

## Overview

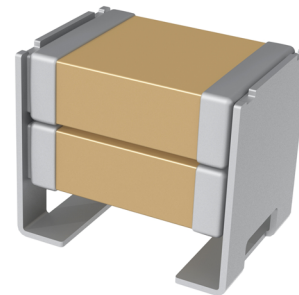
KEMET Power Solutions (KPS) Commercial Series stacked capacitors utilize a proprietary lead-frame technology to vertically stack one or two multilayer ceramic chip capacitors into a single compact surface mount package. The attached lead-frame mechanically isolates the capacitor/s from the printed circuit board, therefore offering advanced mechanical and thermal stress performance. Isolation also addresses concerns for audible, microphonic noise that may occur when a bias voltage is applied. A two chip stack offers up to double the capacitance in the same or smaller design footprint when compared to traditional surface mount MLCCs devices. Providing up to 10 mm of board flex capability, KPS Series capacitors

are environmentally friendly and in compliance with RoHS legislation. Available in X7R dielectric, these devices are capable of Pb-Free reflow profiles and provide lower ESR, ESL and higher ripple current capability when compared to other dielectric solutions.

Combined with the stability of an X7R dielectric, KEMET's KPS Series devices exhibit a predictable change in capacitance with respect to time and voltage and boast a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to  $\pm 15\%$  from  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .

## Benefits

- $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  operating temperature range
- Reliable and robust termination system
- EIA 1210, 1812, and 2220 case sizes
- DC voltage ratings of 10 V, 16 V, 25 V, 50 V, 100 V, and 250 V
- Capacitance offerings ranging from 0.1  $\mu\text{F}$  up to 47  $\mu\text{F}$
- Available capacitance tolerances of  $\pm 10\%$  and  $\pm 20\%$
- Higher capacitance in the same footprint
- Potential board space savings



## Ordering Information

| C       | 2220                 | C                     | 106                                        | M                                  | 5                                                          | R          | 2                                                      | C                             | 7186                                          |
|---------|----------------------|-----------------------|--------------------------------------------|------------------------------------|------------------------------------------------------------|------------|--------------------------------------------------------|-------------------------------|-----------------------------------------------|
| Ceramic | Case Size (L" x W")  | Specification/ Series | Capacitance Code (pF)                      | Capacitance Tolerance <sup>1</sup> | Rated Voltage (VDC)                                        | Dielectric | Failure Rate/Design                                    | Leadframe Finish <sup>2</sup> | Packaging/ Grade (C-Spec)                     |
|         | 1210<br>1812<br>2220 | C = Standard          | Two significant digits and number of zeros | K = $\pm 10\%$<br>M = $\pm 20\%$   | 8 = 10<br>4 = 16<br>3 = 25<br>5 = 50<br>1 = 100<br>A = 250 | R = X7R    | 1 = KPS Single Chip Stack<br>2 = KPS Double Chip Stack | C = 100% Matte Sn             | See "Packaging C-Spec Ordering Options Table" |

<sup>1</sup> Double chip stacks ("2" in the 13th character position of the ordering code) are only available in M ( $\pm 20\%$ ) capacitance tolerance. Single chip stacks ("1" in the 13th character position of the ordering code) are available in K ( $\pm 10\%$ ) or M ( $\pm 20\%$ ) tolerances.

<sup>2</sup> Additional leadframe finish options may be available. Contact KEMET for details.

## Packaging C-Spec Ordering Options Table

| Packaging Type <sup>1</sup>               | Packaging/Grade Ordering Code (C-Spec) <sup>2</sup> |
|-------------------------------------------|-----------------------------------------------------|
| 7" Reel (Embossed Plastic Tape)/Unmarked  | 7186                                                |
| 13" Reel (Embossed Plastic Tape)/Unmarked | 7289                                                |

<sup>1</sup> The terms "Marked" and "Unmarked" pertain to laser marking option of capacitors. All packaging options labeled as "Unmarked" will contain capacitors that have not been laser marked. The option to laser mark is not available on these devices. For more information see "Capacitor Marking".

### Benefits cont.

- Advanced protection against thermal and mechanical stress
- Provides up to 10 mm of board flex capability
- Reduces audible, microphonic noise
- Extremely low ESR and ESL
- Lead (Pb)-free, RoHS and REACH compliant
- Capable of Pb-free reflow profiles
- Non-polar device, minimizing installation concerns
- Tantalum and electrolytic alternative

### Applications

Typical applications include smoothing circuits, DC/DC converters, power supplies (input/output filters), noise reduction (piezoelectric/mechanical), circuits with a direct battery or power source connection, critical and safety relevant circuits without (integrated) current limitation and any application that is subject to high levels of board flexure or temperature cycling. Markets include industrial, military, automotive and telecom.

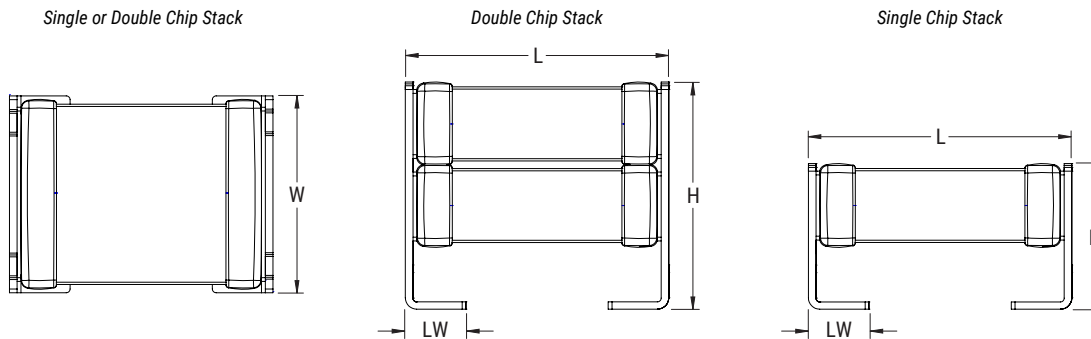
### Qualification/Certification

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

### Environmental Compliance

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

## Dimensions – Millimeters (Inches)



| Number of Chips | EIA Size Code | Metric Size Code | L Length                      | W Width                       | H Height                                       | LW Lead Width                 | Mounting Technique |
|-----------------|---------------|------------------|-------------------------------|-------------------------------|------------------------------------------------|-------------------------------|--------------------|
| Single          | 1210          | 3225             | 3.50 (0.138)<br>±0.30 (0.012) | 2.60 (0.102)<br>±0.30 (0.012) | 3.35 (0.132)<br>±0.10 (0.004)                  | 0.80 (0.032)<br>±0.15 (0.006) | Solder Reflow Only |
|                 | 1812          | 4532             | 5.00 (0.197)<br>±0.50 (0.020) | 3.50 (0.138)<br>±0.50 (0.020) | 2.65 (0.104)<br>±0.35 (0.014)                  | 1.10 (0.043)<br>±0.30 (0.012) |                    |
|                 | 2220          | 5650             | 6.00 (0.236)<br>±0.50 (0.020) | 5.00 (0.197)<br>±0.50 (0.020) | 3.50 (0.138)<br>±0.30 (0.012)                  | 1.60 (0.063)<br>±0.30 (0.012) |                    |
| Double          | 1210          | 3225             | 3.50 (0.138)<br>±0.30 (0.012) | 2.60 (0.102)<br>±0.30 (0.012) | 6.15 (0.242)<br>±0.15 (0.006)                  | 0.80 (0.031)<br>±0.15 (0.006) |                    |
|                 | 1812          | 4532             | 5.00 (0.197)<br>±0.50 (0.020) | 3.50 (0.138)<br>±0.50 (0.020) | 5.00 (0.197)<br>-1.00/+0.50<br>(-0.040/+0.020) | 1.10 (0.043)<br>±0.30 (0.012) |                    |
|                 | 2220          | 5650             | 6.00 (0.236)<br>±0.50 (0.020) | 5.00 (0.197)<br>±0.50 (0.020) | 5.00 (0.197)<br>±0.50 (0.020)                  | 1.60 (0.063)<br>±0.30 (0.012) |                    |

