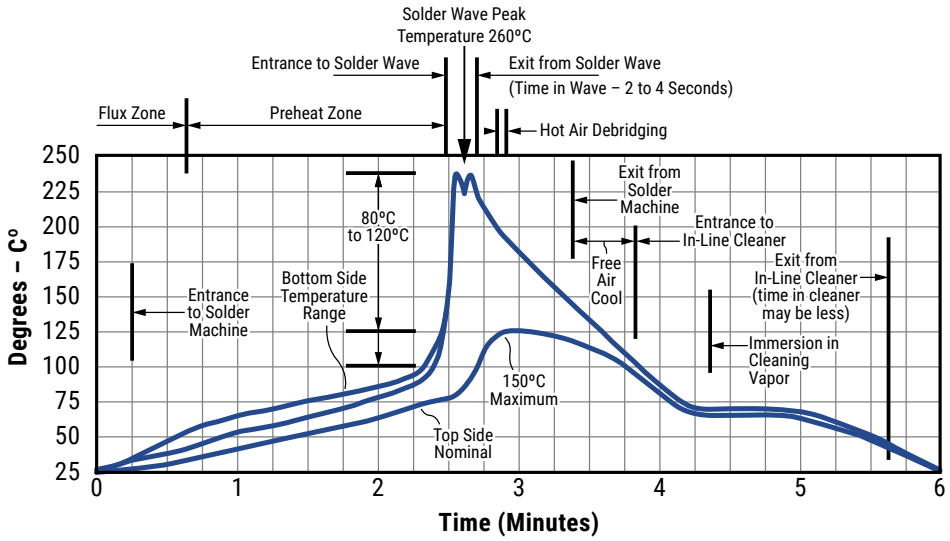
## Soldering Process

**Recommended Soldering Methods:**

- Solder Wave
- Hand Soldering (Manual)

**Recommended Soldering Profile:**

- Optimum Wave Solder Profile



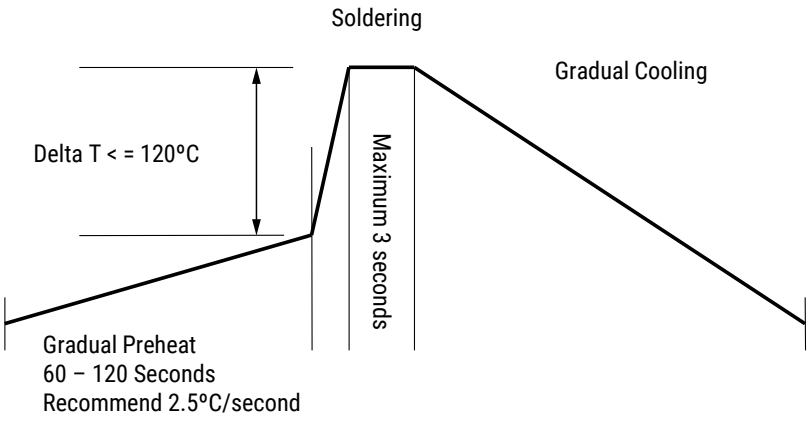

**Mounting**

All encased capacitors will pass the Resistance to Soldering Heat of MIL-STD-202, Method 210, Condition B. This test simulates wave solder topside board mount product. This demonstration of resistance to solder heat is in accordance with what is believed to be the industry standard. More severe treatment must be considered reflective of an improper soldering process.

The above figure is a recommended solder wave profile for both axial and radial leaded ceramic capacitors.

- Hand Soldering (Manual)

