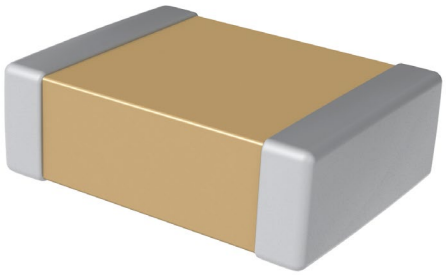
## Overview

KEMET's High Reliability Alternative (HRA) series is designed, tested, and screened to meet the demands of high-reliability applications that require capacitance values beyond those available in traditional MIL-SPEC products. Utilizing the same materials and process flow as MIL-PRF-32535, the HRA series leverages KEMET's patented base metal electrode (BME) technology to deliver up to five times the capacitance compared to MIL-PRF-32535-qualified parts. This increased capacitance enables board space reduction and supports continued miniaturization. KEMET's HRA series also feature more robust designs than Automotive and COTS grades and undergo voltage conditioning and lot-release testing to ensure enhanced reliability

## Benefits

- Patented BME technology
- X7R dielectric
- X-Level, Z-Level
  - Voltage conditioning and post-electrical testing per MIL–PRF–32535 (5% PDA)
  - Biased humidity testing (85°C/85%) per MIL–STD–202
  - Lot Release Testing
  - Lot Traceability
  - Single Lot Date Code Available
  - For additional details, refer to In-Process Inspection and Testing Table
- –55°C to +125°C operating temperature range
- DC voltage ratings of 4 V, 6.3 V, 10 V, 16 V, 25 V, 50 V, and 100 V
- Capacitance offerings ranging from 39 pF to 22 µF
- Available capacitance tolerances of ±5%, ±10%, and ±20%
- Standard and Flexible Termination options
- 100% Matte Sn, SnPb (5% Pb minimum), and Gold (Au) 100µ in minimum plating finishes available



## Applications

- Decoupling
- Bypass
- Filtering
- Transient voltage suppression

## HRA Ordering Information

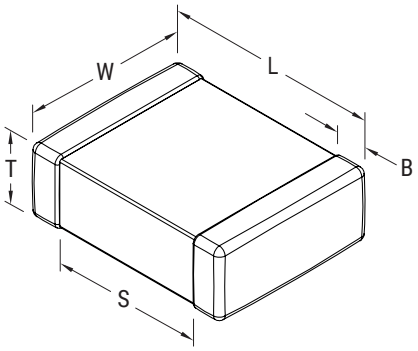
| CHA | 04 | C | 104 | K | 3 | R | X | L | XXXX |
|---|---|---|---|---|---|---|---|---|---|
| Series | Case Size (L" x W") | Specification/ Series[2,3,4,5] | Capacitance Code (pF) | Capacitance Tolerance | Rated Voltage (V) | Dielectric | Failure Rate | Termination Finish[1] | Orientation and Packaging (Suffix/C-Spec) |
| CHA | 04 = 0402<br>06 = 0603<br>08 = 0805<br>12 = 1206<br>13 = 1210<br>18 = 1812<br>21 = 2220 | C = Standard<br>X = Flexible Termination | 2 single digits + number of zeros. | J = ±5%<br>K = ±10%<br>M = ±20% | 7 = 4 V<br>9 = 6.3 V<br>8 = 10 V<br>4 = 16 V<br>3 = 25 V<br>5 = 50 V<br>1 = 100 V | R = X7R | X = X-Level<br>Z = Z-Level | C = 100% Matte Sn<br>L = SnPb (5% Pb min.)<br>G = Gold (Au) 100µin min. | See "Packaging C-Spec Ordering Options Table" |

*[1] Additional termination finish options may be available. Contact KEMET for details.*
*[2] Flex termination (X) not available in EIA 0402 case size.*
*[3] Standard termination (C) not available for EIA 1812 or EIA 2220 case size.*
*[4] Standard termination (C) not available for 100 V part types.*
*[5] Flex termination (X) not available in Z-Level*

## Packaging C-Spec Ordering Options Table

| Packaging Type | Packaging Ordering Code (C-Spec) |
|---|---|
| Standard Packaging (Waffle Tray) | Not required (Blank) |
| 7" Tape & Reel | 7189 |

## Dimensions – Millimeters (Inches)




| EIA Size Code | Metric Size Code | L Length | W Width | T Thickness | B Bandwidth | S Separation Minimum | Mounting Technique |
|---|---|---|---|---|---|---|---|
| **Without Flexible Termination** | | | | | | | |
| 0402 | 1005 | 1.00 (0.040) ± 0.05 (0.002) | 0.50 (0.020) ± 0.05 (0.002) | **See Table 2 for Thickness** | 0.30 (0.012) ± 0.10 (0.004) | 0.30 (0.012) | Solder Reflow Only |
| 0603 | 1608 | 1.60 (0.063) ± 0.15 (0.006) | 0.80 (0.032) ± 0.15 (0.006) | | 0.35 (0.014) ± 0.15 (0.006) | 0.50 (0.020) | Solder Wave or Solder Reflow |
| 0805 | 2012 | 2.00 (0.079) ± 0.20 (0.008) | 1.25 (0.049) ± 0.20 (0.008) | | 0.50 (0.02) ± 0.25 (0.010) | 0.70 (0.028) | |
| 1206 | 3216 | 3.20 (0.126) ± 0.20 (0.008) | 1.60 (0.063) ± 0.20 (0.008) | | 0.50 (0.02) ± 0.25 (0.010) | 1.50 (0.060) | |
| 1210 | 3225 | 3.20 (0.126) ± 0.20 (0.008) | 2.50 (0.098) ± 0.20 (0.008) | | 0.50 (0.02) ± 0.25 (0.010) | 1.50 (0.060) | Solder Reflow Only |
| **With Flexible Termination** | | | | | | | |
| 0603 | 1608 | 1.60 +0.2/−0.15 (0.063 +0.008/−0.006) | 0.81 +0.2/−0.15 (0.032 +0.008/−0.006) | **See Table 2 for Thickness** | 0.45 (0.018) ± 0.15 (0.006) | 0.40 (0.016) | Solder Wave or Solder Reflow |
| 0805[1] | 2012 | 2.00 (0.079) ± 0.30 (0.012) | 1.25 (0.049) ± 0.30 (0.012) | | 0.50 (0.02) ± 0.25 (0.010) | 0.60 (0.024) | |
| 1206 | 3216 | 3.30 (0.130) ± 0.40 (0.016) | 1.60 (0.063) ± 0.35(0.013) | | 0.60 (0.024) ± 0.25 (0.010) | 1.50 (0.060) | |
| 1210 | 3225 | 3.30 (0.130) ± 0.40 (0.016) | 2.60(0.102) ± 0.30(0.012) | | 0.60 (0.024) ± 0.25 (0.010) | 1.50 (0.060) | Solder Reflow Only |
| 1812 | 4532 | 4.50 (0.178) ± 0.40 (0.016) | 3.20 (0.126) ± 0.30 (0.012) | | 0.70 (0.028) ± 0.35 (0.014) | 2.30 (0.091) | |
| 2220 | 5650 | 5.90 (0.232) ± 0.75 (0.030) | 5.00 (0.197) ± 0.40 (0.016) | | 0.70 (0.028) ± 0.35 (0.014) | 3.50 (0.138) | |

*[1] For Cap 2.2µF (6.3V and 4V) add 0.10 (0.004) to length tolerance dimension. (Flexible Termination option only)*