## Electrical Parameters/Characteristics

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

<sup>1</sup> Regarding Aging Rate: Capacitance measurements (including tolerance) are indexed to a referee time of 48 or 1,000 hours. Please refer to a part number specific datasheet for referee time details.

<sup>2</sup> DWV is the voltage a capacitor can withstand (survive) for a short period of time. It exceeds the nominal and continuous working voltage of the capacitor.

<sup>3</sup> Capacitance and dissipation factor (DF) measured under the following conditions:

1 kHz ±50 Hz and 1.0 ±0.2 Vrms if capacitance ≤ 10 μF  
120 Hz ±10 Hz and 0.5 ±0.1 Vrms if capacitance > 10 μF

<sup>4</sup> To obtain IR limit, divide MΩ-μF value by the capacitance and compare to GΩ limit. Select the lower of the two limits.

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

## Post Environmental Limits

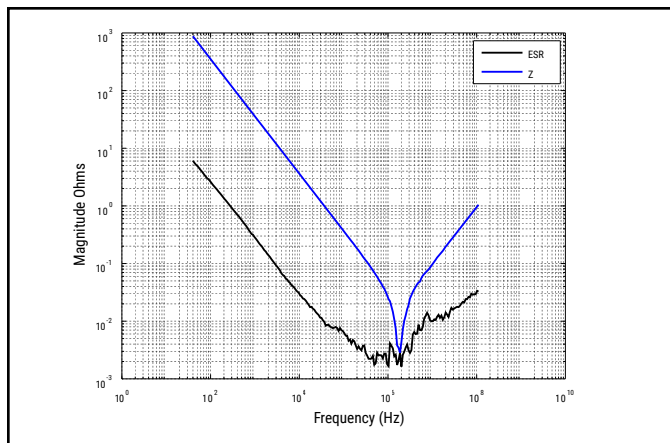
| High Temperature Life, Biased Humidity, Moisture Resistance |                  |                   |                                |                   |                       |
|-------------------------------------------------------------|------------------|-------------------|--------------------------------|-------------------|-----------------------|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

## Insulation Resistance Limit Table

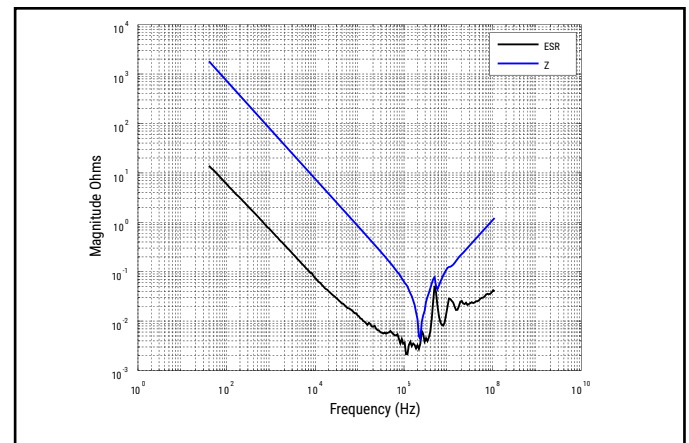
| EIA Case Size | 1,000 Megohm Microfarads or 100 GΩ | 500 Megohm Microfarads or 10 GΩ |
|---------------|------------------------------------|---------------------------------|
| 1210          | < 0.39 μF                          | ≥ 0.39 μF                       |
| 1812          | < 2.2 μF                           | ≥ 2.2 μF                        |
| 2220          | < 10 μF                            | ≥ 10 μF                         |

