

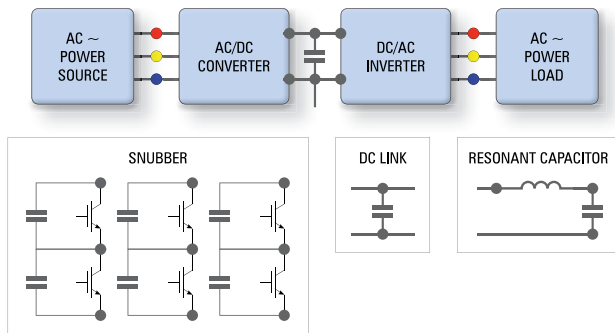
# KC-LINK™ for Fast Switching Semiconductor Applications

## DC Link, Snubber, Resonator Capacitor, 150°C

### (Commercial & Automotive Grade)

#### Overview

KEMET's KC-LINK surface mount capacitors are designed to meet the growing demand for fast switching wide bandgap (WBG) semiconductors that operate at higher voltages, temperatures, and frequencies. By utilizing KEMET's robust and proprietary COG/NPO base metal electrode (BME) dielectric system, these capacitors are well suited for power converters, inverters, snubbers, and resonators, where high efficiency is a primary concern. With extremely low effective series resistance (ESR) and very low thermal resistance, KC-LINK capacitors can operate at very high ripple currents with no change in capacitance versus DC voltage, and negligible change in capacitance versus temperature. With an operating temperature of 150°C, these capacitors can be mounted close to fast switching semiconductors in high power density applications, which require minimal cooling.

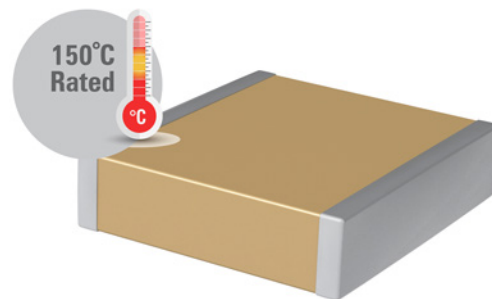


#### Benefits

- EIA 1812, 2220, and 3640 case size
- AEC-Q200 automotive qualified
- Flexible termination option available
- Very high ripple current capability
- Extremely low equivalent series resistance (ESR)
- Extremely low equivalent series inductance (ESL)
- Operating temperature range of -55°C to +150°C
- High frequency operation (> 10 MHz)
- No capacitance shift with voltage
- No piezoelectric noise
- High thermal stability
- RoHS compliant and Pb-free

KC-LINK COG dielectric technology also exhibits high mechanical robustness compared to other dielectric technologies, allowing the capacitor to be mounted without the use of lead frames. This provides extremely low effective series inductance (ESL) increasing the operating frequency range allowing for further miniaturization. For added reliability, KC-LINK is now available with flexible termination technology that provides superior flex performance over standard termination systems, addressing the primary failure mode of MLCC's flex cracks.

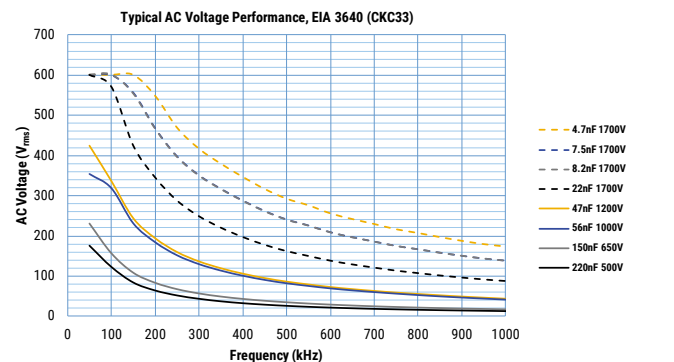
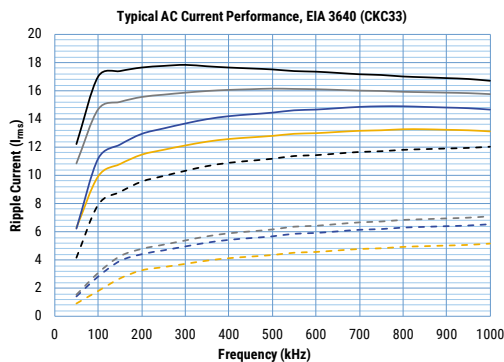
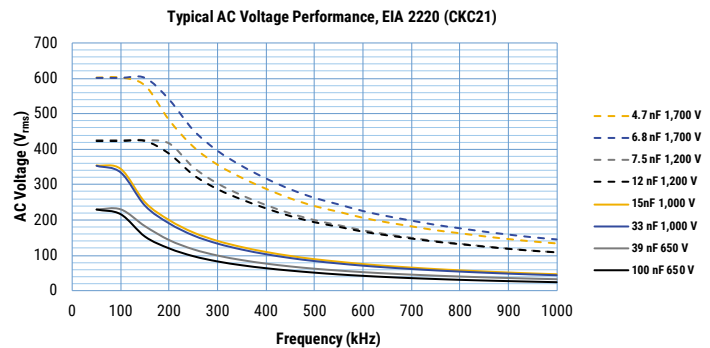
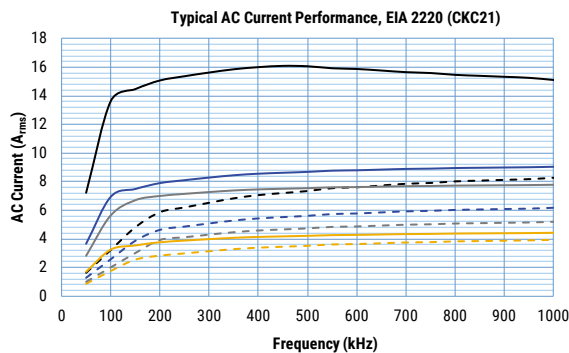
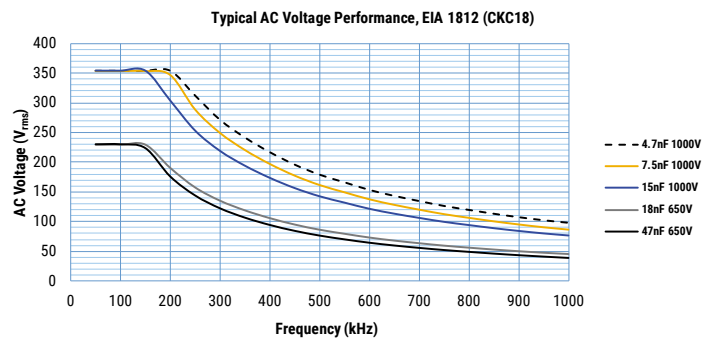
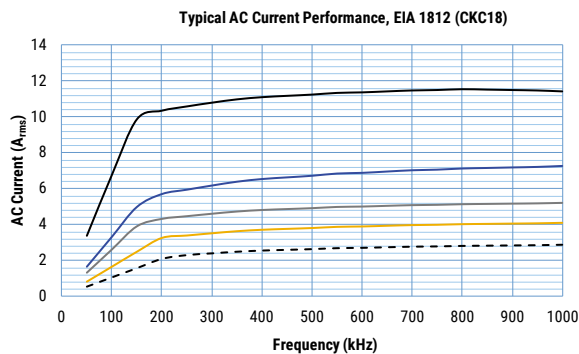
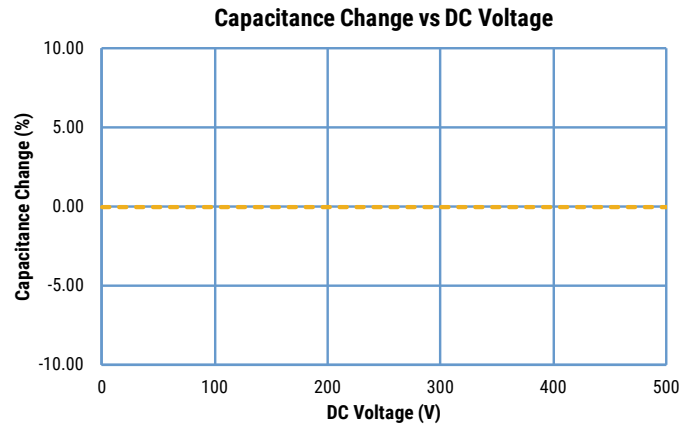
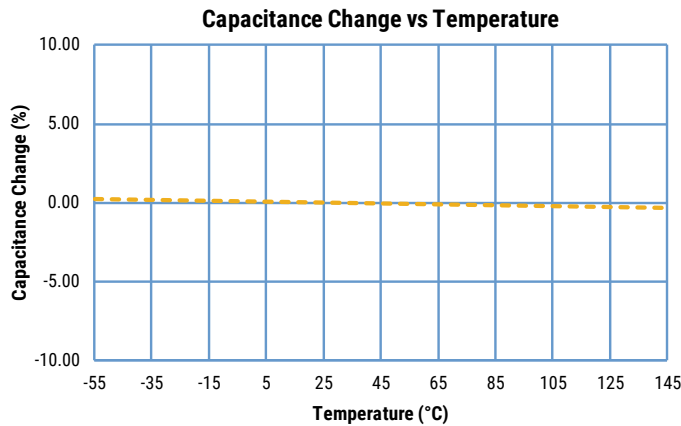
In addition to commercial grade, automotive grade devices are available and meet the demanding Automotive Electronics Council's AEC-Q200 qualification requirements.