## Environmental Compliance

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

## Table 1A –
## Capacitance Range/Selection Waterfall (0402 – 0805 Case Sizes, X-Level Standard Termination)

| Capacitance | Cap Code | Case Size | | | 0402 | | | | | | 0603 | | | | | | 0805 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Voltage Code (KEMET) | | | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 |
| | | Rated Voltage (VDC) | | | 4 | 6.3 | 10 | 16 | 25 | 50 | 4 | 6.3 | 10 | 16 | 25 | 50 | 4 | 6.3 | 10 | 16 | 25 | 50 |
| | | Capacitance Tolerance | | | Product Availability | | | | | | | | | | | | | | | | | |
| 39 pF | 390 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 43 pF | 430 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 47 pF | 470 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 51 pF | 510 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 56 pF | 560 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 62 pF | 620 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 68 pF | 680 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 75 pF | 750 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 82 pF | 820 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 91 pF | 910 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 100 pF | 101 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 110 pF | 111 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 120 pF | 121 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 130 pF | 131 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 150 pF | 151 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 180 pF | 181 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 220 pF | 221 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 270 pF | 271 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 330 pF | 331 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 390 pF | 391 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 470 pF | 471 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 560 pF | 561 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 680 pF | 681 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 820 pF | 821 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 1000 pF | 102 | J | K | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | | | | | | |
| 1200 pF | 122 | J | K | M | BB | BB | BB | BB | BB | BB | CH | CH | CH | CH | CH | CH | | | | | | |
| 1500 pF | 152 | J | K | M | BB | BB | BB | BB | BB | BB | CH | CH | CH | CH | CH | CH | | | | | | |
| 1800 pF | 182 | J | K | M | BB | BB | BB | BB | BB | BB | CH | CH | CH | CH | CH | CH | | | | | | |
| 2200 pF | 222 | J | K | M | BB | BB | BB | BB | BB | BB | CH | CH | CH | CH | CH | CH | | | | | | |
| 2700 pF | 272 | J | K | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | | | | | | |
| 3300 pF | 332 | J | K | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | | | | | | |
| 3900 pF | 392 | J | K | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | | | | | | |
| 4700 pF | 472 | J | K | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | | | | | | |
| 5600 pF | 562 | J | K | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | | | | | | |
| 6800 pF | 682 | J | K | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | | | | | | |
| 8200 pF | 822 | J | K | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | | | | | | |
| 10000 pF | 103 | J | K | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN |
| 12000 pF | 123 | J | K | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN |
| 15000 pF | 153 | J | K | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN |
| 18000 pF | 183 | J | K | M | BB | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN |
| 22000 pF | 223 | J | K | M | BB | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN |
| 27000 pF | 273 | J | K | M | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN |
| 33000 pF | 333 | J | K | M | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | DP | DP | DP | DP | DP | DP |
| 39000 pF | 393 | J | K | M | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | DP | DP | DP | DP | DP | DP |
| 47000 pF | 473 | J | K | M | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | DP | DP | DP | DP | DP | DP |
| 56000 pF | 563 | J | K | M | BB | BB | | | | | CF | CF | CF | CF | CF | CF | DP | DP | DP | DP | DP | DP |
| 68000 pF | 683 | J | K | M | BB | BB | | | | | CF | CF | CF | CF | CF | CF | DP | DP | DP | DP | DP | DP |
| 82000 pF | 823 | J | K | M | BB | BB | | | | | CF | CF | CF | CF | CF | CF | DP | DP | DP | DP | DP | DP |
| 0.1 µF | 104 | J | K | M | BB | BB | | | | | CF | CF | CF | CF | CF | CF | DG | DG | DG | DG | DG | DG |
| 0.12 µF | 124 | J | K | M | | | | | | | CF | CF | CF | CF | CF | | DG | DG | DG | DG | DG | DG |
| 0.15 µF | 154 | J | K | M | | | | | | | CF | CF | CF | CF | CF | | DG | DG | DG | DG | DG | DG |
| 0.18 µF | 184 | J | K | M | | | | | | | CF | CF | CF | CF | | | DP | DP | DP | DP | DP | DP |
| Capacitance | Cap Code | Rated Voltage | | | 4 | 6.3 | 10 | 16 | 25 | 50 | 4 | 6.3 | 10 | 16 | 25 | 50 | 4 | 6.3 | 10 | 16 | 25 | 50 |
| | | Voltage Code | | | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 |
| | | Case Size | | | 0402 | | | | | | 0603 | | | | | | 0805 | | | | | |

## Table 1A – Capacitance Range/Selection Waterfall (0402 – 0805 Case Sizes, X-Level Standard Termination) cont.

| Capacitance | Cap Code | Case Size | | | 0402 | | | | | | 0603 | | | | | | 0805 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Voltage Code (KEMET) | | | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 |
| | | Rated Voltage (VDC) | | | 4 | 6.3 | 10 | 16 | 25 | 50 | 4 | 6.3 | 10 | 16 | 25 | 50 | 4 | 6.3 | 10 | 16 | 25 | 50 |
| | | Capacitance Tolerance | | | Product Availability | | | | | | | | | | | | | | | | | |
| 0.22 µF | 224 | J | K | M | | | | | | | CF | CF | CF | CF | | | DP | DP | DP | DP | DP | DP |
| 0.27 µF | 274 | J | K | M | | | | | | | CF | CF | CF | | | | DP | DP | DP | DP | DP | DP |
| 0.33 µF | 334 | J | K | M | | | | | | | CF | CF | CF | | | | DP | DP | DP | DP | DP | DP |
| 0.39 µF | 394 | J | K | M | | | | | | | CF | CF | | | | | DP | DP | DP | DP | DP | DP |
| 0.47 µF | 474 | J | K | M | | | | | | | CF | CF | | | | | DG | DG | DG | DG | DG | DG |
| 0.56 µF | 564 | J | K | M | | | | | | | | | | | | | DG | DG | DG | DG | DG | |
| 0.68 µF | 684 | J | K | M | | | | | | | | | | | | | DG | DG | DG | DG | DG | |
| 0.82 µF | 824 | J | K | M | | | | | | | | | | | | | DG | DG | DG | DG | | |
| 1.0 µF | 105 | J | K | M | | | | | | | | | | | | | DG | DG | DG | DG | | |
| 1.2 µF | 125 | J | K | M | | | | | | | | | | | | | DE | DE | DE | | | |
| 1.5 µF | 155 | J | K | M | | | | | | | | | | | | | DG | DG | DG | | | |
| 1.8 µF | 185 | J | K | M | | | | | | | | | | | | | DG | DG | | | | |
| 2.2 µF | 225 | J | K | M | | | | | | | | | | | | | DG | DG | | | | |
| Capacitance | Cap Code | Rated Voltage | | | 4 | 6.3 | 10 | 16 | 25 | 50 | 4 | 6.3 | 10 | 16 | 25 | 50 | 4 | 6.3 | 10 | 16 | 25 | 50 |
| | | Voltage Code | | | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 |
| | | Case Size | | | 0402 | | | | | | 0603 | | | | | | 0805 | | | | | |