## Electrical Characteristics

Z and ESR C1210C475M5R1C

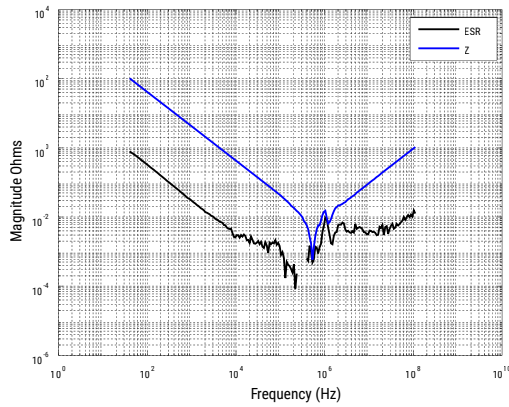


Z and ESR C2220C225MAR2C

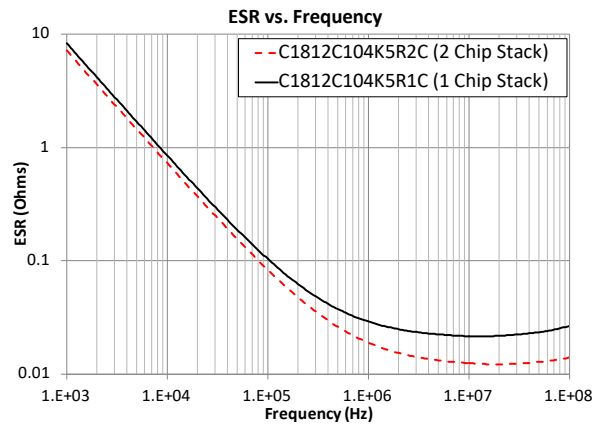


## Electrical Characteristics cont.

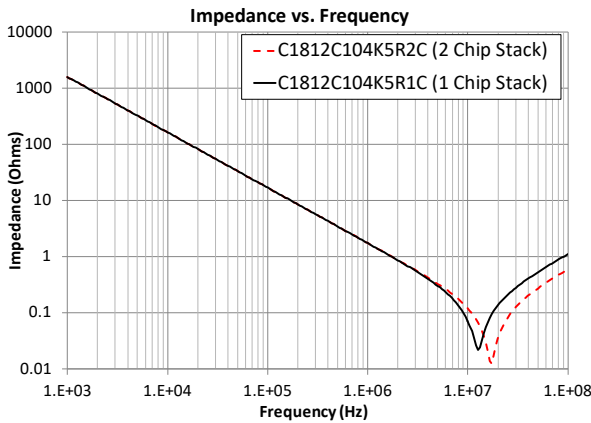
Z and ESR C2220C476M3R2C



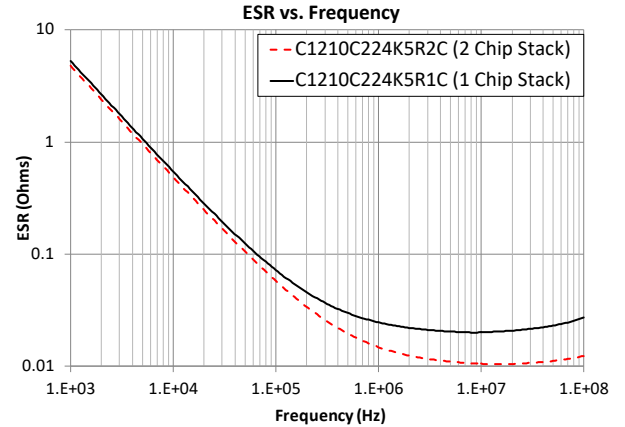
ESR – 1812, .10 μF, 50 V X7R



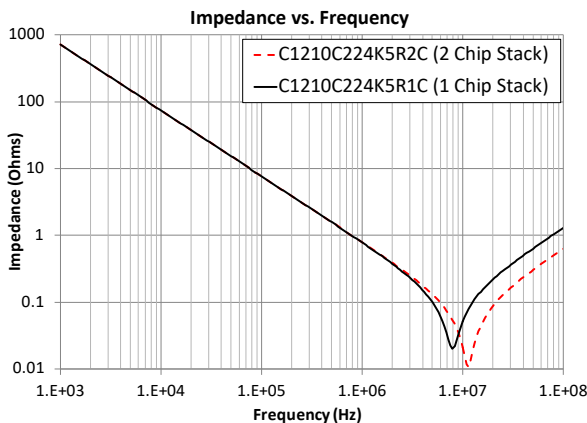
Impedance – 1812, .10 μF, 50 V X7R



ESR – 1210, .22 μF, 50 V X7R

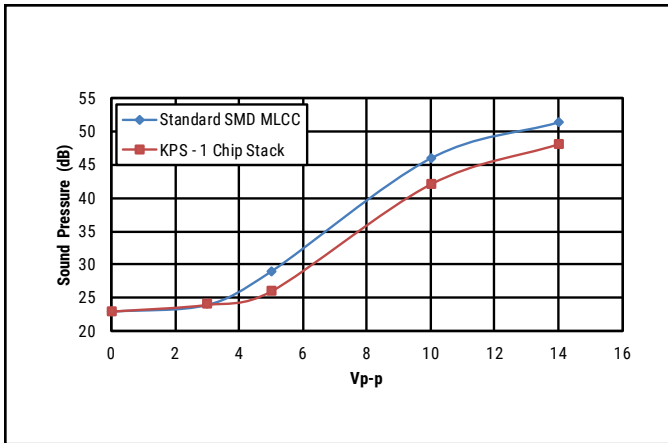


Impedance – 1210, .22 μF, 50 V X7R

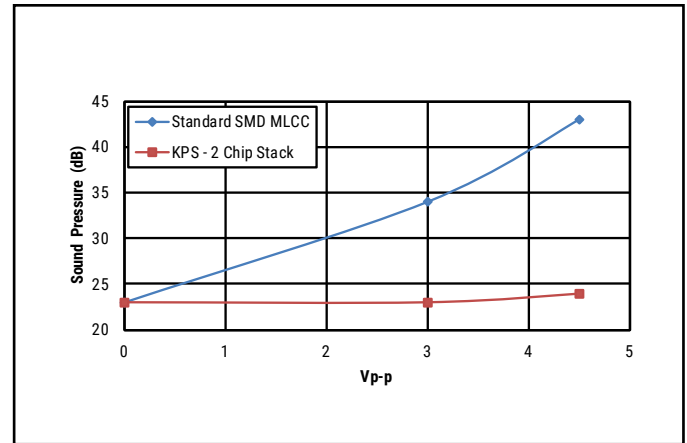


## Electrical Characteristics cont.

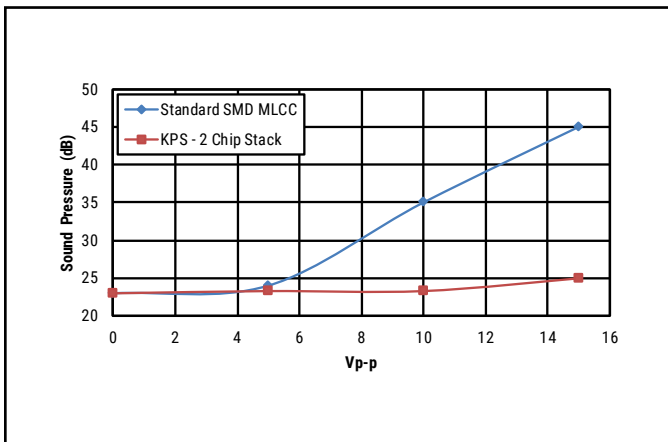
Microphonics – 1210, 4.7  $\mu$ F, 50 V, X7R



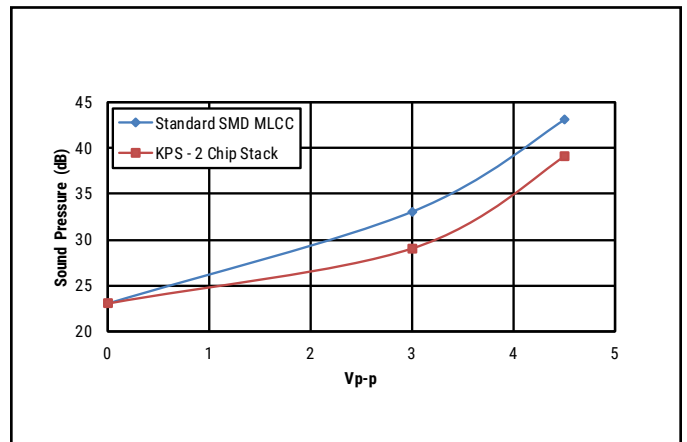
Microphonics – 2220, 22  $\mu$ F, 50 V, X7R