**Manual Solder Profile with Pre-heating**



## Table 2 – Performance & Reliability: Test Methods and Conditions

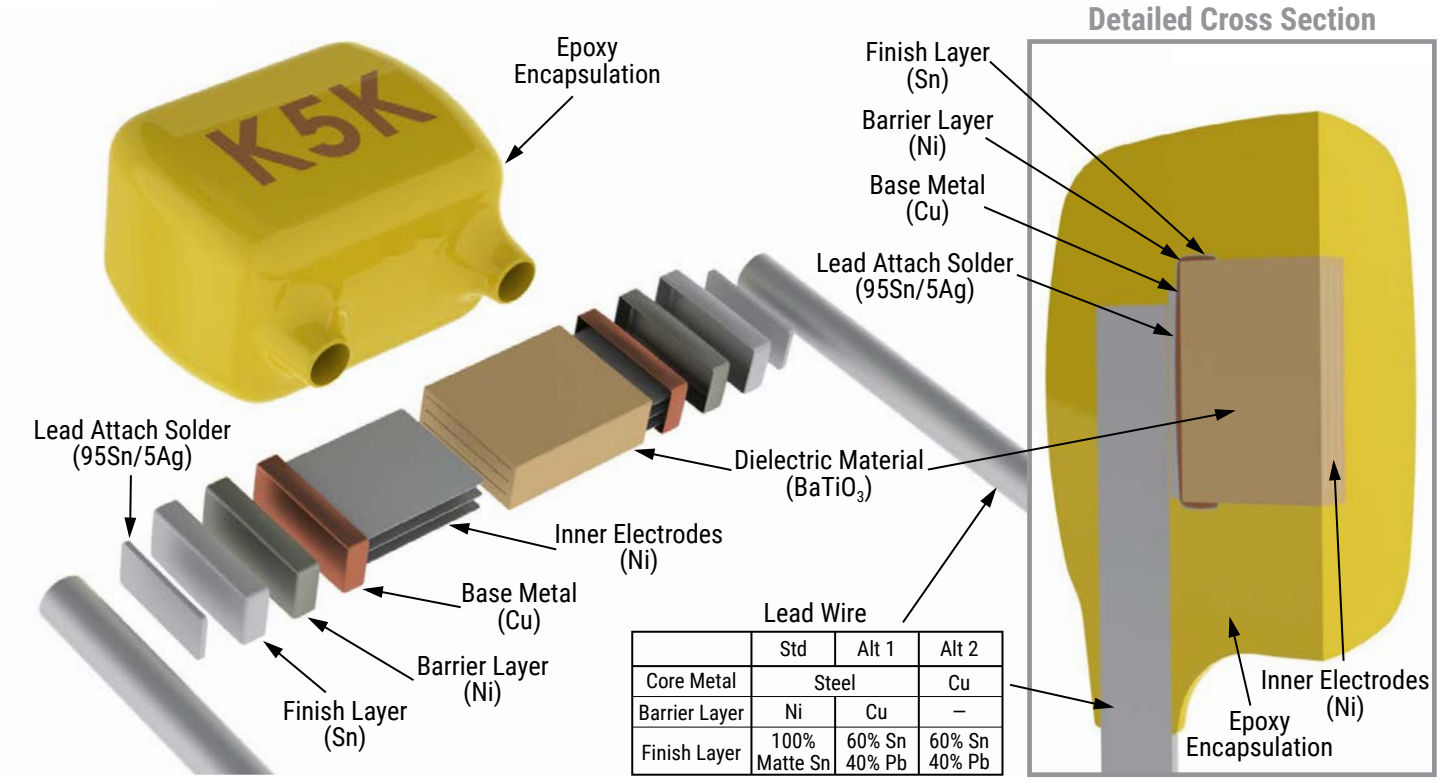
| Stress | Reference | Test or Inspection Method |
|---|---|---|
| Solderability | J–STD–002 | Magnification 50X. Conditions:<br>a) Method A, at 235°C, Category 3 |
| Temperature Cycling | JESD22 Method JA–104 | 5 cycles (–55°C to +125°C), measurement at 24 hours +/–4 hours after test conclusion. |
| Biased Humidity | MIL–STD–202 Method 103 | Load humidity, 1,000 hours 85°C/85%RH and rated voltage. Add 100 K ohm resistor. Measurement at 24 hours +/–4 hours after test conclusion. |
| | | Low volt humidity, 1,000 hours 85C°/85%RH and 1.5 V. Add 100 K ohm resistor. Measurement at 24 hours +/–4 hours after test conclusion. |
| Moisture Resistance | MIL–STD–202 Method 106 | t = 24 hours/cycle. Steps 7a & 7b not required. Unpowered. Measurement at 24 hours +/–4 hours after test conclusion. |
| Thermal Shock | MIL–STD–202 Method 107 | –55°C to +125°C. 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 125°C (85°C for Z5U) with 1 X rated voltage applied. |
| Storage Life | MIL–STD–202 Method 108 | 125°C, 0 VDC for 1,000 hours. |
| Vibration | MIL–STD–202 Method 204 | 5 g for 20 minutes, 12 cycles each of 3 orientations. Note: Use 8"X5" PCB .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 10–2000 Hz. |
| Resistance to Soldering Heat | MIL–STD–202 Method 210 | Condition B. No preheat of samples. Note: single wave solder – procedure 2. |
| Terminal Strength | MIL–STD–202 Method 211 | Conditions A (454g), Condition C (227g) |
| Mechanical Shock | MIL–STD–202 Method 213 | Figure 1 of Method 213, Condition C. |
| Resistance to Solvents | MIL–STD–202 Method 215 | Add aqueous wash chemical – OKEM Clean or equivalent. |