## Table 1B –
## Capacitance Range/Selection Waterfall (1206 – 1210 Case Sizes, X-Level Standard Termination)

| Capacitance | Cap Code | Case Size | | | 1206 | | | | | | 1210 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Voltage Code (KEMET) | | | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 |
| | | Rated Voltage (VDC) | | | 4 | 6.3 | 10 | 16 | 25 | 50 | 4 | 6.3 | 10 | 16 | 25 | 50 |
| | | Capacitance Tolerance | | | Product Availability | | | | | | | | | | | |
| 8.2 µF | 823 | J | K | M | | | | | | | FC | FC | FC | FC | FC | FC |
| 0.1 µF | 104 | J | K | M | EB | EB | EB | EB | EB | EB | FC | FC | FC | FC | FC | FC |
| 0.12 µF | 124 | J | K | M | EB | EB | EB | EB | EB | EB | FC | FC | FC | FC | FC | FC |
| 0.15 µF | 154 | J | K | M | EC | EC | EC | EC | EC | EC | FC | FC | FC | FC | FC | FC |
| 0.18 µF | 184 | J | K | M | EC | EC | EC | EC | EC | EC | FC | FC | FC | FC | FC | FC |
| 0.22 µF | 224 | J | K | M | ED | ED | ED | ED | ED | ED | FC | FC | FC | FC | FC | FC |
| 0.27 µF | 274 | J | K | M | EM | EM | EM | EM | EM | EM | FC | FC | FC | FC | FC | FC |
| 0.33 µF | 334 | J | K | M | EM | EM | EM | EM | EM | EM | FE | FE | FE | FE | FE | FE |
| 0.39 µF | 394 | J | K | M | EB | EB | EB | EB | EB | EB | FG | FG | FG | FG | FG | FG |
| 0.47 µF | 474 | J | K | M | EB | EB | EB | EB | EB | EB | FG | FG | FG | FG | FG | FG |
| 0.56 µF | 564 | J | K | M | EB | EB | EB | EB | EB | EB | FH | FH | FH | FH | FH | FH |
| 0.68 µF | 684 | J | K | M | EC | EC | EC | EC | EC | EC | FH | FH | FH | FH | FH | FH |
| 0.82 µF | 824 | J | K | M | ED | ED | ED | ED | ED | ED | FF | FF | FF | FF | FF | FF |
| 1 µF | 105 | J | K | M | ED | ED | ED | ED | ED | ED | FC | FC | FC | FC | FC | FC |
| 1.2 µF | 125 | J | K | M | EM | EM | EM | EM | EM | | FC | FC | FC | FC | FC | FC |
| 1.5 µF | 155 | J | K | M | EM | EM | EM | EM | EM | | FE | FE | FE | FE | FE | FE |
| 1.8 µF | 185 | J | K | M | EM | EM | EM | EH | EH | | FG | FG | FG | FG | FG | FG |
| 2.2 µF | 225 | J | K | M | EM | EM | EM | EH | EH | | FG | FG | FG | FG | FG | FG |
| 2.7 µF | 275 | J | K | M | EH | EH | EH | EH | | | FG | FG | FG | FH | FH | FH |
| 3.3 µF | 335 | J | K | M | EH | EH | EH | EH | | | FG | FG | FG | FM | FM | FM |
| 3.9 µF | 395 | J | K | M | EF | EF | EF | | | | FK | FK | FK | FK | FK | |
| 4.7 µF | 475 | J | K | M | EF | EF | EF | | | | FS | FS | FS | FS | FS | |
| 5.6 µF | 565 | J | K | M | EH | EH | | | | | FH | FH | FH | FH | | |
| 6.8 µF | 685 | J | K | M | EH | EH | | | | | FM | FM | FM | FM | | |
| 8.2 µF | 825 | J | K | M | EH | EH | | | | | FK | FK | FK | | | |
| 10 µF | 106 | J | K | M | EH | EH | | | | | FS | FS | FS | | | |
| 12 µF | 126 | J | K | M | | | | | | | | | | | | |
| 15 µF | 156 | J | K | M | | | | | | | | | | | | |
| 18 µF | 186 | J | K | M | | | | | | | | | | | | |
| 22 µF | 226 | J | K | M | | | | | | | | | | | | |
| Capacitance | Cap Code | Rated Voltage | | | 4 | 6.3 | 10 | 16 | 25 | 50 | 4 | 6.3 | 10 | 16 | 25 | 50 |
| | | Voltage Code | | | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 |
| | | Case Size | | | 1206 | | | | | | 1210 | | | | | |