#### Applications

- Wide bandgap (WBG), silicon carbide (SiC) and gallium nitride (GaN) systems
- EV/HEV (drive systems, charging)
- Wireless charging
- Photovoltaic systems
- Power converters
- Inverters
- LLC resonant converters
- DC link
- Snubber

## Typical Performance



\*Ripple current measurements conditions: - Ripple current measurement were took under ambient temperature. Ripple current measurements performed with a peak capacitor temperature of 150°C. Samples mounted to heat sink with no forced air cooling.

## Ordering Information

| CKC           | 33                                  | C                                     | 224                                                                                    | K                                                     | C                                                                                  | G          | A                    | C                  | TU                                            |
|---------------|-------------------------------------|---------------------------------------|----------------------------------------------------------------------------------------|-------------------------------------------------------|------------------------------------------------------------------------------------|------------|----------------------|--------------------|-----------------------------------------------|
| Series        | Case Size (L"x W")                  | Specification/ Series                 | Capacitance Code (pF)                                                                  | Capacitance Tolerance                                 | Rated Voltage (V)                                                                  | Dielectric | Subclass Designation | Termination Finish | Packaging (Suffix/C-Spec)                     |
| CKC = KC-LINK | 18 = 1812<br>21 = 2220<br>33 = 3640 | C = Standard<br>X = Flex <sup>1</sup> | Two single digits and number of zeros.<br>Use 9 for 1.0 – 9.9 pF<br>e.g., 2.2 pF = 229 | F = ±1%<br>G = ±2%<br>J = ±5%<br>K = ±10%<br>M = ±20% | C = 500 V<br>W = 650 V<br>D = 1,000 V<br>E = 1,200 V<br>J = 1,700 V<br>G = 2,000 V | G = C0G    | A = N/A              | C = 100% matte Sn  | See "Packaging C-Spec Ordering Options Table" |

<sup>1</sup> Flexible termination is only available for EIA 1812 and 2220 case sizes.

## Environmental Compliance

Lead (Pb)-free, RoHS, and REACH compliant without exemptions.



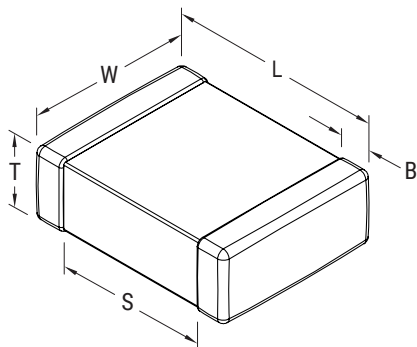
## Packaging C-Spec Ordering Options Table

| Packaging Type                            | Packaging/Grade Ordering Code (C-Spec) |
|-------------------------------------------|----------------------------------------|
| <b>Commercial Grade</b>                   |                                        |
| Bulk Bag <sup>1</sup> /Unmarked           | Not required (Blank)                   |
| 7" Reel/Unmarked                          | TU                                     |
| 13" Reel (Embossed Plastic Tape)/Unmarked | 7210                                   |
| <b>Automotive Grade<sup>2</sup></b>       |                                        |
| 7" Reel                                   | AUTO                                   |
| 13" Reel (Embossed Plastic Tape)/Unmarked | AUTO7210                               |

<sup>1</sup> Default packaging is "Bulk Bag". An ordering code C-Spec is not required for "Bulk Bag" packaging. "Bulk Bag" packaging option is not available for case sizes larger than 2225 (5664 Metric).

<sup>2</sup> For additional information regarding "AUTO" C-Spec options, see "Automotive C-Spec Information."

## Dimensions – Millimeters (Inches)



### Standard Termination

| KC-LINK CODE | EIA SIZE CODE | METRIC SIZE CODE | L LENGTH                      | W WIDTH                        | T THICKNESS               | B BANDWIDTH                   | S SEPARATION Minimum | Mounting Technique |
|--------------|---------------|------------------|-------------------------------|--------------------------------|---------------------------|-------------------------------|----------------------|--------------------|
| 18           | 1812          | 4532             | 4.50 (0.177)<br>±0.30 (0.012) | 3.20 (0.126)<br>±0.30 (0.012)  | See Table 2 for Thickness | 0.60 (0.024)<br>±0.35 (0.014) | 2.30 (0.091)         | Solder Reflow Only |
| 21           | 2220          | 5650             | 5.70 (0.224)<br>±0.40 (0.016) | 5.00 (0.197)<br>±0.40 (0.016)  |                           | 0.60 (0.024)<br>±0.35 (0.014) | 3.50 (0.138)         |                    |
| 33           | 3640          | 9210             | 9.30 (0.366)<br>±0.40 (0.016) | 10.20 (0.402)<br>±0.40 (0.016) |                           | 1.27 (0.050)<br>±0.40 (0.016) | 6.30 (0.248)         |                    |

### Flex Termination

| KC-LINK CODE | EIA SIZE CODE | METRIC SIZE CODE | L LENGTH                      | W WIDTH                       | T THICKNESS               | B BANDWIDTH                   | S SEPARATION Minimum | Mounting Technique |
|--------------|---------------|------------------|-------------------------------|-------------------------------|---------------------------|-------------------------------|----------------------|--------------------|
| 18           | 1812          | 4532             | 4.50 (0.178)<br>±0.40 (0.016) | 3.20 (0.126)<br>±0.30 (0.012) | See Table 2 for Thickness | 0.70 (0.028)<br>±0.35 (0.014) | 2.30 (0.091)         | Solder Reflow Only |
| 21           | 2220          | 5650             | 5.90 (0.232)<br>±0.75 (0.030) | 5.00 (0.197)<br>±0.40 (0.016) |                           | 0.70 (0.028)<br>±0.35 (0.014) | 3.50 (0.138)         |                    |