## Storage & Handling

The un-mounted storage life of a leaded ceramic capacitor is dependent upon storage and atmospheric conditions as well as packaging materials. While the ceramic chips enveloped under the epoxy coating themselves are quite robust in most environments, solderability of the wire lead on the final epoxy-coated product will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will be degraded by high temperature and exposure to direct sunlight – reels may soften or warp, and tape peel force may increase.

KEMET recommends storing the un-mounted capacitors in their original packaging, in a location away from direct sunlight, and where the temperature and relative humidity do not exceed 40 degrees centigrade and 70% respectively. For optimum solderability, capacitor stock should be used promptly, preferably within 18 months of receipt. For applications requiring pre-tinning of components, storage life may be extended if solderability is verified. Before cleaning, bonding or molding these devices, it is important to verify that your process does not affect product quality and performance. KEMET recommends testing and evaluating the performance of a cleaned, bonded or molded product prior to implementing and/or qualifying any of these processes.

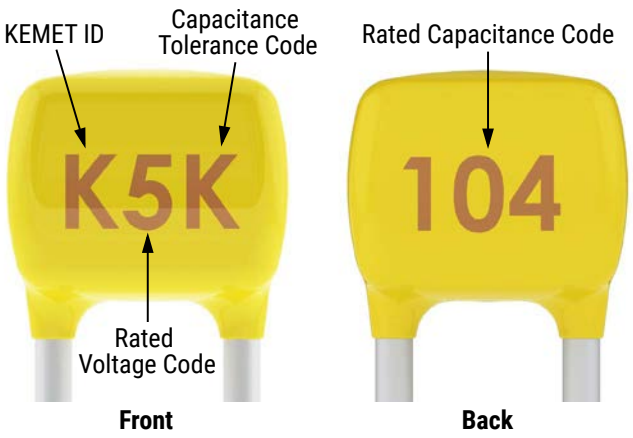
## Construction




| | Std | Alt 1 | Alt 2 |
|---|---|---|---|
| Core Metal | Steel | | Cu |
| Barrier Layer | Ni | Cu | – |
| Finish Layer | 100% Matte Sn | 60% Sn 40% Pb | 60% Sn 40% Pb |

## Marking

**STYLE/SIZE C31X, C32X**




[1] *To properly request the inclusion of the date code in the marking ordering code please contact your KEMET representative.*

## Packaging Quantities

| Style/ Size | Standard Bulk Quantity | Ammo Pack Quantity Maximum | Reel Quantity Maximum (12" Reel) |
|---|---|---|---|
| 315 | 500/Bag | 2,500 | 2,500 |
| 316 | | | |
| 317 | | | |
| 318 | | | |
| 320 | | | |
| 321 | | N/A | N/A |
| 322 | | 2,500 | 2,500 |
| 323 | | | |
| 324 | | | |
| 325 | | | |
| 326 | | | |
| 327 | | | |
| 328 | | | |

## Tape & Reel Packaging Information

KEMET offers standard reeling of Molded and Conformally Coated Radial Leaded Capacitors in accordance with EIA standard 468. Parts are taped to a tagboard carrier strip, and wound on a reel as shown in Figure 1. Kraft paper interleaving is inserted between the layers of capacitors on the reel. Ammopack is also available, with the same lead tape configuration and package quantities.