Microphonics – 2220, 47  $\mu$ F, 25 V, X7R

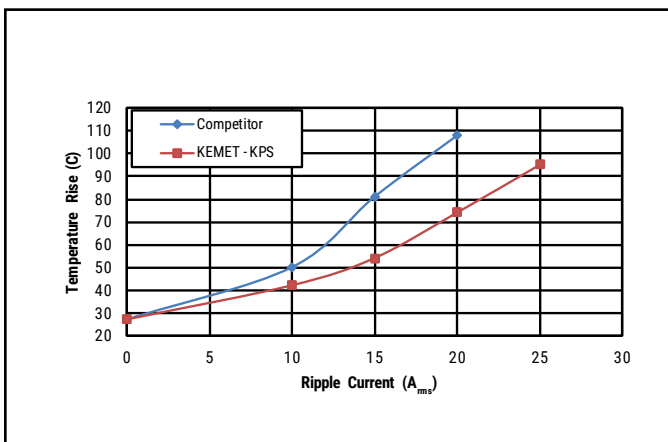


Microphonics – 1210, 22  $\mu$ F, 25 V, X7R



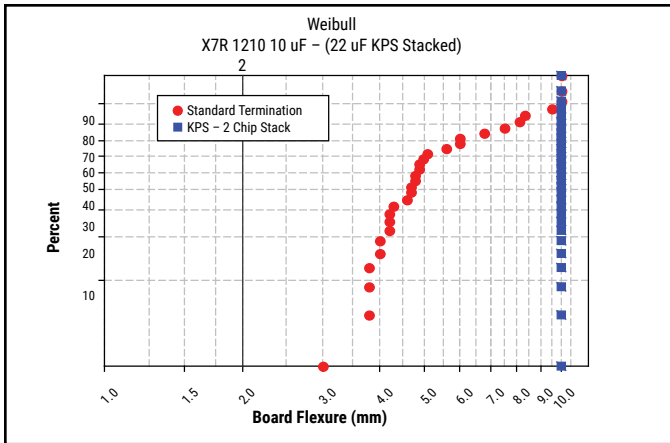
## Competitive Comparison

Ripple Current ( $A_{rms}$ ) 2220, 22  $\mu$ F, 50 V

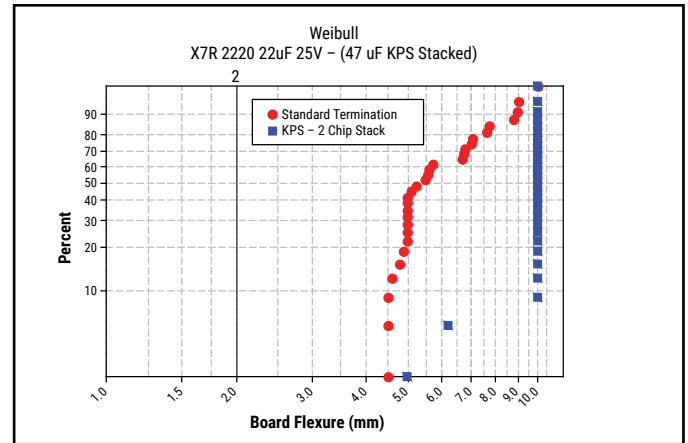


## Electrical Characteristics cont.

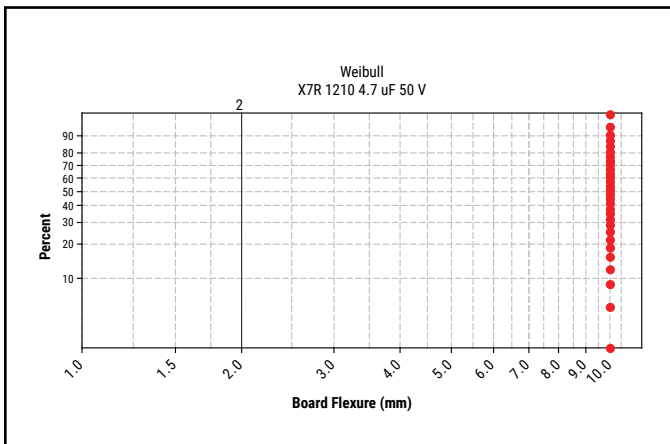
### Board Flex vs. Termination Type



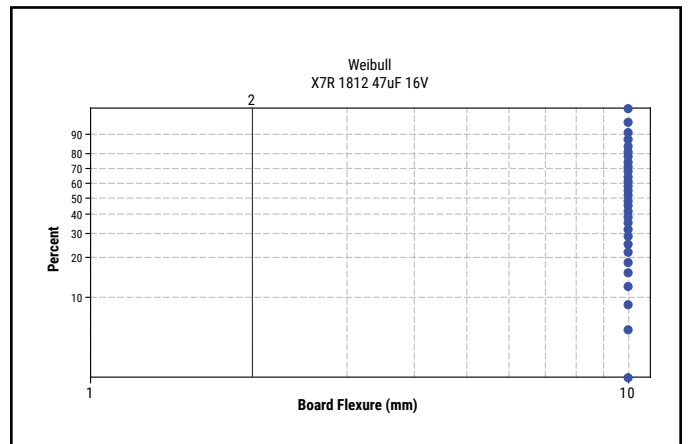
### Board Flex vs. Termination Type



### Board Flexure to 10 mm



### Board Flexure to 10 mm



**Table 1 – Capacitance Range/Selection Waterfall (1210 – 2220 Case Sizes)**

| Capacitance              | Cap Code | Case Size/Series      |   | C1210C                                                                                     |    |    |    |     |     | C1812C |    |    |     |     | C2220C |    |    |     |     |
|--------------------------|----------|-----------------------|---|--------------------------------------------------------------------------------------------|----|----|----|-----|-----|--------|----|----|-----|-----|--------|----|----|-----|-----|
|                          |          | Voltage Code          |   | 8                                                                                          | 4  | 3  | 5  | 1   | A   | 4      | 3  | 5  | 1   | A   | 4      | 3  | 5  | 1   | A   |
|                          |          | Rated Voltage (VDC)   |   | 10                                                                                         | 16 | 25 | 50 | 100 | 250 | 16     | 25 | 50 | 100 | 250 | 16     | 25 | 50 | 100 | 250 |
|                          |          | Capacitance Tolerance |   | Product Availability and Chip Thickness Codes<br>See Table 2 for Chip Thickness Dimensions |    |    |    |     |     |        |    |    |     |     |        |    |    |     |     |
| <b>Single Chip Stack</b> |          |                       |   |                                                                                            |    |    |    |     |     |        |    |    |     |     |        |    |    |     |     |
| 0.10 µF                  | 104      | K                     | M | FV                                                                                         | FV | FV | FV | FV  | FV  | GP     | GP | GP | GP  | GP  | JP     | JP | JP | JP  | JP  |
| 0.22 µF                  | 224      | K                     | M | FV                                                                                         | FV | FV | FV | FV  | FV  | GP     | GP | GP | GP  | GP  | JP     | JP | JP | JP  | JP  |
| 0.47 µF                  | 474      | K                     | M | FV                                                                                         | FV | FV | FV | FV  | FV  | GP     | GP | GP | GP  | GP  | JP     | JP | JP | JP  | JP  |
| 1.0 µF                   | 105      | K                     | M | FV                                                                                         | FV | FV | FV | FV  | FV  | GP     | GP | GP | GP  | GP  | JP     | JP | JP | JP  | JP  |
| 2.2 µF                   | 225      | K                     | M | FV                                                                                         | FV | FV | FV | FV  | FV  | GP     | GP | GP | GP  | GP  | JP     | JP | JP | JP  | JP  |
| 3.3 µF                   | 335      | K                     | M | FV                                                                                         | FV | FV | FV | FV  | FV  | GP     | GP | GP | GP  | GP  | JP     | JP | JP | JP  | JP  |
| 4.7 µF                   | 475      | K                     | M | FV                                                                                         | FV | FV | FV | FV  | FV  | GP     | GP | GP | GP  | GP  | JP     | JP | JP | JP  | JP  |
| 10 µF                    | 106      | K                     | M | FV                                                                                         | FV | FV | FV | FV  | FV  | GP     | GP | GP | GP  | GP  | JP     | JP | JP | JP  | JP  |
| 15 µF                    | 156      | K                     | M | FV                                                                                         | FV | FV | FV | FV  | FV  | GP     | GP | GP | GP  | GP  | JP     | JP | JP | JP  | JP  |
| 22 µF                    | 226      | K                     | M | FV                                                                                         | FV | FV | FV | FV  | FV  | GP     | GP | GP | GP  | GP  | JP     | JP | JP | JP  | JP  |
| <b>Double Chip Stack</b> |          |                       |   |                                                                                            |    |    |    |     |     |        |    |    |     |     |        |    |    |     |     |
| 0.10 µF                  | 104      |                       | M | FW                                                                                         | FW | FW | FW | FW  | FW  | GR     | GR | GR | GR  | GR  | JR     | JR | JR | JR  | JR  |
| 0.22 µF                  | 224      |                       | M | FW                                                                                         | FW | FW | FW | FW  | FW  | GR     | GR | GR | GR  | GR  | JR     | JR | JR | JR  | JR  |
| 0.47 µF                  | 474      |                       | M | FW                                                                                         | FW | FW | FW | FW  | FW  | GR     | GR | GR | GR  | GR  | JR     | JR | JR | JR  | JR  |