**Table 1 – Capacitance Range/Selection Waterfall Standard Termination**

| Capacitance | Capacitance Code | Case Size/Series      |   |   |   |   | CKC18C                                                                                             |     |      | CKC21C |     |      |      |      | CKC33C |     |      |      |      |      |
|-------------|------------------|-----------------------|---|---|---|---|----------------------------------------------------------------------------------------------------|-----|------|--------|-----|------|------|------|--------|-----|------|------|------|------|
|             |                  |                       |   |   |   |   | 1812                                                                                               |     |      | 2220   |     |      |      |      | 3640   |     |      |      |      |      |
|             |                  | Voltage Code          |   |   |   |   | C                                                                                                  | W   | D    | C      | W   | D    | E    | J    | C      | W   | D    | E    | J    | G    |
|             |                  | Rated Voltage (VDC)   |   |   |   |   | 500                                                                                                | 650 | 1000 | 500    | 650 | 1000 | 1200 | 1700 | 500    | 650 | 1000 | 1200 | 1700 | 2000 |
|             |                  | Capacitance Tolerance |   |   |   |   | Product Availability and Chip Thickness Codes<br>See Packaging Specs for Chip Thickness Dimensions |     |      |        |     |      |      |      |        |     |      |      |      |      |
| 4,700 pF    | 472              | F                     | G | J | K | M | GD                                                                                                 | GD  | GD   | JK     | JK  | JK   | JK   | JK   | MA     | MA  | MA   | MA   | MA   | MA   |
| 5,100 pF    | 512              | F                     | G | J | K | M | GD                                                                                                 | GD  | GD   | JL     | JL  | JL   | JL   | JL   | MA     | MA  | MA   | MA   | MA   | MA   |
| 5,600 pF    | 562              | F                     | G | J | K | M | GD                                                                                                 | GD  | GD   | JL     | JL  | JL   | JL   | JL   | MA     | MA  | MA   | MA   | MA   | MA   |
| 6,200 pF    | 622              | F                     | G | J | K | M | GH                                                                                                 | GH  | GH   | JN     | JN  | JN   | JN   | JN   | MA     | MA  | MA   | MA   | MA   | MA   |
| 6,800 pF    | 682              | F                     | G | J | K | M | GH                                                                                                 | GH  | GH   | JN     | JN  | JN   | JN   | JN   | MA     | MA  | MA   | MA   | MA   | MA   |
| 7,500 pF    | 752              | F                     | G | J | K | M | GK                                                                                                 | GK  | GK   | JK     | JK  | JK   | JK   |      | MB     | MB  | MB   | MB   | MB   | MB   |
| 8,200 pF    | 822              | F                     | G | J | K | M | GK                                                                                                 | GK  | GK   | JL     | JL  | JL   | JL   |      | MB     | MB  | MB   | MB   | MB   | MB   |
| 9,100 pF    | 912              | F                     | G | J | K | M | GM                                                                                                 | GM  | GM   | JL     | JL  | JL   | JL   |      | MB     | MB  | MB   | MB   | MB   | MB   |
| 10,000 pF   | 103              | F                     | G | J | K | M | GM                                                                                                 | GM  | GM   | JL     | JL  | JL   | JL   |      | MB     | MB  | MB   | MB   | MB   | MB   |
| 12,000 pF   | 123              | F                     | G | J | K | M | GO                                                                                                 | GO  | GO   | JN     | JN  | JN   | JN   |      | MB     | MB  | MB   | MB   | MB   | MB   |
| 15,000 pF   | 153              | F                     | G | J | K | M | GO                                                                                                 | GO  | GO   | JE     | JE  | JE   |      |      | MC     | MC  | MC   | MC   | MC   | MC   |
| 18,000 pF   | 183              | F                     | G | J | K | M | GH                                                                                                 | GH  |      | JE     | JE  | JE   |      |      | MC     | MC  | MC   | MC   | MC   | MC   |
| 22,000 pF   | 223              | F                     | G | J | K | M | GH                                                                                                 | GH  |      | JK     | JK  | JK   |      |      | MC     | MC  | MC   | MC   | MC   | MC   |
| 27,000 pF   | 273              | F                     | G | J | K | M | GK                                                                                                 | GK  |      | JL     | JL  | JL   |      |      | MB     | MB  | MB   | MB   |      |      |
| 33,000 pF   | 333              | F                     | G | J | K | M | GM                                                                                                 | GM  |      | JN     | JN  | JN   |      |      | MB     | MB  | MB   | MB   |      |      |
| 39,000 pF   | 393              | F                     | G | J | K | M | GO                                                                                                 | GO  |      | JE     | JE  |      |      |      | MC     | MC  | MC   | MC   |      |      |
| 47,000 pF   | 473              | F                     | G | J | K | M | GO                                                                                                 | GO  |      | JE     | JE  |      |      |      | MC     | MC  | MC   | MC   |      |      |
| 56,000 pF   | 563              | F                     | G | J | K | M |                                                                                                    |     |      | JK     | JK  |      |      |      | MC     | MC  | MC   |      |      |      |
| 68,000 pF   | 683              | F                     | G | J | K | M |                                                                                                    |     |      | JL     | JL  |      |      |      | MC     | MC  |      |      |      |      |
| 82,000 pF   | 823              | F                     | G | J | K | M |                                                                                                    |     |      | JL     | JL  |      |      |      | MB     | MB  |      |      |      |      |
| 0.1 µF      | 104              | F                     | G | J | K | M |                                                                                                    |     |      | JN     | JN  |      |      |      | MB     | MB  |      |      |      |      |
| 0.12 µF     | 124              | F                     | G | J | K | M |                                                                                                    |     |      |        |     |      |      |      | MB     | MB  |      |      |      |      |
| 0.15 µF     | 154              | F                     | G | J | K | M |                                                                                                    |     |      |        |     |      |      |      | MC     | MC  |      |      |      |      |
| 0.18 µF     | 184              | F                     | G | J | K | M |                                                                                                    |     |      |        |     |      |      |      | MC     |     |      |      |      |      |
| 0.22 µF     | 224              | F                     | G | J | K | M |                                                                                                    |     |      |        |     |      |      |      | MC     |     |      |      |      |      |
| Capacitance | Capacitance Code | Rated Voltage (VDC)   |   |   |   |   | 500                                                                                                | 650 | 1000 | 500    | 650 | 1000 | 1200 | 1700 | 500    | 650 | 1000 | 1200 | 1700 | 2000 |
|             |                  | Voltage Code          |   |   |   |   | C                                                                                                  | W   | D    | C      | W   | D    | E    | J    | C      | W   | D    | E    | J    | G    |
|             |                  | Case Size/Series      |   |   |   |   | 1812                                                                                               |     |      | 2220   |     |      |      |      | 3640   |     |      |      |      |      |
|             |                  |                       |   |   |   |   | CKC18C                                                                                             |     |      | CKC22C |     |      |      |      | CKC33C |     |      |      |      |      |

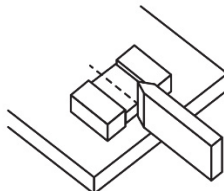
Note: Flexible termination available only for EIA 1812 and 2220.