## Table 1C –
## Capacitance Range/Selection Waterfall (0603 – 1206 Case Sizes, X-Level Flexible Termination)

| Capacitance | Cap Code | Case Size | | | 0603 | | | | | | 0805 | | | | | | | 1206 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Voltage Code (KEMET) | | | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 7 | 9 | 8 | 4 | 3 | 5 | 1 |
| | | Rated Voltage (VDC) | | | 4 | 6.3 | 10 | 16 | 25 | 50 | 4 | 6.3 | 10 | 16 | 25 | 50 | 100 | 4 | 6.3 | 10 | 16 | 25 | 50 | 100 |
| | | Capacitance Tolerance | | | Product Availability | | | | | | | | | | | | | | | | | | | |
| 1000 pF | 102 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | | | | | | | | | | | | | | |
| 1200 pF | 122 | J | K | M | CH | CH | CH | CH | CH | CH | | | | | | | | | | | | | | |
| 1500 pF | 152 | J | K | M | CH | CH | CH | CH | CH | CH | | | | | | | | | | | | | | |
| 1800 pF | 182 | J | K | M | CH | CH | CH | CH | CH | CH | | | | | | | | | | | | | | |
| 2200 pF | 222 | J | K | M | CH | CH | CH | CH | CH | CH | | | | | | | | | | | | | | |
| 2700 pF | 272 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | | | | | | | | | | | | | | |
| 3300 pF | 332 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | | | | | | | | | | | | | | |
| 3900 pF | 392 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | | | | | | | | | | | | | | |
| 4700 pF | 472 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | | | | | | | | | | | | | | |
| 5600 pF | 562 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | | | | | | | | | | | | | | |
| 6800 pF | 682 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | | | | | | | | | | | | | | |
| 8200 pF | 822 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | | | | | | | | | | | | | | |
| 10000 pF | 103 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | | | | | | | |
| 12000 pF | 123 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | | | | | | | |
| 15000 pF | 153 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | | | | | | | |
| 18000 pF | 183 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DR | | | | | | | |
| 22000 pF | 223 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DD | | | | | | | |
| 27000 pF | 273 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | DR | DR | DR | DR | DR | DR | DD | | | | | | | |
| 33000 pF | 333 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | DD | DD | DD | DD | DD | DD | DD | | | | | | | |
| 39000 pF | 393 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | DD | DD | DD | DD | DD | DD | DD | | | | | | | |
| 47000 pF | 473 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | DD | DD | DD | DD | DD | DD | DG | | | | | | | |
| 56000 pF | 563 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | DD | DD | DD | DD | DD | DD | DG | | | | | | | |
| 68000 pF | 683 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | DD | DD | DD | DD | DD | DD | | | | | | | | |
| 82000 pF | 823 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | DD | DD | DD | DD | DD | DD | | | | | | | | |
| 0.1 µF | 104 | J | K | M | CJ | CJ | CJ | CJ | CJ | CJ | DG | DG | DG | DG | DG | DG | | EQ | EQ | EQ | EQ | EQ | EQ | EL |
| 0.12 µF | 124 | J | K | M | CJ | CJ | CJ | CJ | CJ | | DG | DG | DG | DG | DG | DG | | EQ | EQ | EQ | EQ | EQ | EQ | EL |
| 0.15 µF | 154 | J | K | M | CJ | CJ | CJ | CJ | CJ | | DG | DG | DG | DG | DG | DG | | ER | ER | ER | ER | ER | ER | EL |
| 0.18 µF | 184 | J | K | M | CJ | CJ | CJ | CJ | | | DD | DD | DD | DD | DD | DD | | ER | ER | ER | ER | ER | ER | |
| 0.22 µF | 224 | J | K | M | CJ | CJ | CJ | CJ | | | DD | DD | DD | DD | DD | DD | | ES | ES | ES | ES | ES | ES | |
| 0.27 µF | 274 | J | K | M | CJ | CJ | CJ | | | | DD | DD | DD | DD | DD | DD | | EL | EL | EL | EL | EL | EL | |
| 0.33 µF | 334 | J | K | M | CJ | CJ | CJ | | | | DD | DD | DD | DD | DD | DD | | EL | EL | EL | EL | EL | EL | |
| 0.39 µF | 394 | J | K | M | CJ | CJ | | | | | DD | DD | DD | DD | DD | DD | | EQ | EQ | EQ | EQ | EQ | EQ | |
| 0.47 µF | 474 | J | K | M | CJ | CJ | | | | | DG | DG | DG | DG | DG | DG | | EQ | EQ | EQ | EQ | EQ | EQ | |
| 0.56 µF | 564 | J | K | M | | | | | | | DG | DG | DG | DG | DG | | | EQ | EQ | EQ | EQ | EQ | EQ | |
| 0.68 µF | 684 | J | K | M | | | | | | | DG | DG | DG | DG | DG | | | ER | ER | ER | ER | ER | ER | |
| 0.82 µF | 824 | J | K | M | | | | | | | DG | DG | DG | DG | | | | ES | ES | ES | ES | ES | ES | |
| 1 µF | 105 | J | K | M | | | | | | | DG | DG | DG | DG | | | | ES | ES | ES | ES | ES | ES | |
| 1.2 µF | 125 | J | K | M | | | | | | | DS | DS | DS | | | | | EL | EL | EL | EL | EL | | |
| 1.5 µF | 155 | J | K | M | | | | | | | DG | DG | DG | | | | | EL | EL | EL | EL | EL | | |
| 1.8 µF | 185 | J | K | M | | | | | | | DG | DG | | | | | | EL | EL | EL | EL | EH | | |
| 2.2 µF | 225 | J | K | M | | | | | | | DG | DG | | | | | | EL | EL | EL | EL | EH | | |
| 2.7 µF | 275 | J | K | M | | | | | | | | | | | | | | EH | EH | EH | EH | | | |
| 3.3 µF | 335 | J | K | M | | | | | | | | | | | | | | EH | EH | EH | EH | | | |
| 3.9 µF | 395 | J | K | M | | | | | | | | | | | | | | EP | EP | EP | | | | |
| 4.7 µF | 475 | J | K | M | | | | | | | | | | | | | | EP | EP | EP | | | | |
| 5.6 µF | 565 | J | K | M | | | | | | | | | | | | | | EH | EH | | | | | |
| 6.8 µF | 685 | J | K | M | | | | | | | | | | | | | | EH | EH | | | | | |
| 8.2 µF | 825 | J | K | M | | | | | | | | | | | | | | EH | EH | | | | | |
| 10 µF | 106 | J | K | M | | | | | | | | | | | | | | EH | EH | | | | | |
| Capacitance | Cap Code | Rated Voltage | | | 4 | 6.3 | 10 | 16 | 25 | 50 | 4 | 6.3 | 10 | 16 | 25 | 50 | 100 | 4 | 6.3 | 10 | 16 | 25 | 50 | 100 |
| | | Voltage Code | | | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 7 | 9 | 8 | 4 | 3 | 5 | 1 |
| | | Case Size | | | 0402 | | | | | | 0805 | | | | | | | 1206 | | | | | | |

## Table 1D –
## Capacitance Range/Selection Waterfall (1210 – 2220 Case Sizes, X-Level Flexible Termination)

| Capacitance | Cap Code | Case Size | | | 1210 | | | | | | | 1812 | | | | | | | 2220 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Voltage Code (KEMET) | | | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 7 | 9 | 8 | 4 | 3 | 5 |
| | | Rated Voltage (VDC) | | | 4 | 6.3 | 10 | 16 | 25 | 50 | 100 | 4 | 6.3 | 10 | 16 | 25 | 50 | 100 | 4 | 6.3 | 10 | 16 | 25 | 50 |
| | | Capacitance Tolerance | | | Product Availability | | | | | | | | | | | | | | | | | | | |
| 82000 pF | 823 | J | K | M | FQ | FQ | FQ | FQ | FQ | FQ | FN | | | | | | | | | | | | | |
| 0.1 µF | 104 | J | K | M | FQ | FQ | FQ | FQ | FQ | FQ | FQ | GB | GB | GB | GB | GB | GB | GB | JC | JC | JC | JC | JC | JC |
| 0.12 µF | 124 | J | K | M | FQ | FQ | FQ | FQ | FQ | FQ | FE | GB | GB | GB | GB | GB | GB | GB | JC | JC | JC | JC | JC | JC |
| 0.15 µF | 154 | J | K | M | FQ | FQ | FQ | FQ | FQ | FQ | FE | GB | GB | GB | GB | GB | GB | GB | JC | JC | JC | JC | JC | JC |
| 0.18 µF | 184 | J | K | M | FQ | FQ | FQ | FQ | FQ | FQ | FF | GB | GB | GB | GB | GB | GB | GB | JC | JC | JC | JC | JC | JC |
| 0.22 µF | 224 | J | K | M | FQ | FQ | FQ | FQ | FQ | FQ | FZ | GB | GB | GB | GB | GB | GB | GB | JC | JC | JC | JC | JC | JC |
| 0.27 µF | 274 | J | K | M | FQ | FQ | FQ | FQ | FQ | FQ | FU | GB | GB | GB | GB | GB | GB | GC | JC | JC | JC | JC | JC | JC |
| 0.33 µF | 334 | J | K | M | FE | FE | FE | FE | FE | FE | FU | GB | GB | GB | GB | GB | GB | GC | JC | JC | JC | JC | JC | JC |
| 0.39 µF | 394 | J | K | M | FZ | FZ | FZ | FZ | FZ | FZ | | GB | GB | GB | GB | GB | GB | GE | JC | JC | JC | JC | JC | JC |
| 0.47 µF | 474 | J | K | M | FZ | FZ | FZ | FZ | FZ | FZ | | GB | GB | GB | GB | GB | GB | GG | JC | JC | JC | JC | JC | JC |
| 0.56 µF | 564 | J | K | M | FU | FU | FU | FU | FU | FU | | GB | GB | GB | GB | GB | GB | GG | JC | JC | JC | JC | JC | JD |
| 0.68 µF | 684 | J | K | M | FU | FU | FU | FU | FU | FU | | GB | GB | GB | GB | GB | GB | GN | JD | JD | JD | JD | JD | JF |
| 0.82 µF | 824 | J | K | M | FF | FF | FF | FF | FF | FF | | GB | GB | GB | GB | GB | GB | GS | JD | JD | JD | JD | JD | JF |
| 1 µF | 105 | J | K | M | FQ | FQ | FQ | FQ | FQ | FQ | | GB | GB | GB | GB | GB | GB | GO | JF | JF | JF | JF | JF | JL |
| 1.2 µF | 125 | J | K | M | FQ | FQ | FQ | FQ | FQ | FQ | | GG | GG | GG | GG | GG | GG | | JF | JF | JF | JF | JF | JO |
| 1.5 µF | 155 | J | K | M | FE | FE | FE | FE | FE | FE | | GN | GN | GN | GN | GN | GN | | JF | JF | JF | JF | JF | JO |
| 1.8 µF | 185 | J | K | M | FZ | FZ | FZ | FZ | FZ | FZ | | GN | GN | GN | GN | GN | GN | | JF | JF | JF | JF | JF | |
| 2.2 µF | 225 | J | K | M | FZ | FZ | FZ | FZ | FZ | FZ | | GE | GE | GE | GE | GE | GE | | JF | JF | JF | JF | JF | |
| 2.7 µF | 275 | J | K | M | FZ | FZ | FZ | FU | FU | FU | | GE | GE | GE | GE | GE | GE | | JF | JF | JF | JF | JF | |
| 3.3 µF | 335 | J | K | M | FZ | FZ | FZ | FM | FM | FM | | GE | GE | GE | GE | GE | GE | | JF | JF | JF | JF | JF | |
| 3.9 µF | 395 | J | K | M | FK | FK | FK | FK | FK | | | GE | GE | GE | GE | GE | | | JC | JC | JC | JC | | |
| 4.7 µF | 475 | J | K | M | FS | FS | FS | FS | FS | | | GB | GB | GB | GK | GK | | | JD | JD | JD | JD | | |
| 5.6 µF | 565 | J | K | M | FU | FU | FU | FU | | | | | | | | | | | JC | JC | | | | |
| 6.8 µF | 685 | J | K | M | FM | FM | FM | FM | | | | | | | | | | | JC | JC | | | | |
| 8.2 µF | 825 | J | K | M | FK | FK | FK | | | | | | | | | | | | JC | JC | | | | |
| 10 µF | 106 | J | K | M | FS | FS | FS | | | | | GK | GK | GK | GK | | | | JC | JC | JO | JO | JO | |
| 12 µF | 126 | J | K | M | | | | | | | | | | | | | | | | | | | | |
| 15 µF | 156 | J | K | M | | | | | | | | | | | | | | | JO | JO | JO | JO | | |
| 18 µF | 186 | J | K | M | | | | | | | | | | | | | | | | | | | | |
| 22 µF | 226 | J | K | M | | | | | | | | | | | | | | | JO | JO | JO | JO | | |
| Capacitance | Cap Code | Rated Voltage | | | 4 | 6.3 | 10 | 16 | 25 | 50 | 100 | 4 | 6.3 | 10 | 16 | 25 | 50 | 100 | 4 | 6.3 | 10 | 16 | 25 | 50 |
| | | Voltage Code | | | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 7 | 9 | 8 | 4 | 3 | 5 | 1 | 7 | 9 | 8 | 4 | 3 | 5 |
| | | Case Size | | | 1210 | | | | | | | 1812 | | | | | | | 2220 | | | | | |