| 1.0 µF                   | 105      |                       | M | FW                                                                                         | FW | FW | FW | FW  | FW  | GR     | GR | GR | GR  | GR  | JR     | JR | JR | JR  | JR  |
| 2.2 µF                   | 225      |                       | M | FW                                                                                         | FW | FW | FW | FW  | FW  | GR     | GR | GR | GR  | GR  | JR     | JR | JR | JR  | JR  |
| 3.3 µF                   | 335      |                       | M | FW                                                                                         | FW | FW | FW | FW  | FW  | GR     | GR | GR | GR  | GR  | JR     | JR | JR | JR  | JR  |
| 4.7 µF                   | 475      |                       | M | FW                                                                                         | FW | FW | FW | FW  | FW  | GR     | GR | GR | GR  | GR  | JR     | JR | JR | JR  | JR  |
| 10 µF                    | 106      |                       | M | FW                                                                                         | FW | FW | FW | FW  | FW  | GR     | GR | GR | GR  | GR  | JR     | JR | JR | JR  | JR  |
| 22 µF                    | 226      |                       | M | FW                                                                                         | FW | FW | FW | FW  | FW  | GR     | GR | GR | GR  | GR  | JR     | JR | JR | JR  | JR  |
| 33 µF                    | 336      |                       | M | FW                                                                                         | FW | FW | FW | FW  | FW  | GR     | GR | GR | GR  | GR  | JR     | JR | JR | JR  | JR  |
| 47 µF                    | 476      |                       | M | FW                                                                                         | FW | FW | FW | FW  | FW  | GR     | GR | GR | GR  | GR  | JR     | JR | JR | JR  | JR  |
| Capacitance              | Cap Code | Rated Voltage (VDC)   |   | 10                                                                                         | 16 | 25 | 50 | 100 | 250 | 16     | 25 | 50 | 100 | 250 | 16     | 25 | 50 | 100 | 250 |
|                          |          | Voltage Code          |   | 8                                                                                          | 4  | 3  | 5  | 1   | A   | 4      | 3  | 5  | 1   | A   | 4      | 3  | 5  | 1   | A   |
|                          |          | Case Size/Series      |   | C1210C                                                                                     |    |    |    |     |     | C1812C |    |    |     |     | C2220C |    |    |     |     |

These products are protected under US Patent 8,331,078 other patents pending, and any foreign counterparts.



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

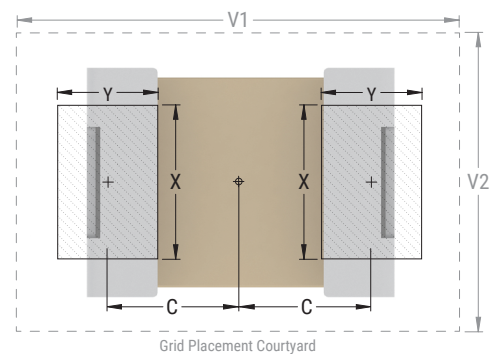
| Thickness Code | Case Size | Thickness ± Range (mm) | Paper Quantity |          | Plastic Quantity |          |
|----------------|-----------|------------------------|----------------|----------|------------------|----------|
|                |           |                        | 7" Reel        | 13" Reel | 7" Reel          | 13" Reel |
| FV             | 1210      | 3.35 ± 0.10            | 0              | 0        | 600              | 2,000    |
| FW             | 1210      | 6.15 ± 0.15            | 0              | 0        | 300              | 1,000    |
| GP             | 1812      | 2.65 ± 0.35            | 0              | 0        | 500              | 2,000    |
| GR             | 1812      | 5.00 ± 0.50            | 0              | 0        | 400              | 1,700    |
| JP             | 2220      | 3.50 ± 0.30            | 0              | 0        | 300              | 1,300    |
| JR             | 2220      | 5.00 ± 0.50            | 0              | 0        | 200              | 800      |
| 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 3 – KPS Land Pattern Design Recommendations (mm)**

| EIA SIZE CODE | METRIC SIZE CODE | Median (Nominal) Land Protrusion |      |      |      |      |
|---------------|------------------|----------------------------------|------|------|------|------|
|               |                  | C                                | Y    | X    | V1   | V2   |
| 1210          | 3225             | 1.50                             | 1.14 | 1.75 | 5.05 | 3.40 |
| 1812          | 4532             | 2.20                             | 1.35 | 2.87 | 6.70 | 4.50 |
| 2220          | 5650             | 2.69                             | 2.08 | 4.78 | 7.70 | 6.00 |

Image at right based on an EIA 1210 case size.



KEMET’s KPS Series land pattern design recommendations have been evaluated through extensive internal testing and validation. KPS lead frames are used to mechanically isolate the MLCC from the PCB and provide stress relief for increased mechanical robustness. The land pattern dimensions for each EIA size code are designed to be encompassed within the end terminations thus regulating solder wicking and maintaining lead frame flexibility. This design is optimized to enable durable solder joint fillets which improve the mechanical integrity and reliability upon placement.

## Soldering Process

KEMET's KPS Series devices are compatible with IR reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for IR reflow reflect the profile conditions of the IPC/J-STD-020D standard for moisture sensitivity testing.

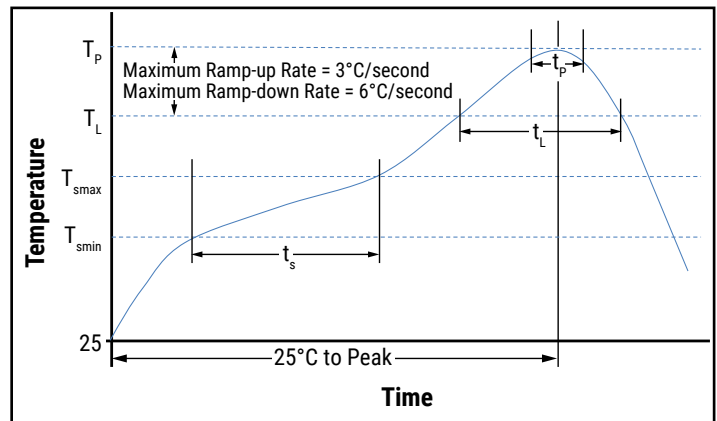
To prevent degradation of temperature cycling capability, care must be taken to prevent solder from flowing into the inner side of the lead frames (inner side of "J" lead in contact with the circuit board).