**Table 2 – Chip Thickness/Tape & Reel Packaging Quantities**

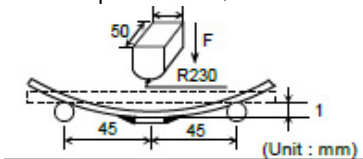
| Thickness Code | Case Size <sup>1</sup> | Thickness ± Range (mm) | Plastic Quantity |          | Thickness Code | Case Size <sup>1</sup> | Thickness ± Range (mm) | Plastic Quantity |          |
|----------------|------------------------|------------------------|------------------|----------|----------------|------------------------|------------------------|------------------|----------|
|                |                        |                        | 7" Reel          | 13" Reel |                |                        |                        | 7" Reel          | 13" Reel |
| GD             | 1812                   | 1.25 ± 0.15            | 1,000            | 4,000    | JL             | 2220                   | 2.00 ± 0.20            | 500              | 2,000    |
| GH             | 1812                   | 1.40 ± 0.15            | 1,000            | 4,000    | JN             | 2220                   | 2.50 ± 0.20            | 500              | 2,000    |
| GK             | 1812                   | 1.60 ± 0.20            | 1,000            | 4,000    | MA             | 3640                   | 1.40 ± 0.15            | 250              | 1,000    |
| GM             | 1812                   | 2.00 ± 0.20            | 500              | 2,000    | MB             | 3640                   | 2.00 ± 0.20            | 250              | 1,000    |
| GO             | 1812                   | 2.50 ± 0.20            | 500              | 2,000    | MC             | 3640                   | 2.50 ± 0.20            | 250              | 1,000    |
| JE             | 2220                   | 1.40 ± 0.15            | 1,000            | 4,000    |                |                        |                        |                  |          |
| JK             | 2220                   | 1.60 ± 0.20            | 1,000            | 4,000    |                |                        |                        |                  |          |
| Thickness Code | Case Size <sup>1</sup> | Thickness ± Range (mm) | 7" Reel          | 13" Reel | Thickness Code | Case Size <sup>1</sup> | Thickness ± Range (mm) | 7" Reel          | 13" Reel |
|                |                        |                        | Plastic Quantity |          |                |                        |                        | Plastic Quantity |          |

Package quantity based on finished chip thickness specifications.

**Table 3 – Performance & Reliability: 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           | 1 kHz ±50 Hz and 1.0 ±0.2 V <sub>rms</sub> if capacitance<br>Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours                                                                                                                                                                                                         | Within Tolerance                                                                                                                                                            |                          |       |       |                                  |       |           |                   |                                                                                                                                    |        |              |
| Dissipation Factor (DF)                             | KEMET Internal           | 1 kHz ±50 Hz and 1.0 ±0.2 V <sub>rms</sub>                                                                                                                                                                                                                                                                                                                       | Dissipation factor (DF) maximum limit at 25°C = 0.1%                                                                                                                        |                          |       |       |                                  |       |           |                   |                                                                                                                                    |        |              |
| Insulation Resistance (IR)                          | KEMET Internal           | 500 VDC applied for 120±5 seconds at 25°C                                                                                                                                                                                                                                                                                                                        | Within Specification<br>To obtain IR limit, divide MΩ-μF value by the capacitance and compare to GΩ limit. Select the lower of the two limits.<br><br>1,000 MΩ-μF or 100 GΩ |                          |       |       |                                  |       |           |                   |                                                                                                                                    |        |              |
| Temperature Coefficient of Capacitance (TCC)        | KEMET Internal           | Frequency: 1 kHz ±50 Hz<br>Capacitance change with reference to +25°C and 0 VDC applied.<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)</td></tr><tr><td>4</td><td>+150°C</td></tr></table> | Step                                                                                                                                                                        | Temperature (°C)         | 1     | +25°C | 2                                | -55°C | 3         | +25°C (Reference) | 4                                                                                                                                  | +150°C | ±30 PPM / °C |
| Step                                                | Temperature (°C)         |                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                             |                          |       |       |                                  |       |           |                   |                                                                                                                                    |        |              |
| 1                                                   | +25°C                    |                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                             |                          |       |       |                                  |       |           |                   |                                                                                                                                    |        |              |
| 2                                                   | -55°C                    |                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                             |                          |       |       |                                  |       |           |                   |                                                                                                                                    |        |              |
| 3                                                   | +25°C (Reference)        |                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                             |                          |       |       |                                  |       |           |                   |                                                                                                                                    |        |              |
| 4                                                   | +150°C                   |                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                             |                          |       |       |                                  |       |           |                   |                                                                                                                                    |        |              |
| Dielectric Withstanding Voltage (DWV)               | KEMET Internal           | <table><tr><th>Rated DC Voltage</th><th>DWV Voltage (% of Rated)</th></tr><tr><td>500 V</td><td>150%</td></tr><tr><td>650 V</td><td>130%</td></tr><tr><td>≥ 1,000 V</td><td>120%</td></tr></table><br>(5 ±1 seconds and charge/discharge not exceeding 50 mA)                                                                                                    | Rated DC Voltage                                                                                                                                                            | DWV Voltage (% of Rated) | 500 V | 150%  | 650 V                            | 130%  | ≥ 1,000 V | 120%              | Cap: Initial Limit<br>DF: Initial Limit<br>IR: Initial Limit<br><br>Withstand test voltage without insulation breakdown or damage. |        |              |
| Rated DC Voltage                                    | DWV Voltage (% of Rated) |                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                             |                          |       |       |                                  |       |           |                   |                                                                                                                                    |        |              |
| 500 V                                               | 150%                     |                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                             |                          |       |       |                                  |       |           |                   |                                                                                                                                    |        |              |
| 650 V                                               | 130%                     |                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                             |                          |       |       |                                  |       |           |                   |                                                                                                                                    |        |              |
| ≥ 1,000 V                                           | 120%                     |                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                             |                          |       |       |                                  |       |           |                   |                                                                                                                                    |        |              |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | KEMET Internal           | Maximum % capacitance loss/decade hour                                                                                                                                                                                                                                                                                                                           | 0% Loss/Decade Hour                                                                                                                                                         |                          |       |       |                                  |       |           |                   |                                                                                                                                    |        |              |
| Terminal Strength                                   | Kemet Internal           | Shear stress test per specific case size, Time: 60±1 seconds<br><table><tr><th>Case Size</th><th>Force</th></tr><tr><td>3640</td><td>18N</td></tr></table><br>                                                                                                                | Case Size                                                                                                                                                                   | Force                    | 3640  | 18N   | No evidence of mechanical damage |       |           |                   |                                                                                                                                    |        |              |
| Case Size                                           | Force                    |                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                             |                          |       |       |                                  |       |           |                   |                                                                                                                                    |        |              |
| 3640                                                | 18N                      |                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                             |                          |       |       |                                  |       |           |                   |                                                                                                                                    |        |              |