## Table 1E –
## Capacitance Range/Selection Waterfall (0402 – 0805 Case Sizes, Z-Level Standard Termination)

| Capacitance | Cap Code | Case Size | | | 0402 | | | | | | 0603 | | | | | | 0805 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Voltage Code (KEMET) | | | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 |
| | | Rated Voltage (VDC) | | | 4 | 6.3 | 10 | 16 | 25 | 50 | 4 | 6.3 | 10 | 16 | 25 | 50 | 4 | 6.3 | 10 | 16 | 25 | 50 |
| | | Capacitance Tolerance | | | Product Availability | | | | | | | | | | | | | | | | | |
| 39 pF | 390 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 43 pF | 430 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 47 pF | 470 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 51 pF | 510 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 56 pF | 560 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 62 pF | 620 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 68 pF | 680 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 75 pF | 750 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 82 pF | 820 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 91 pF | 910 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 100 pF | 101 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 110 pF | 111 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 120 pF | 121 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 130 pF | 131 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 150 pF | 151 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 180 pF | 181 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 220 pF | 221 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 270 pF | 271 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 330 pF | 331 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 390 pF | 391 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 470 pF | 471 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 560 pF | 561 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 680 pF | 681 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 820 pF | 821 | J | K | M | BB | BB | BB | BB | BB | BB | | | | | | | | | | | | |
| 1000 pF | 102 | J | K | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | | | | | | |
| 1200 pF | 122 | J | K | M | BB | BB | BB | BB | BB | BB | CH | CH | CH | CH | CH | CH | | | | | | |
| 1500 pF | 152 | J | K | M | BB | BB | BB | BB | BB | BB | CH | CH | CH | CH | CH | CH | | | | | | |
| 1800 pF | 182 | J | K | M | BB | BB | BB | BB | BB | BB | CH | CH | CH | CH | CH | CH | | | | | | |
| 2200 pF | 222 | J | K | M | BB | BB | BB | BB | BB | BB | CH | CH | CH | CH | CH | CH | | | | | | |
| 2700 pF | 272 | J | K | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | | | | | | |
| 3300 pF | 332 | J | K | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | | | | | | |
| 3900 pF | 392 | J | K | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | | | | | | |
| 4700 pF | 472 | J | K | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | | | | | | |
| 5600 pF | 562 | J | K | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | | | | | | |
| 6800 pF | 682 | J | K | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | | | | | | |
| 8200 pF | 822 | J | K | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | | | | | | |
| 10000 pF | 103 | J | K | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN |
| 12000 pF | 123 | J | K | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN |
| 15000 pF | 153 | J | K | M | BB | BB | BB | BB | BB | BB | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN |
| 18000 pF | 183 | J | K | M | BB | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN |
| 22000 pF | 223 | J | K | M | BB | BB | BB | BB | BB | | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN |
| 27000 pF | 273 | J | K | M | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | DN | DN | DN | DN | DN | DN |
| 33000 pF | 333 | J | K | M | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | DP | DP | DP | DP | DP | DP |
| 39000 pF | 393 | J | K | M | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | DP | DP | DP | DP | DP | DP |
| 47000 pF | 473 | J | K | M | BB | BB | BB | BB | | | CF | CF | CF | CF | CF | CF | DP | DP | DP | DP | DP | DP |
| 56000 pF | 563 | J | K | M | | | | | | | CF | CF | CF | CF | CF | CF | DP | DP | DP | DP | DP | DP |
| 68000 pF | 683 | J | K | M | | | | | | | CF | CF | CF | CF | CF | CF | DP | DP | DP | DP | DP | DP |
| 82000 pF | 823 | J | K | M | | | | | | | CF | CF | CF | CF | CF | CF | DP | DP | DP | DP | DP | DP |
| 0.1 µF | 104 | J | K | M | | | | | | | CF | CF | CF | CF | CF | CF | DG | DG | DG | DG | DG | DG |
| 0.12 µF | 124 | J | K | M | | | | | | | CF | CF | CF | CF | CF | | DG | DG | DG | DG | DG | DG |
| 0.15 µF | 154 | J | K | M | | | | | | | CF | CF | CF | CF | CF | | DG | DG | DG | DG | DG | DG |
| 0.18 µF | 184 | J | K | M | | | | | | | CF | CF | CF | CF | | | DP | DP | DP | DP | DP | DP |
| Capacitance | Cap Code | Rated Voltage | | | 4 | 6.3 | 10 | 16 | 25 | 50 | 4 | 6.3 | 10 | 16 | 25 | 50 | 4 | 6.3 | 10 | 16 | 25 | 50 |
| | | Voltage Code | | | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 |
| | | Case Size | | | 0402 | | | | | | 0603 | | | | | | 0805 | | | | | |