After soldering, the capacitors should be air cooled to room temperature before further processing. Forced air cooling is not recommended.

Hand soldering should be performed with care due to the difficulty in process control. If performed, care should be taken to avoid contact of the soldering iron to the capacitor body. The iron should be used to heat the solder pad, applying solder between the pad and the lead, until reflow occurs. Once reflow occurs, the iron should be removed immediately. (Preheating is required when hand soldering to avoid thermal shock.)

| Profile Feature                                       | SnPb Assembly       | Pb-Free Assembly    |
|-------------------------------------------------------|---------------------|---------------------|
| <b>Preheat/Soak</b>                                   |                     |                     |
| Temperature Minimum ( $T_{smin}$ )                    | 100°C               | 150°C               |
| Temperature Maximum ( $T_{smax}$ )                    | 150°C               | 200°C               |
| Time ( $t_s$ ) from $T_{smin}$ to $T_{smax}$          | 60 – 120 seconds    | 60 – 120 seconds    |
| Ramp-up Rate ( $T_L$ to $T_p$ )                       | 3°C/seconds maximum | 3°C/seconds maximum |
| Liquidous Temperature ( $T_L$ )                       | 183°C               | 217°C               |
| Time Above Liquidous ( $t_L$ )                        | 60 – 150 seconds    | 60 – 150 seconds    |
| Peak Temperature ( $T_p$ )                            | 235°C               | 250°C               |
| Time within 5°C of Maximum Peak Temperature ( $t_p$ ) | 20 seconds maximum  | 10 seconds maximum  |
| Ramp-down Rate ( $T_p$ to $T_L$ )                     | 6°C/seconds maximum | 6°C/seconds maximum |
| Time 25°C to Peak Temperature                         | 6 minutes maximum   | 8 minutes maximum   |

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



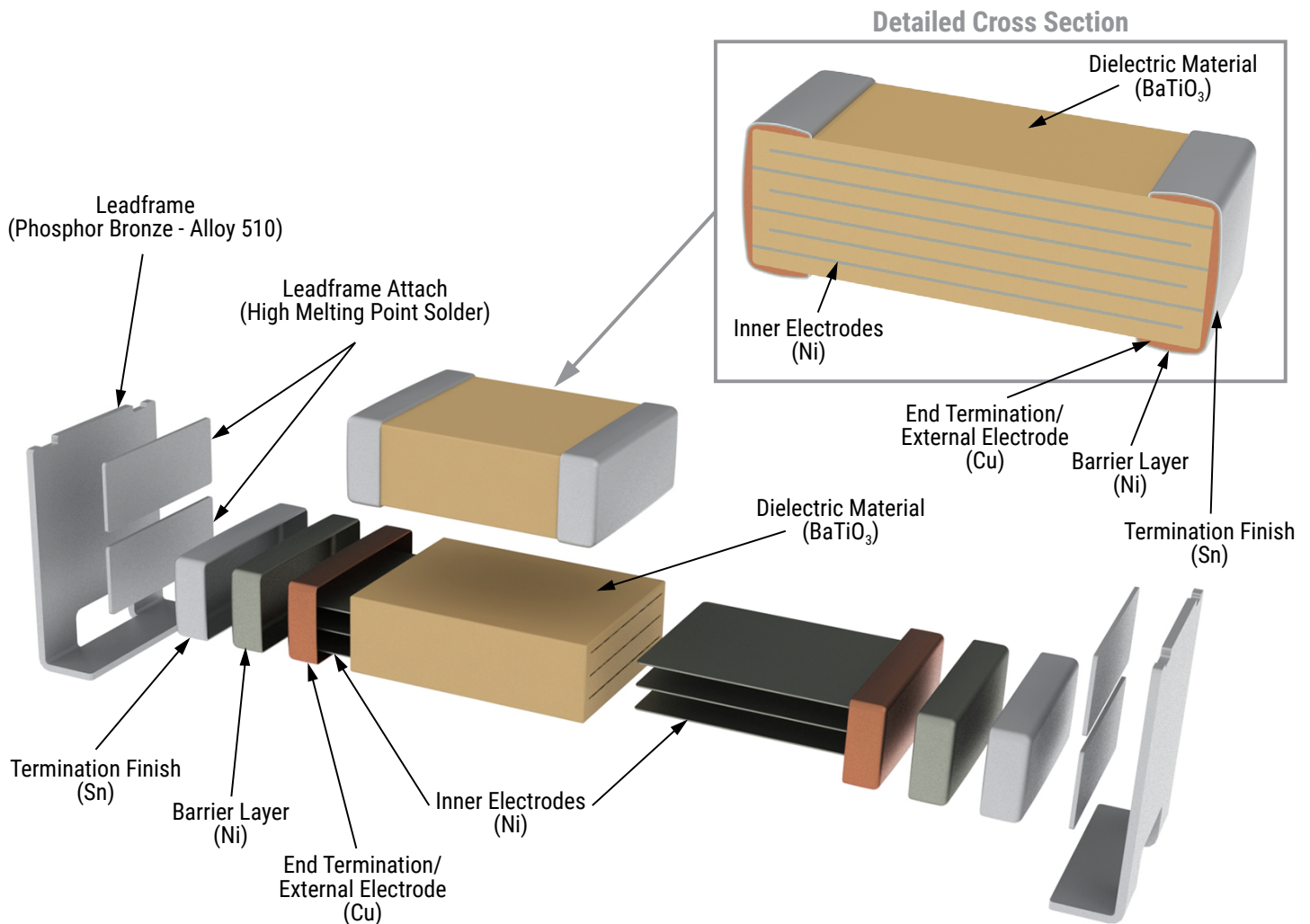
**Table 4 – Performance & Reliability: Test Methods and Conditions**

| 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: 5.0 mm minimum                                                                                                                                                                                                                      |
| Solderability          | J-STD-002              | Magnification 50 X. Conditions:                                                                                                                                                                                                                       |
|                        |                        | a) Method B, 4 hours at 155°C, dry heat at 235°C                                                                                                                                                                                                      |
|                        |                        | b) Method B at 215°C category 3                                                                                                                                                                                                                       |
|                        |                        | c) Method D, category 3 at 250°C                                                                                                                                                                                                                      |
| Temperature Cycling    | JESD22 Method JA-104   | 1,000 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 85°C/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 and 7b not required. Measurement at 24 hours +/- 4 hours after test conclusion.                                                                                                                                          |
| Thermal Shock          | MIL-STD-202 Method 107 | -55°C/+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 | 1,000 hours at 125°C with 1.5X 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 minutes, 12 cycles each of 3 orientations. Note: Use 8" X 5" 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 – 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 & 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 (Typical)