**Table 3 – Performance & Reliability: Test Methods and Conditions cont.**

| Test                   | Reference                 | Test Condition                                                                                                                                                                | Limits                                                                                                                                                                                |
|------------------------|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Board Flex             | AEC-Q200-005              | Standard Termination system 3.0 mm<br>Test time: 60±5 seconds<br>Ramp time: 1 mm/seconds<br> | No evidence of mechanical damage                                                                                                                                                      |
| Solderability          | J-STD-002                 | Magnification 50X. Conditions:<br>a) Method B, 4 hours at 155°C, dry heat at 235°C<br>b) Method B at 215°C category 3<br>c) Method D, category 3 at 260°C                     | Visual Inspection.<br>95% coverage on termination.<br>No leaching                                                                                                                     |
| Temperature Cycling    | JESD22<br>Method JA-104   | 1,000 cycles (-55°C to +150°C)<br>2-3 cycles per hour<br>Soak Time 1 or 5 minutes                                                                                             | Measurement at 24 hours ±4 hours<br>after test conclusion.<br>Cap: Initial Limit<br>DF: Initial Limit<br>IR: Initial Limit                                                            |
| Biased Humidity        | MIL-STD-202<br>Method 103 | Load Humidity: 1,000 hours 85°C/85% RH and 200 VDC.<br>Add 100 K $\Omega$ resistor.<br>Low Volt Humidity: 1,000 hours 85°C/85% RH and 1.5 V.<br>Add 100 K $\Omega$ resistor.  | Measurement at 24 hours ±4 hours<br>after test conclusion.<br>Within Post Environmental Limits<br>Cap: ±0.3% or ±0.25 pF shift<br>IR: 10% of Initial Limit<br>DF Limits Maximum: 0.5% |
| Moisture Resistance    | MIL-STD-202<br>Method 106 | Number of cycles required 10, 24 hours per cycle.<br>Steps 7a and 7b not required                                                                                             | Measurement at 24 hours ±4 hours<br>after test conclusion.<br>Within Post Environmental Limits<br>Cap: ±0.3% or ±0.25 pF shift<br>IR: 10% of Initial Limit<br>DF Limits Maximum: 0.5% |
| Thermal Shock          | MIL-STD-202<br>Method 107 | Number of cycles required 5, (-55°C to 125°C)<br>Dwell time 15 minutes.                                                                                                       | Cap: Initial Limit<br>DF: Initial Limit<br>IR: Initial Limit                                                                                                                          |
| High Temperature Life  | MIL-STD-202<br>Method 108 | 1,000 hours at 150°C with 1.0 X rated voltage applied.                                                                                                                        | Within Post Environmental Limits<br>Cap: ±0.3% or ±0.25 pF shift<br>IR: 10% of Initial Limit<br>DF Limits Maximum: 0.5%                                                               |
| Storage Life           |                           | 1,000 hours at 150°C, Unpowered                                                                                                                                               |                                                                                                                                                                                       |
| Vibration              | MIL-STD-202<br>Method 204 | 5 g's for 20 minutes, 12 cycles each of 3 orientations.<br>Test from 10 – 2,000 Hz                                                                                            | Cap: Initial Limit<br>DF: Initial Limit<br>IR: Initial Limit                                                                                                                          |
| Mechanical Shock       | MIL-STD-202<br>Method 213 | 1,500 g's 0.5ms Half-sine, Velocity Change 15.4 ft/second<br>(Condition F)                                                                                                    | Cap: Initial Limit<br>DF: Initial Limit<br>IR: Initial Limit                                                                                                                          |
| Resistance to Solvents | MIL-STD-202<br>Method 215 | Add Aqueous wash chemical OKEMCLEAN<br>(A 6% concentrated Oakite cleaner) or equivalent.<br>Do not use banned solvents                                                        | Visual Inspection 10X<br>Readable marking, no decoloration or stains.<br>No physical damage.                                                                                          |

**Table 4 – Chip Capacitor Land Pattern Design Recommendations per IPC-7351**

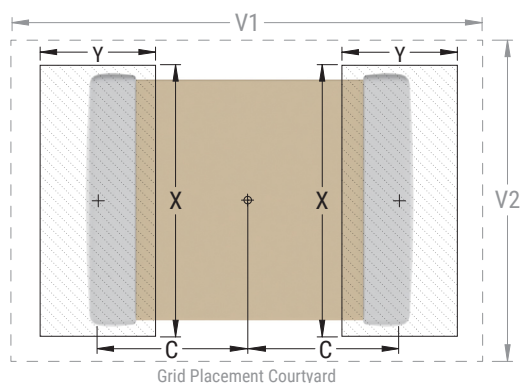
| KC-LINK CODE | EIA SIZE CODE | METRIC SIZE CODE | Density Level A:<br>Maximum (Most) Land Protrusion |      |       |       |       | Density Level B:<br>Median (Nominal) Land Protrusion |      |       |       |       | Density Level C:<br>Minimum (Least) Land Protrusion |      |       |       |       |
|--------------|---------------|------------------|----------------------------------------------------|------|-------|-------|-------|------------------------------------------------------|------|-------|-------|-------|-----------------------------------------------------|------|-------|-------|-------|
|              |               |                  | C                                                  | Y    | X     | V1    | V2    | C                                                    | Y    | X     | V1    | V2    | C                                                   | Y    | X     | V1    | V2    |
| 18           | 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  |
| 21           | 2220          | 5650             | 2.75                                               | 1.70 | 5.50  | 8.20  | 6.50  | 2.65                                                 | 1.50 | 5.40  | 7.30  | 5.90  | 2.55                                                | 1.30 | 5.30  | 6.60  | 5.60  |
| 33           | 3640          | 9210             | 4.45                                               | 1.70 | 10.70 | 11.60 | 11.70 | 4.35                                                 | 1.50 | 10.60 | 10.70 | 11.10 | 4.25                                                | 1.30 | 10.50 | 10.00 | 10.80 |

**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.





## 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 <sup>1</sup> | Yes (with approval and sign off) | Yes           | 180 days minimum             |
| AUTO                        | Yes (without approval)           | Yes           | 90 days minimum              |

<sup>1</sup> 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 <sup>1</sup> | •          | • | • | • | • |
| AUTO                        |            |   | ○ |   |   |

<sup>1</sup> KEMET assigned C-Specs require the submittal of a customer SCD or customer specification for review. For additional information contact KEMET.

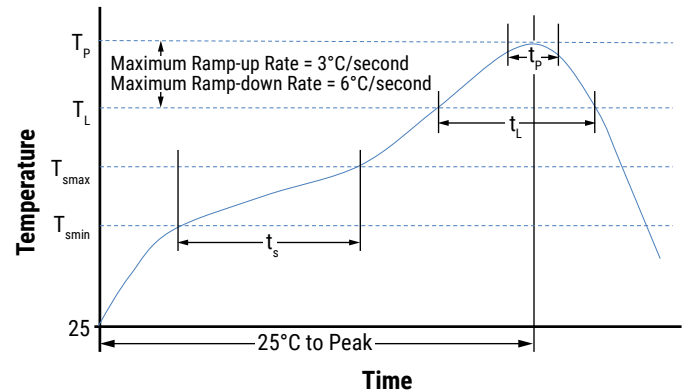
- Part number specific PPAP available with customer information included.
- Product family PPAP only

## Soldering Process

### Recommended Reflow Soldering Profile

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with convection and IR 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 |
|-------------------------------------------------------|--------------------|
|                                                       | 100% matte Sn      |
| <b>Preheat/Soak</b>                                   |                    |
| Temperature Minimum ( $T_{smin}$ )                    | 150°C              |
| Temperature Maximum ( $T_{smax}$ )                    | 200°C              |
| Time ( $t_s$ ) from $T_{smin}$ to $T_{smax}$          | 60 – 120 seconds   |
| Ramp-Up Rate ( $T_L$ to $T_p$ )                       | 3°C/second maximum |
| Liquidous Temperature ( $T_L$ )                       | 217°C              |
| Time Above Liquidous ( $t_L$ )                        | 60 – 150 seconds   |
| Peak Temperature ( $T_p$ )                            | 260°C              |
| Time Within 5°C of Maximum Peak Temperature ( $t_p$ ) | 30 seconds maximum |
| Ramp-Down Rate ( $T_p$ to $T_L$ )                     | 6°C/second maximum |
| Time 25°C to Peak Temperature                         | 8 minutes maximum  |