## Table 1E – Capacitance Range/Selection Waterfall (0402 – 0805 Case Sizes, Z-Level Standard Termination) cont.

| Capacitance | Cap Code | Case Size | | | 0402 | | | | | | 0603 | | | | | | 0805 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Voltage Code (KEMET) | | | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 |
| | | Rated Voltage (VDC) | | | 4 | 6.3 | 10 | 16 | 25 | 50 | 4 | 6.3 | 10 | 16 | 25 | 50 | 4 | 6.3 | 10 | 16 | 25 | 50 |
| | | Capacitance Tolerance | | | Product Availability | | | | | | | | | | | | | | | | | |
| 0.22 µF | 224 | J | K | M | | | | | | | CF | CF | CF | CF | | | DP | DP | DP | DP | DP | DP |
| 0.27 µF | 274 | J | K | M | | | | | | | CF | CF | CF | | | | DP | DP | DP | DP | DP | DP |
| 0.33 µF | 334 | J | K | M | | | | | | | CF | CF | CF | | | | DP | DP | DP | DP | DP | DP |
| 0.39 µF | 394 | J | K | M | | | | | | | CF | CF | | | | | DP | DP | DP | DP | DP | DP |
| 0.47 µF | 474 | J | K | M | | | | | | | CF | CF | | | | | DG | DG | DG | DG | DG | DG |
| 0.56 µF | 564 | J | K | M | | | | | | | | | | | | | DG | DG | DG | DG | DG | |
| 0.68 µF | 684 | J | K | M | | | | | | | | | | | | | DG | DG | DG | DG | DG | |
| 0.82 µF | 824 | J | K | M | | | | | | | | | | | | | DG | DG | DG | DG | | |
| 1 µF | 105 | J | K | M | | | | | | | | | | | | | DG | DG | DG | DG | | |
| 1.2 µF | 125 | J | K | M | | | | | | | | | | | | | DE | DE | DE | | | |
| 1.5 µF | 155 | J | K | M | | | | | | | | | | | | | DG | DG | DG | | | |
| 1.8 µF | 185 | J | K | M | | | | | | | | | | | | | DG | DG | | | | |
| 2.2 µF | 225 | J | K | M | | | | | | | | | | | | | DG | DG | | | | |
| Capacitance | Cap Code | Rated Voltage | | | 4 | 6.3 | 10 | 16 | 25 | 50 | 4 | 6.3 | 10 | 16 | 25 | 50 | 4 | 6.3 | 10 | 16 | 25 | 50 |
| | | Voltage Code | | | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 |
| | | Case Size | | | 0402 | | | | | | 0603 | | | | | | 0805 | | | | | |

## Table 1F –
## Capacitance Range/Selection Waterfall (1206 – 1210 Case Sizes, Z-Level Standard Termination)

| Capacitance | Cap Code | Case Size | | | 1206 | | | | | | 1210 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Voltage Code (KEMET) | | | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 |
| | | Rated Voltage (VDC) | | | 4 | 6.3 | 10 | 16 | 25 | 50 | 4 | 6.3 | 10 | 16 | 25 | 50 |
| | | Capacitance Tolerance | | | Product Availability | | | | | | | | | | | |
| 82000 pF | 823 | J | K | M | | | | | | | FC | FC | FC | FC | FC | FC |
| 0.1 µF | 104 | J | K | M | EB | EB | EB | EB | EB | EB | FC | FC | FC | FC | FC | FC |
| 0.12 µF | 124 | J | K | M | EB | EB | EB | EB | EB | EB | FC | FC | FC | FC | FC | FC |
| 0.15 µF | 154 | J | K | M | EC | EC | EC | EC | EC | EC | FC | FC | FC | FC | FC | FC |
| 0.18 µF | 184 | J | K | M | EC | EC | EC | EC | EC | EC | FC | FC | FC | FC | FC | FC |
| 0.22 µF | 224 | J | K | M | ED | ED | ED | ED | ED | ED | FC | FC | FC | FC | FC | FC |
| 0.27 µF | 274 | J | K | M | EM | EM | EM | EM | EM | EM | FC | FC | FC | FC | FC | FC |
| 0.33 µF | 334 | J | K | M | EM | EM | EM | EM | EM | EM | FE | FE | FE | FE | FE | FE |
| 0.39 µF | 394 | J | K | M | EB | EB | EB | EB | EB | EB | FG | FG | FG | FG | FG | FG |
| 0.47 µF | 474 | J | K | M | EB | EB | EB | EB | EB | EB | FG | FG | FG | FG | FG | FG |
| 0.56 µF | 564 | J | K | M | EB | EB | EB | EB | EB | EB | FH | FH | FH | FH | FH | FH |
| 0.68 µF | 684 | J | K | M | EC | EC | EC | EC | EC | EC | FH | FH | FH | FH | FH | FH |
| 0.82 µF | 824 | J | K | M | ED | ED | ED | ED | ED | ED | FF | FF | FF | FF | FF | FF |
| 1 µF | 105 | J | K | M | ED | ED | ED | ED | ED | ED | FC | FC | FC | FC | FC | FC |
| 1.2 µF | 125 | J | K | M | EM | EM | EM | EM | EM | | FC | FC | FC | FC | FC | FC |
| 1.5 µF | 155 | J | K | M | EM | EM | EM | EM | EM | | FE | FE | FE | FE | FE | FE |
| 1.8 µF | 185 | J | K | M | EM | EM | EM | EH | EH | | FG | FG | FG | FG | FG | FG |
| 2.2 µF | 225 | J | K | M | EM | EM | EM | EH | EH | | FG | FG | FG | FG | FG | FG |
| 2.7 µF | 275 | J | K | M | EH | EH | EH | EH | | | FG | FG | FG | FH | FH | FH |
| 3.3 µF | 335 | J | K | M | EH | EH | EH | EH | | | FG | FG | FG | FM | FM | FM |
| 3.9 µF | 395 | J | K | M | EF | EF | EF | | | | FK | FK | FK | FK | FK | |
| 4.7 µF | 475 | J | K | M | EF | EF | EF | | | | FS | FS | FS | FS | FS | |
| 5.6 µF | 565 | J | K | M | EH | EH | | | | | FH | FH | FH | FH | | |
| 6.8 µF | 685 | J | K | M | EH | EH | | | | | FM | FM | FM | FM | | |
| 8.2 µF | 825 | J | K | M | EH | EH | | | | | FK | FK | FK | | | |
| 10 µF | 106 | J | K | M | EH | EH | | | | | FS | FS | FS | | | |
| 12 µF | 126 | J | K | M | | | | | | | | | | | | |
| 15 µF | 156 | J | K | M | | | | | | | | | | | | |
| 18 µF | 186 | J | K | M | | | | | | | | | | | | |
| 22 µF | 226 | J | K | M | | | | | | | | | | | | |
| Capacitance | Cap Code | Rated Voltage | | | 4 | 6.3 | 10 | 16 | 25 | 50 | 4 | 6.3 | 10 | 16 | 25 | 50 |
| | | Voltage Code | | | 7 | 9 | 8 | 4 | 3 | 5 | 7 | 9 | 8 | 4 | 3 | 5 |
| | | Case Size | | | 1206 | | | | | | 1210 | | | | | |