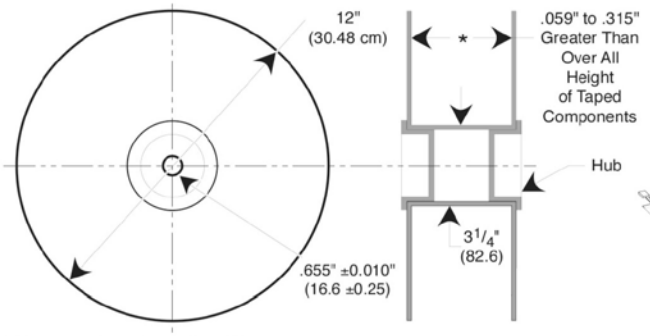
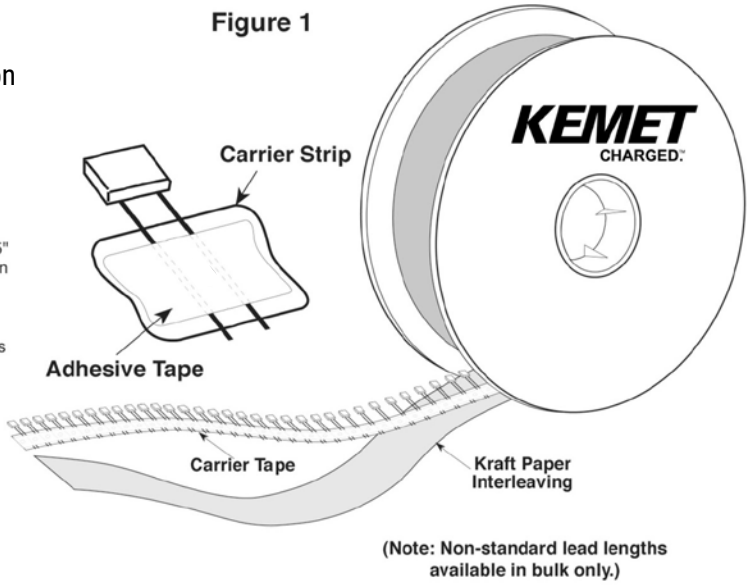



Figure 3: Standard Reel

Figure 1



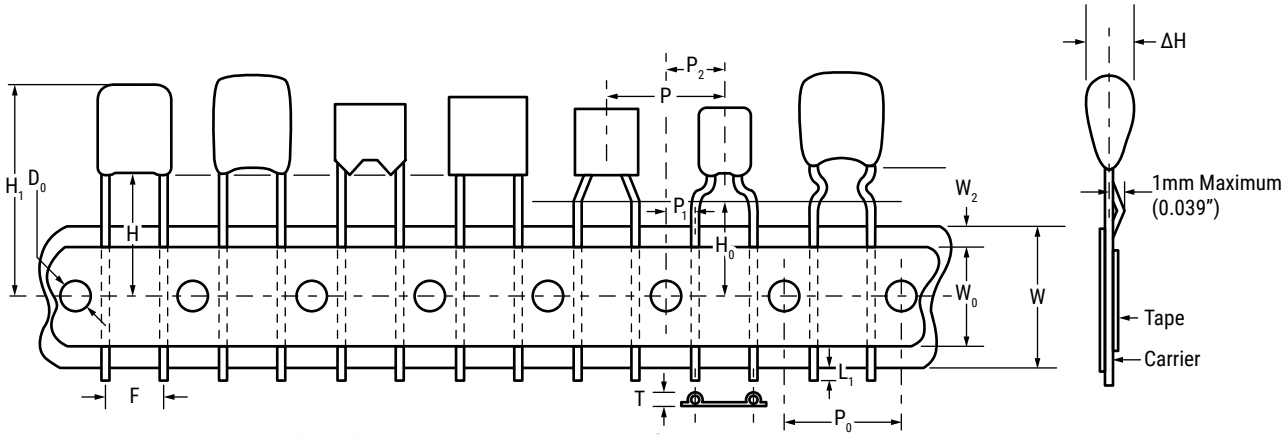




Figure 2: Lead Tape Configuration (See Table Below)