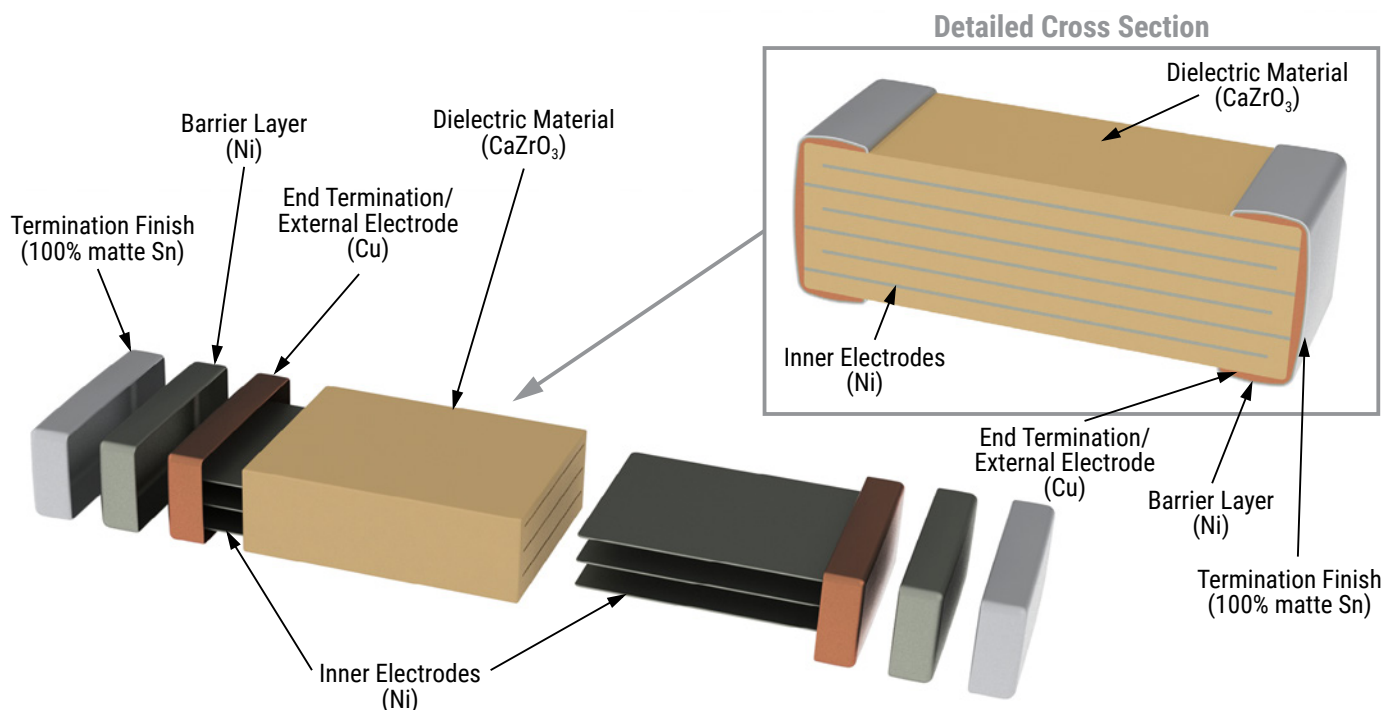
Note: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.

## Storage & Handling

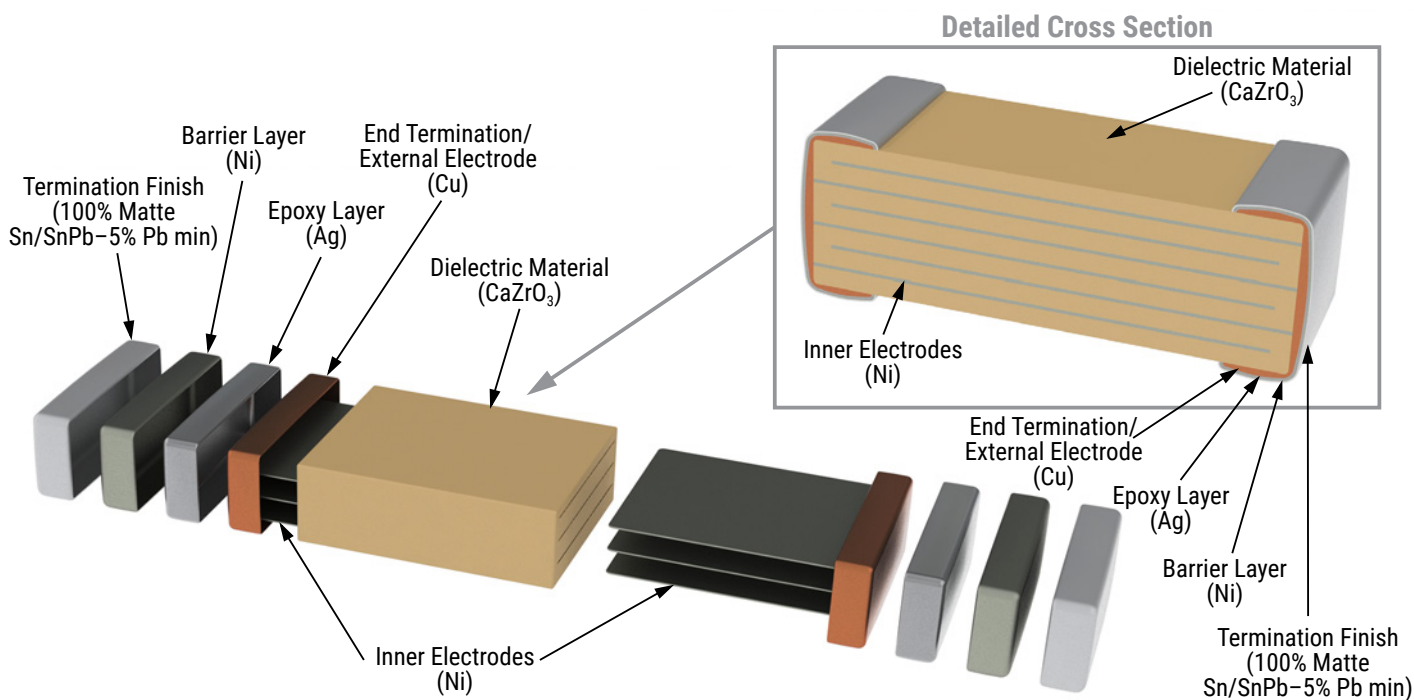
Ceramic chip capacitors should be stored in normal working environments. While the chips themselves are quite robust in other environments, solderability will be degraded by exposure to high temperatures, high humidity, corrosive atmospheres, and long term storage. In addition, packaging materials will 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. In addition, 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 upon receipt.