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

| Thickness Code | Case Size[1] | Thickness ± Range (mm) | Paper Quantity[1] | | Plastic Quantity | |
|---|---|---|---|---|---|---|
| | | | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| BB | 0402 | 0.50 ±0.05 | 10,000 | 50,000 | 0 | 0 |
| CF | 0603 | 0.80 ±0.07 | 4,000 | 15,000 | 0 | 0 |
| CH | 0603 | 0.85 ±0.07 | 4,000 | 10,000 | 0 | 0 |
| DN | 0805 | 0.78 ±0.10 | 0 | 0 | 4,000 | 15,000 |
| DP | 0805 | 0.90 ±0.10 | 0 | 0 | 4,000 | 15,000 |
| DE | 0805 | 1.00 ±0.10 | 0 | 0 | 2,500 | 10,000 |
| DG | 0805 | 1.25 ±0.15 | 0 | 0 | 2,500 | 10,000 |
| EB | 1206 | 0.78 ±0.10 | 0 | 0 | 4,000 | 10,000 |
| EC | 1206 | 0.90 ±0.10 | 0 | 0 | 4,000 | 10,000 |
| ED | 1206 | 1.00 ±0.10 | 0 | 0 | 2,500 | 10,000 |
| EF | 1206 | 1.20 ±0.15 | 0 | 0 | 2,500 | 10,000 |
| EM | 1206 | 1.25 ±0.15 | 0 | 0 | 2,500 | 8,000 |
| EH | 1206 | 1.60 ±0.20 | 0 | 0 | 2,000 | 8,000 |
| FC | 1210 | 0.90 ±0.10 | 0 | 0 | 4,000 | 10,000 |
| FE | 1210 | 1.00 ±0.10 | 0 | 0 | 2,500 | 10,000 |
| FF | 1210 | 1.10 ±0.10 | 0 | 0 | 2,500 | 10,000 |
| FG | 1210 | 1.25 ±0.15 | 0 | 0 | 2,500 | 10,000 |
| FH | 1210 | 1.55 ±0.15 | 0 | 0 | 2,000 | 8,000 |
| FM | 1210 | 1.70 ±0.20 | 0 | 0 | 2,000 | 8,000 |
| FK | 1210 | 2.10 ±0.20 | 0 | 0 | 2,000 | 8,000 |
| FS | 1210 | 2.50 ±0.30 | 0 | 0 | 1,000 | 4,000 |
| JC | 2220 | 1.10 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| JD | 2220 | 1.30 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| JF | 2220 | 1.50 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| JO | 2220 | 2.40 ±0.15 | 0 | 0 | 500 | 2,000 |
| **Thickness Code** | **Case Size[1]** | **Thickness ± Range (mm)** | **7" Reel** | **13" Reel** | **7" Reel** | **13" Reel** |
| | | | **Paper Quantity[1]** | | **Plastic Quantity** | |

*Package quantity based on finished chip thickness specifications.*

*[1] If ordering using the 2mm Tape and Reel pitch option, the packaging quantity outlined in the table above will be doubled. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2mm pitch option see "Tape & Reel Packaging Information".*

## Table 2B – Chip Thickness/Tape & Reel Packaging Quantities - Flexible Termination

| Thickness Code | Case Size[1] | Thickness ±Range (mm) | Paper Quantity | | Plastic Quantity | |
|---|---|---|---|---|---|---|
| | | | 7" Reel | 13" Reel | 7" Reel | 13" Reel |
| CJ | 0603 | 0.80 ±0.15 | 4,000 | 15,000 | 0 | 0 |
| CH | 0603 | 0.85 ±0.07 | 4,000 | 10,000 | 0 | 0 |
| DR | 0805 | 0.78 ±0.20 | 0 | 0 | 4,000 | 10,000 |
| DD | 0805 | 0.90 ±0.10 | 0 | 0 | 4,000 | 10,000 |
| DS | 0805 | 1.00 ±0.20 | 0 | 0 | 2,500 | 10,000 |
| DG | 0805 | 1.25 ±0.15 | 0 | 0 | 2,500 | 10,000 |
| EQ | 1206 | 0.78 ±0.20 | 0 | 0 | 4,000 | 10,000 |
| ER | 1206 | 0.90 ±0.20 | 0 | 0 | 4,000 | 10,000 |
| ES | 1206 | 1.00 ±0.20 | 0 | 0 | 2,500 | 10,000 |
| EP | 1206 | 1.20 ±0.20 | 0 | 0 | 2,500 | 10,000 |
| EL | 1206 | 1.25 ±0.20 | 0 | 0 | 2,500 | 10,000 |
| EH | 1206 | 1.60 ±0.20 | 0 | 0 | 2,000 | 8,000 |
| FN | 1210 | 0.78 ±0.20 | 0 | 0 | 4,000 | 10,000 |
| FQ | 1210 | 0.90 ±0.20 | 0 | 0 | 4,000 | 10,000 |
| FE | 1210 | 1.00 ±0.10 | 0 | 0 | 2,500 | 10,000 |
| FF | 1210 | 1.10 ±0.10 | 0 | 0 | 2,500 | 10,000 |
| FZ | 1210 | 1.25 ±0.20 | 0 | 0 | 2,500 | 10,000 |
| FU | 1210 | 1.55 ±0.20 | 0 | 0 | 2,000 | 8,000 |
| FM | 1210 | 1.70 ±0.20 | 0 | 0 | 2,000 | 8,000 |
| FK | 1210 | 2.10 ±0.20 | 0 | 0 | 2,000 | 8,000 |
| FS | 1210 | 2.50 ±0.30 | 0 | 0 | 1,000 | 4,000 |
| GB | 1812 | 1.00 ±0.10 | 0 | 0 | 1,000 | 4,000 |
| GC | 1812 | 1.10 ±0.10 | 0 | 0 | 1,000 | 4,000 |
| GE | 1812 | 1.30 ±0.10 | 0 | 0 | 1,000 | 4,000 |
| GG | 1812 | 1.55 ±0.10 | 0 | 0 | 1,000 | 4,000 |
| GK | 1812 | 1.60 ±0.20 | 0 | 0 | 1,000 | 4,000 |
| GN | 1812 | 1.70 ±0.20 | 0 | 0 | 1,000 | 4,000 |
| GS | 1812 | 2.10 ±0.20 | 0 | 0 | 500 | 2,000 |
| GO | 1812 | 2.50 ±0.20 | 0 | 0 | 500 | 2,000 |
| JC | 2220 | 1.10 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| JD | 2220 | 1.30 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| JF | 2220 | 1.50 ±0.15 | 0 | 0 | 1,000 | 4,000 |
| JL | 2220 | 2.00 ±0.20 | 0 | 0 | 500 | 2,000 |
| JO | 2220 | 2.40 ±0.15 | 0 | 0 | 500 | 2,000 |
| **Thickness Code** | **Case Size[1]** | **Thickness ± Range (mm)** | **7" Reel** | **13" Reel** | **7" Reel** | **13" Reel** |
| | | | **Paper Quantity[1]** | | **Plastic Quantity** | |

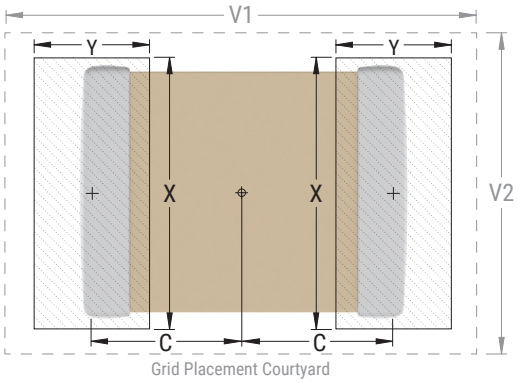
*Package quantity based on finished chip thickness specifications.*

## Table 3– Chip Capacitor Land Pattern Design Recommendations per IPC–7351 (mm)

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

***Density Level A:*** *For low-density Product applications. Recommended for wave solder applications and provides a wider process window for reflow solder processes. KEMET only recommends wave soldering of EIA 0603, 0805 and 1206 case sizes.*
***Density Level B:*** *For products with a moderate level of component density. Provides a robust solder attachment condition for reflow solder processes.*
***Density Level C:*** *For high component density product applications. Before adapting the minimum land pattern variations the user should perform qualification testing based on the conditions outlined in IPC Standard 7351 (IPC-7351).*