## Product Marking

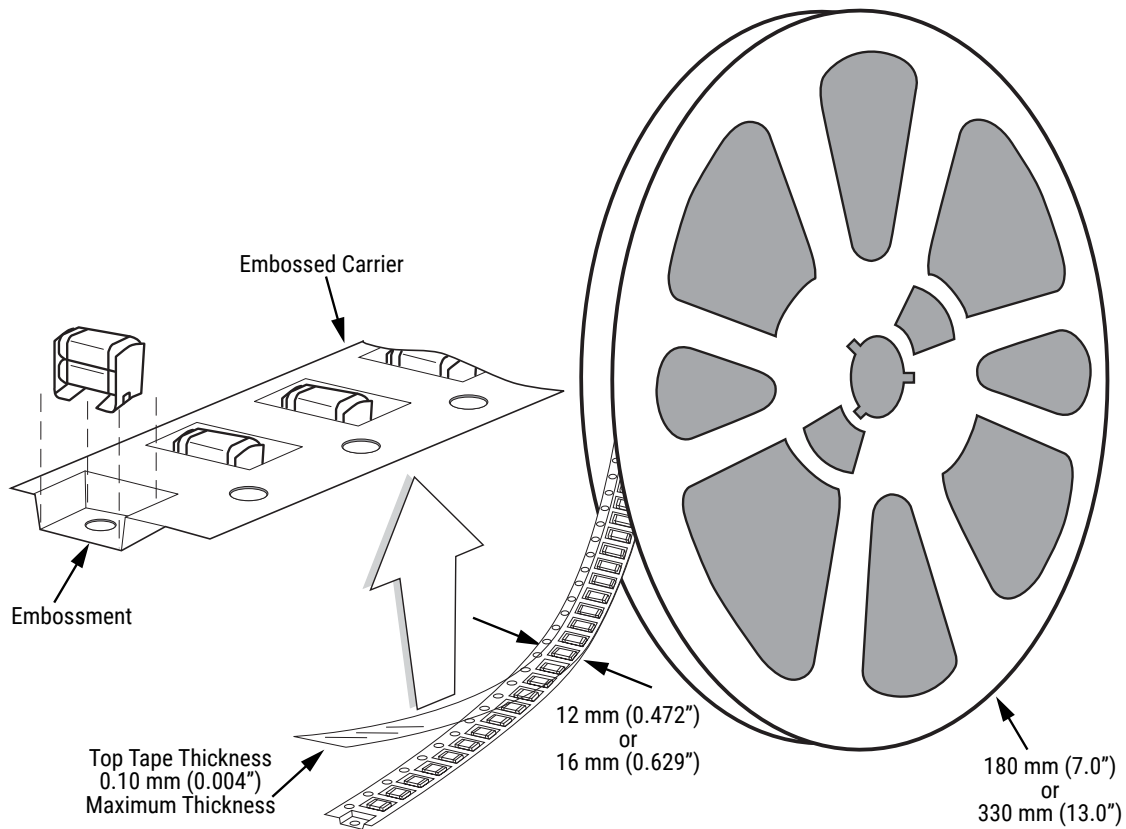
Laser marking option is not available on:

- 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.

These capacitors are supplied unmarked only.

## 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.



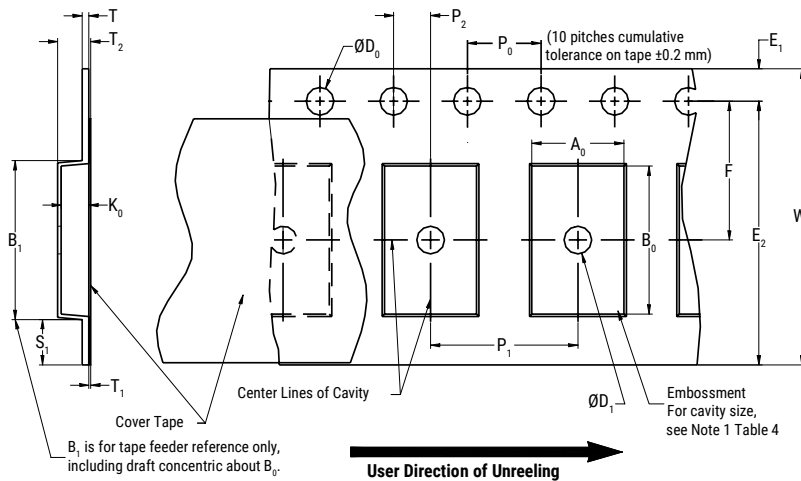
**Table 5 – Carrier Tape Configuration – Embossed Plastic (mm)**

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

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

\*Refer to Table 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 <sub>0</sub>                           | D <sub>1</sub> Minimum<br>Note 1 | E <sub>1</sub>               | P <sub>0</sub>              | P <sub>2</sub>               | R Reference<br>Note 2     | S <sub>1</sub> Minimum<br>Note 3 | T<br>Maximum                                     | T <sub>1</sub><br>Maximum |
| 8 mm                                       | 1.5 +0.10/0.0-0.0<br>(0.059 +0.004/-0.0) | 1.0<br>(0.039)                   | 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)  | 25.0<br>(0.984)           | 0.600<br>(0.024)                 | 0.600<br>(0.024)                                 | 0.100<br>(0.004)          |
| 12 mm                                      |                                          | 1.5<br>(0.059)                   |                              |                             |                              | 30<br>(1.181)             |                                  |                                                  |                           |
| 16 mm                                      |                                          |                                  |                              |                             |                              |                           |                                  |                                                  |                           |
| Variable Dimensions – Millimeters (Inches) |                                          |                                  |                              |                             |                              |                           |                                  |                                                  |                           |
| Tape Size                                  | Pitch                                    | B <sub>1</sub> Maximum<br>Note 4 | E <sub>2</sub> Minimum       | F                           | P <sub>1</sub>               | T <sub>2</sub><br>Maximum | W<br>Maximum                     | A <sub>0</sub> , B <sub>0</sub> & K <sub>0</sub> |                           |
| 8 mm                                       | Single (4 mm)                            | 4.35<br>(0.171)                  | 6.25<br>(0.246)              | 3.5 ±0.05<br>(0.138 ±0.002) | 4.0 ±0.10<br>(0.157 ±0.004)  | 2.5<br>(0.098)            | 8.3<br>(0.327)                   | Note 5                                           |                           |
| 12 mm                                      | Single (4 mm) and<br>Double (8 mm)       | 8.2<br>(0.323)                   | 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)                  |                                                  |                           |
| 16 mm                                      | Triple (12 mm)                           | 12.1<br>(0.476)                  | 14.25<br>(0.561)             | 7.5 ±0.05<br>(0.138 ±0.002) | 12.0 ±0.10<br>(0.157 ±0.004) | 4.6<br>(0.181)            | 16.3<br>(0.642)                  |                                                  |                           |

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 5).
3. If S<sub>1</sub> < 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).
4. B<sub>1</sub> dimension is a reference dimension for tape feeder clearance only.
5. The cavity defined by A<sub>0</sub>, B<sub>0</sub> and K<sub>0</sub> 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 2).
  - (d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 3).
  - (e) for KPS Series product, A<sub>0</sub> and B<sub>0</sub> are measured on a plane 0.3 mm above the bottom of the pocket.
  - (f) see Addendum in EIA Standard 481 for standards relating to more precise taping requirements.