## Construction

### Standard Termination

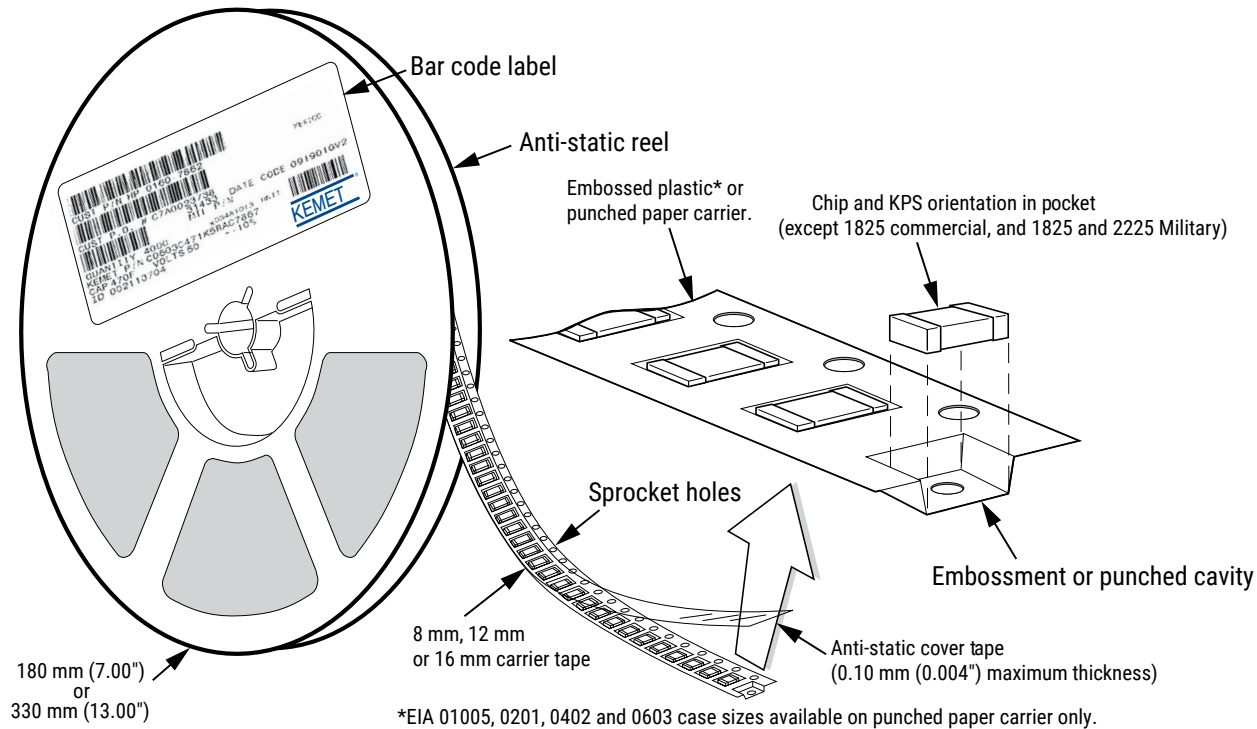


### Flex Termination



## Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12, 16 and 24 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.

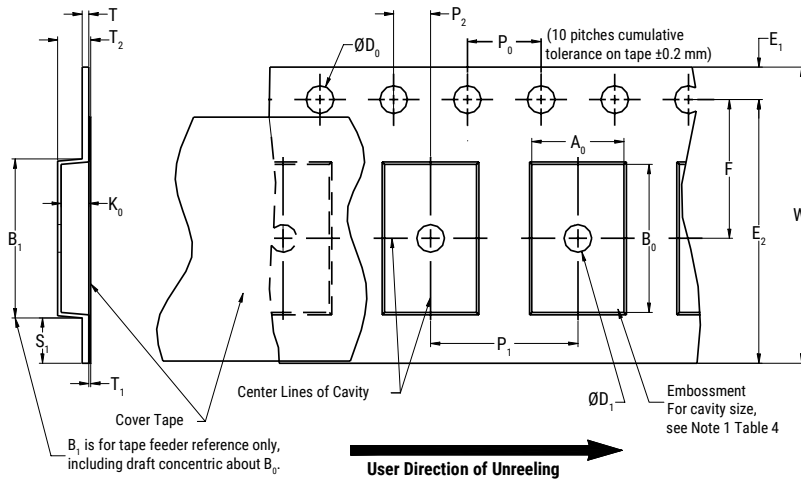


**Table 5 – Carrier Tape Configuration, Embossed Plastic (mm)**

| EIA Case Size | Tape Size (W)* | Embossed Plastic         |          |
|---------------|----------------|--------------------------|----------|
|               |                | 7" Reel                  | 13" Reel |
|               |                | Pitch (P <sub>1</sub> )* |          |
| 1812, 2220    | 12             | 8                        | 8        |
| 3640          | 24             | 16                       | 16       |

\*Refer to Figure 1 for W and P<sub>1</sub> carrier tape reference locations.

\*Refer to Tables 4 and 5 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<br>Note 1 | $E_1$                      | $P_0$                      | $P_2$                     | R Reference<br>Note 2 | S1 Minimum<br>Note 3 | T<br>Maximum         | $T_1$<br>Maximum |
| 12 mm                                      | 1.5+0.10/-0.0<br>(0.059+0.004/-0.0) | 1.5<br>(0.059)          | 1.75±0.10<br>(0.069±0.004) | 4.0±0.10<br>(0.157±0.004)  | 2.0±0.05<br>(0.079±0.002) | 30<br>(1.181)         | 0.600<br>(0.024)     | 0.600<br>(0.024)     | 0.600<br>(0.024) |
| 24 mm                                      | 1.5+0.10/-0.0<br>(0.059+0.004/-0.0) | 1.5<br>(0.059)          | 1.75±0.10<br>(0.069±0.004) | 4.0±0.10<br>(0.157±0.004)  | 2.0±0.10<br>(0.078±0.003) | 30<br>(1.181)         | 5<br>(0.196)         | 0.250<br>(0.009)     | 0.350<br>(0.013) |
| Variable Dimensions – Millimeters (Inches) |                                     |                         |                            |                            |                           |                       |                      |                      |                  |
| Tape Size                                  | Pitch                               | $B_1$ Maximum<br>Note 4 | $E_2$<br>Minimum           | F                          | $P_1$                     | $T_2$<br>Maximum      | W<br>Maximum         | $A_0, B_0$ and $K_0$ |                  |
| 12 mm                                      | Single (4 mm) and<br>Double (8 mm)  |                         | 10.25<br>(0.404)           | 5.5±0.05<br>(0.217±0.002)  | 8.0±0.10<br>(0.315±0.004) | 4.6<br>(0.181)        | 12.3<br>(0.484)      | Note 5               |                  |
| 24 mm                                      | 16 mm                               | 22.25<br>(0.875)        | 11.5±0.10<br>(0.452±0.003) | 16.0±0.10<br>(0.629±0.004) | 3<br>(0.118)              | 24.3<br>(0.956)       | 24.3<br>(0.956)      |                      |                  |

1. 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.
2. The tape with or without components shall pass around R without damage (see Figure 6).
3. If  $S1 < 1.0$  mm, there may not be enough area for cover tape to be properly applied (see EIA Document 481 paragraph 4.3 (b)).
4.  $B1$  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 mm and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4)
  - (e) For KPS Series product,  $A0$  and  $B0$  are measured on a plane 0.3 mm above the bottom of the pocket.
  - (f) see Addendum in EIA Document 481 for standards relating to more precise taping requirements.

## Packaging Information Performance Notes

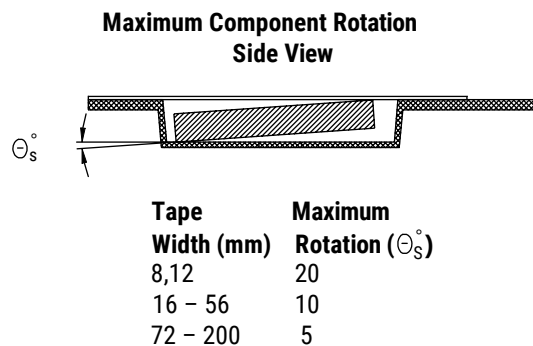
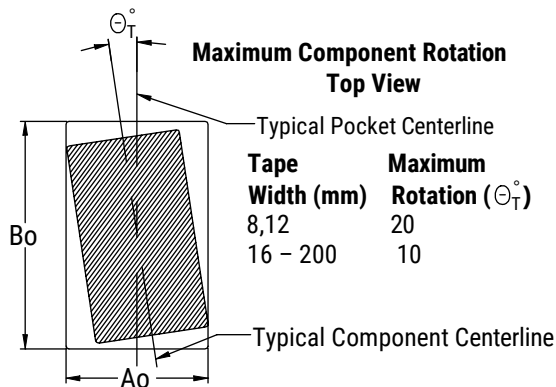
- 1. Cover Tape Break Force:** 1.0 kg minimum.
- 2. Cover Tape Peel Strength:** The total peel strength of the cover tape from the carrier tape shall be:

| 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) |
| 24 mm        | 0.1 to 1.6 Newton (10 to 160 gf) |

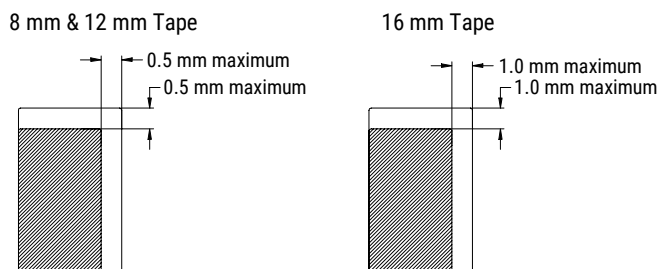
The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300±10 mm/minute.