## Ceramic Radial Tape and Reel Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $D_0$ ±0.2 (0.008) | $P_0$ ±0.3 (0.012) | ΔH ±0.2 (0.008) | $L_1$ Maximum | t ±0.2 (0.008) | T Maximum | W +1.0/−0.5 (+0.039/−0.020) | $W_0$ Minimum | $W_2$ Maximum |
| 4.00 (0.157) | 12.7 (0.500) | 4.0 (0.157) | 1.0 (0.039) | 0.7 (0.051) | 1.5 (0.059) | 18.0 (0.709) | 5.0 (0.197) | 3.0 (0.118) |

## Ceramic Radial Tape and Reel Dimensions cont'd

Metric will govern

| Variable Dimensions — Millimeters (Inches) | | | | | | | |
|---|---|---|---|---|---|---|---|
| F ±0.78 (0.030)[1] | $P_1$ ±0.30 (0.012)[1] | P ±0.3 (0.012) | $P_2$ ±1.3 (0.51) | H | | $H_0$ | |
| | | | | Straight Lead Configuration | | Formed Lead Configuration[2] | |
| | | | | Packaging C-Spec[3] | | | |
| | | | | 7301/7305 | 7303/7317 | 7301/7305 | 7303/7317 |
| 2.54 (0.100) | 5.08 (0.200) | 12.7 (0.500) | 6.35 (0.250) | 16.0±0.5 (0.630±0.020) | 18.0 (0.709) Minimum | 16.0±0.5 (0.630±0.020) | 18.0 (0.709) Minimum |
| 4.32 (0.170) | 3.89 (0.153) | 12.7 (0.500) | 6.35 (0.250) | | | | |
| 5.08 (0.200) | 3.81 (0.150) | 12.7 (0.500) | 6.35 (0.250) | | | | |
| 5.59 (0.220) | 3.25 (0.128) | 12.7 (0.500) | 6.35 (0.250) | | | | |
| 6.98 (0.275) | 2.54 (0.100) | 12.7 (0.500) | 6.35 (0.250) | | | | |
| 7.62 (0.300) | 2.24 (0.088) | 12.7 (0.500) | 6.35 (0.250) | | | | |
| 9.52 (0.375) | 7.62 (0.300) | 12.7 (0.500) | 6.35 (0.250) | | | | |
| 10.16 (0.400) | 7.34 (0.290) | 25.4 (1.000) | N/A | | | | |
| 12.06 (0.475) | 6.35 (0.250) | 25.4 (1.000) | N/A | | | | |
| 14.60 (0.575) | 5.08 (0.200) | 25.4 (1.000) | N/A | | | | |
| 17.14 (0.675) | 3.81 (0.15) | 25.4 (1.000) | N/A | | | | |

*[1] Measured at the egress from the carrier tape, on the component side.*

*[2] Formed lead configuration includes: "shoulder bend", "inside kink", "outside kink", and "snap-in". For more information regarding available lead configurations see "Dimensions" section of this document.*

*[3] The "Packaging C-Spec" is a 4 digit code which identifies the packaging type, lead length and/or lead material. When ordering, the proper code must be included in the 15th through 18th character positions of the ordering code. See "Ordering Information" section of this document for further details.*

| Symbol Reference Table | |
|---|---|
| $D_0$ | Sprocket Hole Diameter |
| $P_0$ | Sprocket Hole Pitch |
| P | Component Pitch |
| F | Lead Spacing |
| $P_1$ | Sprocket Hole Center to Lead Center |
| $P_2$ | Sprocket Hole Center To Component Center |
| H | Height to Seating Plane (Straight Leads Only) |
| $H_0$ | Height to Seating Plane (Formed Leads Only) |
| $H_1$ | Component Height Above Tape Center |
| ΔH | Component Alignment |
| $L_1$ | Lead Protrusion |
| t | Composite Tape Thickness |
| W | Carrier Tape Width |
| $W_0$ | Hold-Down Tape Width |
| $W_2$ | Hold-Down Tape Location |

## KEMET Electronic Corporation Sales Offices

For a complete list of our global sales offices, please visit www.kemet.com/sales.

## Disclaimer

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