## Packaging Information Performance Notes

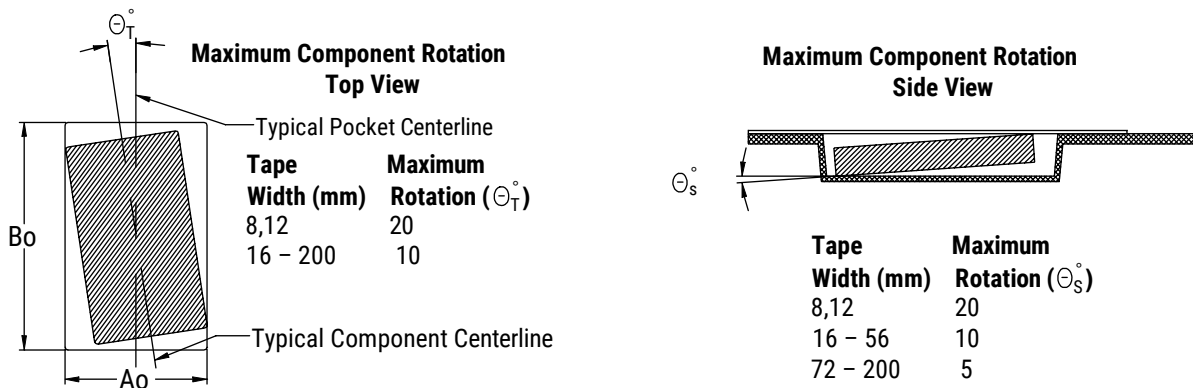
- 1. Cover Tape Break Force:** 1.0 kg minimum.
- 2. Cover Tape Peel Strength:** The total peel strength of the cover tape from the carrier tape shall be:

| 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 2 – Maximum Component Rotation



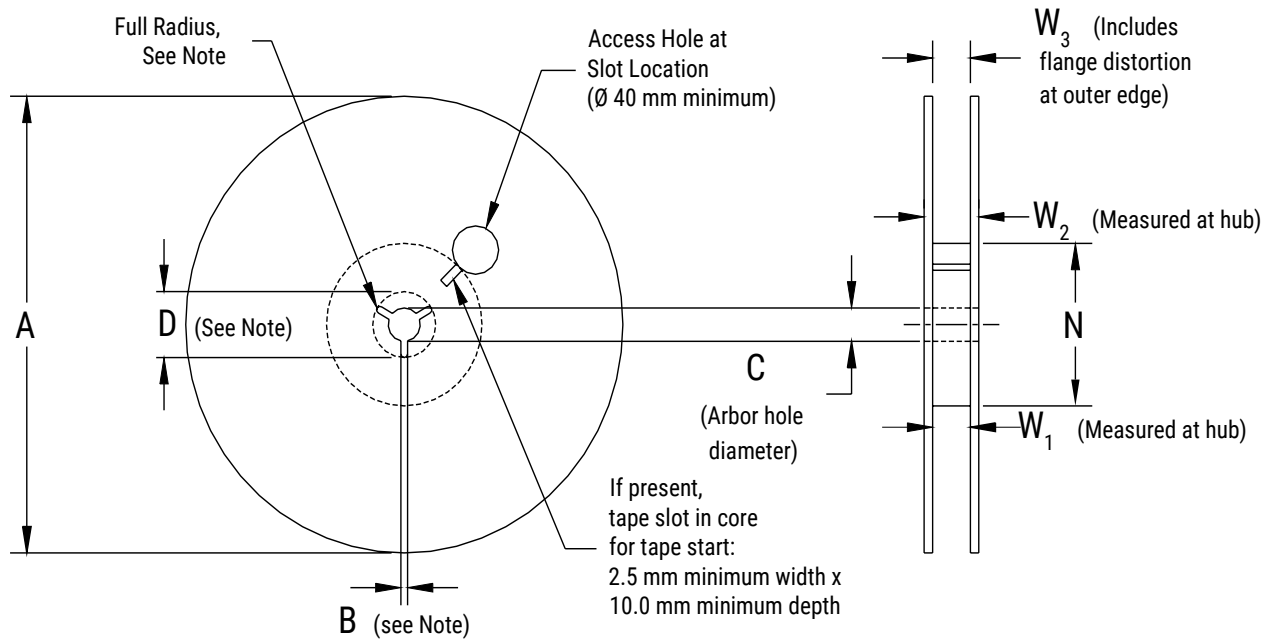
## Figure 3 – Maximum Lateral Movement



## 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

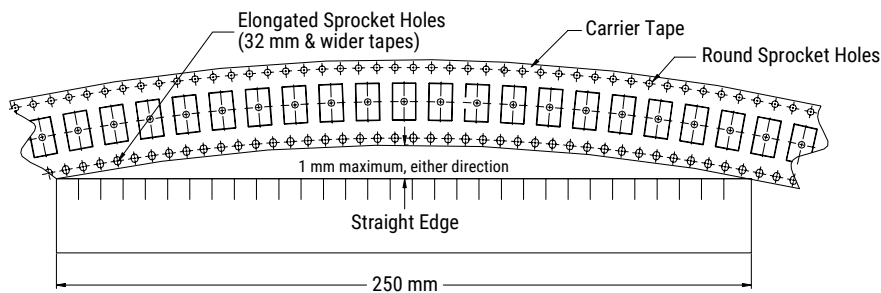
| Constant Dimensions – Millimeters (Inches) |                                                                   |                                       |                                        |                                                   |
|--------------------------------------------|-------------------------------------------------------------------|---------------------------------------|----------------------------------------|---------------------------------------------------|
| Tape Size                                  | A                                                                 | B Minimum                             | C                                      | D Minimum                                         |
| 8 mm                                       | 178 ±0.20<br>(7.008 ±0.008)<br>or<br>330 ±0.20<br>(13.000 ±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)                                   |
| 12 mm                                      |                                                                   |                                       |                                        |                                                   |
| 16 mm                                      |                                                                   |                                       |                                        |                                                   |
| Variable Dimensions – Millimeters (Inches) |                                                                   |                                       |                                        |                                                   |
| Tape Size                                  | N Minimum                                                         | $W_1$                                 | $W_2$ Maximum                          | $W_3$                                             |
| 8 mm                                       | 50<br>(1.969)                                                     | 8.4 +1.5/-0.0<br>(0.331 +0.059/-0.0)  | 14.4<br>(0.567)                        | Shall accommodate tape width without interference |
| 12 mm                                      |                                                                   | 12.4 +2.0/-0.0<br>(0.488 +0.078/-0.0) | 18.4<br>(0.724)                        |                                                   |
| 16 mm                                      |                                                                   | 16.4 +2.0/-0.0<br>(0.646 +0.078/-0.0) | 22.4<br>(0.882)                        |                                                   |



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



**Figure 7 – Maximum Camber**



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