- 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.

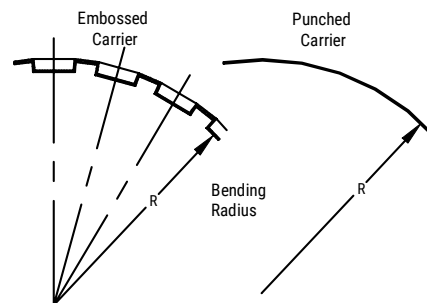
### Figure 2 – Maximum Component Rotation

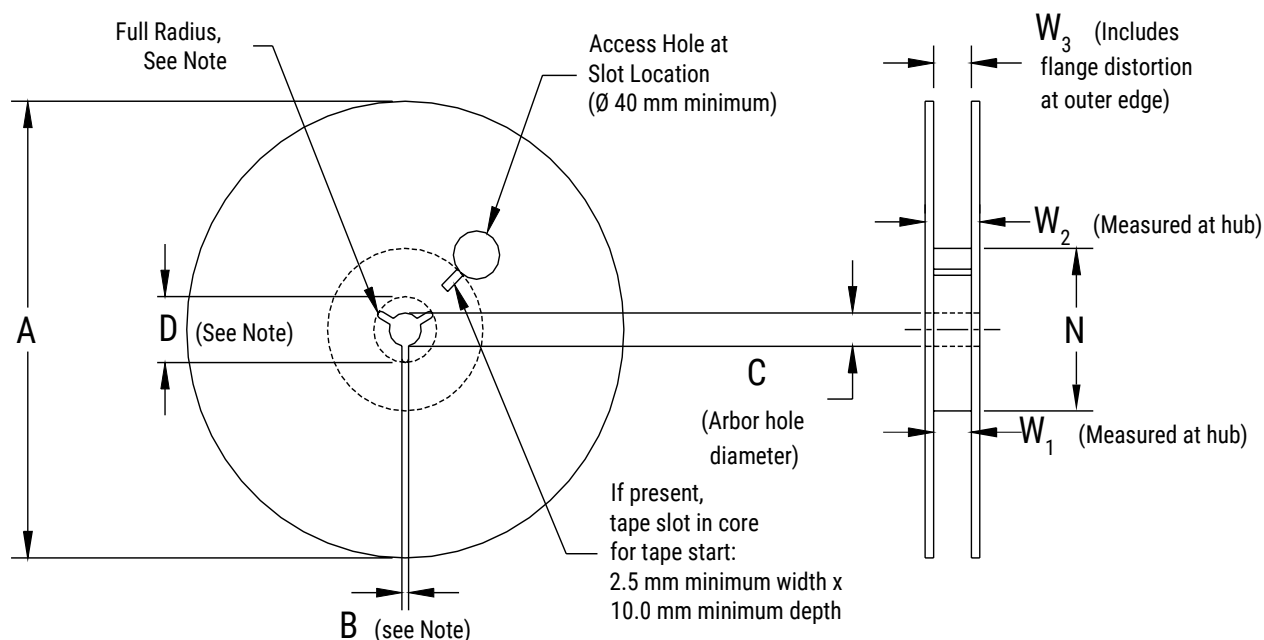


### Figure 3 – Maximum Lateral Movement



### Figure 4 – Bending Radius



**Figure 5 – Reel Dimensions**

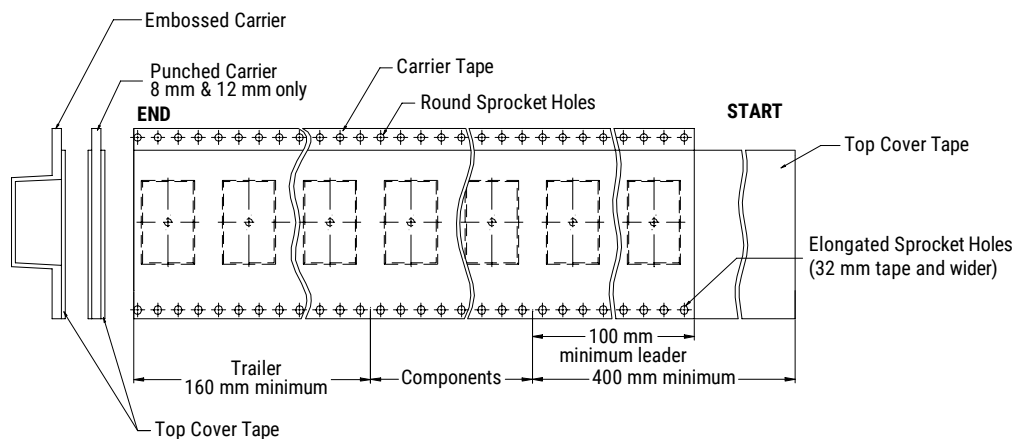
Note: Drive spokes optional; if used, dimensions B and D shall apply.

**Table 7 – Reel Dimensions**

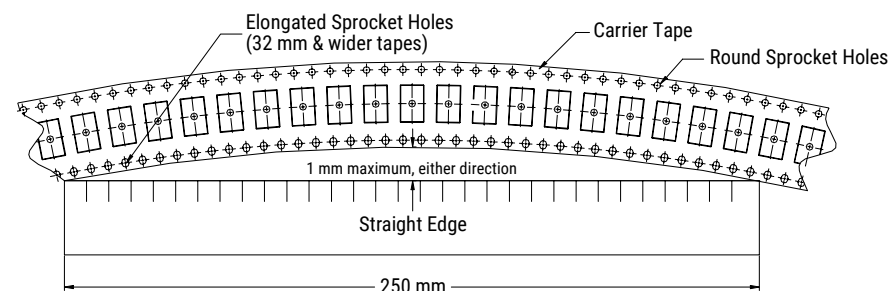
Metric will govern

| Constant Dimensions – Millimeters (Inches) |                                  |                                     |                                      |                                                   |
|--------------------------------------------|----------------------------------|-------------------------------------|--------------------------------------|---------------------------------------------------|
| Tape Size                                  | A                                | B Minimum                           | C                                    | D Minimum                                         |
| 12 mm                                      | 178±0.20<br>(7.008±0.008)        | 1.5<br>(0.059)                      | 13.0+0.5/-0.2<br>(0.521+0.02/-0.008) | 20.2<br>(0.795)                                   |
| 24 mm                                      | or<br>330±0.20<br>(13.000±0.008) | 1.2<br>(0.047)                      | 13.0 ±0.2<br>(0.521 ±0.008)          | 21<br>(0.826)                                     |
| Variable Dimensions – Millimeters (Inches) |                                  |                                     |                                      |                                                   |
| Tape Size                                  | N Minimum                        | W <sub>1</sub>                      | W <sub>2</sub> Maximum               | W <sub>3</sub>                                    |
| 12 mm                                      | 50<br>(1.969)                    | 12.4+2.0/-0.0<br>(0.488+0.078/-0.0) | 18.4<br>(0.724)                      | Shall accommodate tape width without interference |
| 24 mm                                      |                                  | 25 +1.0/-0.0<br>(0.984 +0.039/-0.0) | 27.4 ±1.0<br>(1.078 ±0.039)          |                                                   |

**Figure 6 – Tape Leader & Trailer Dimensions**



**Figure 7 – Maximum Camber**





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