*Image below based on Density Level B for an EIA 1210 case size.*



## Soldering Process

**Recommended Soldering Technique:**

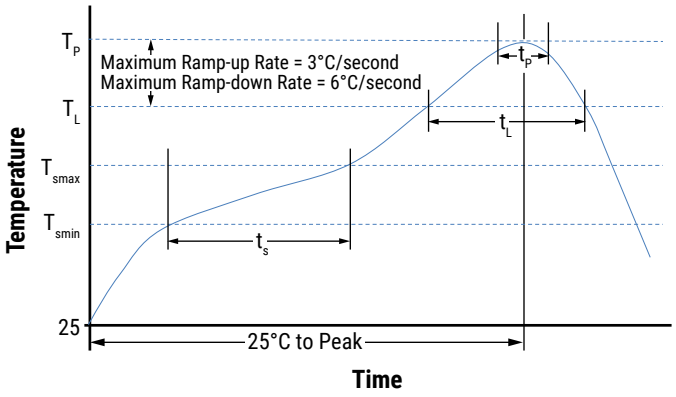
- Solder wave or solder reflow for EIA case sizes 0603, 0805 and 1206
- All other EIA case sizes are limited to solder reflow only

**Recommended Reflow Soldering Profile:**

KEMET's families of surface mount multilayer ceramic capacitors (SMD MLCCs) are compatible with wave (single or dual), convection, IR or vapor phase reflow techniques. Preheating of these components is recommended to avoid extreme thermal stress. KEMET's recommended profile conditions for convection and IR reflow reflect the profile conditions of the IPC/JSTD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature | Termination Finish | |
|---|---|---|
| | SnPb | 100% Matte Sn |
| **Preheat/Soak** | | |
| Temperature minimum ($T_{Smin}$) | 100°C | 150°C |
| Temperature maximum ($T_{Smax}$) | 150°C | 200°C |
| Time ($t_s$) from $T_{Smin}$ to $T_{Smax}$ | 60 – 120 seconds | 60 – 120 seconds |
| Ramp-up rate ($T_L$ to $T_P$) | 3°C/second maximum | 3°C/second maximum |
| Liquidous temperature ($T_L$) | 183°C | 217°C |
| Time above liquidous ($t_L$) | 60 – 150 seconds | 60 – 150 seconds |
| Peak temperature ($T_P$) | 235°C | 260°C |
| Time within 5°C of maximum peak temperature ($t_P$) | 20 seconds maximum | 30 seconds maximum |
| Ramp-down rate ($T_P$ to $T_L$) | 6°C/second maximum | 6°C/second maximum |
| Time 25°C to peak temperature | 6 minutes maximum | 8 minutes maximum |

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



## In-Process Inspection and Testing

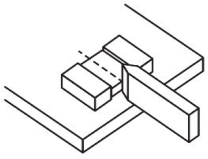
| Inspection | Test Method | HRA X-Level | HRA Z-Level |
|---|---|---|---|
| In-Process Inspection | | | |
| Production Electrical Testing | Internal | 100 % Cap / DF / IR / DWV | 100 % Cap / DF / IR / DWV |
| In-Process Visual Inspection | Internal | AOI 100% (≥ 1812 Manual 100%) | AOI 100% (≥ 1812 Manual 100%) |
| Group A Inspection | | | |
| Thermal shock | MIL-PRF-32535 Method 4.6.3 | No | Yes (100%) |
| Ultrasonic inspection[1] | MIL-PRF-32535 Method 4.6.1 | No | Yes (100%) |
| Voltage conditioning with 5% PDA[2] 96 Hours | MIL-PRF-32535 Method 4.6.3 | Yes (100%) | Yes (100%) |
| Visual and mechanical inspection | MIL-PRF-32535 Method 4.6.2 | No | Yes (production lot sample) |
| DPA analysis | MIL-PRF-32535 Method 4.6.8 | Yes (production lot sample) | Yes (production lot sample) |
| Solderability (solder dipped and solder plated terminations only) | MIL-PRF-32535 Method 4.6.11 | No | Yes (production lot sample) |
| Group A Data | | Yes (Summary) | Yes |
| Group B Inspection | | | |
| Thermal shock[3] | MIL-PRF-32535 Method 4.6.3 | No | Yes (production lot sample) |
| Life[3] | MIL-PRF-32535 Method 4.6.16 | No | Yes (production lot sample) |
| Temperature humidity bias (load humidity) | MIL-PRF-32535 Method 4.6.15 | Yes (production lot sample) | Yes (production lot sample) |
| Temperature limits/temperature characteristic | MIL-PRF-32535 Method 4.6.14 | No | Yes (production lot sample) |
| Dielectric voltage breakdown (UVBD) | MIL-PRF-32535 Method 4.6.17 | No | Yes (production lot sample) |
| Group B Data | | Yes (Summary) | Yes |

*[1] Required for ≥ 0805*
*[2] HOT IR on production lot sample only. HOT IR limit: 25 Mohm-uF for all part numbers*
*[3] Thermal Shock and Life testing are sequential tests.*

## Table 4 – HRA Performance and Reliability: SMD Test Methods and Conditions

<table>
<tr><th>Test</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Visual and Mechanical</td><td>KEMET Internal</td><td>No defects that may affect performance (10X)</td><td>Dimensions according KEMET Spec Sheet</td></tr>
<tr><td>Capacitance (Cap)</td><td>KEMET Internal</td><td>C ≤ 10µF 1 kHz ±50 Hz and 1.0 ±0.2 Vrms or 0.5 ±0.2 Vrms*<br>C > 10µF120 Hz ±10 Hz and 0.5 ±0.1 Vrms<br>* See part number specification sheet for voltage<br><br>Capacitance measurements (including tolerance) are indexed to a referee time of 48 or 1,000 hours<br>Please refer to a part number specification sheet for referee time details</td><td>Within Tolerance</td></tr>
<tr><td>Dissipation Factor (DF)</td><td>KEMET Internal</td><td>C ≤ 10µF<br>Frequency: 1 kHz ±50 Hz<br>Voltage*:1.0 ±0.2 Vrms, 0.5 ±0.2 Vrms,<br>C > 10µF<br>Frequency: 120 Hz ±10 Hz<br>Voltage: 0.5 ±0.1 Vrms<br>* See part number specification sheet for voltage</td><td>Within Specification<br><table><tr><th>Voltage</th><th>Limit</th></tr><tr><td>4 V</td><td>5.0%</td></tr><tr><td>6.3 V</td><td>5.0%</td></tr><tr><td>10 V</td><td>5.0%</td></tr><tr><td>16 V</td><td>3.5%</td></tr><tr><td>25 V</td><td>3.5%</td></tr><tr><td>50 V</td><td>2.5%</td></tr><tr><td>100 V</td><td>2.5%</td></tr></table></td></tr>
<tr><td>Insulation Resistance (IR)</td><td>KEMET Internal</td><td>Apply rated voltage for 120 seconds at 25°C</td><td>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><table><tr><th>Chip</th><th>1,000 megohm microfarads or 100 GΩ</th><th>500 megohm microfarads or 100 GΩ</th></tr><tr><td>0402</td><td>< 0.012 µF</td><td>≥ 0.012 µF</td></tr><tr><td>0603</td><td>< 0.047 µF</td><td>≥ 0.047 µF</td></tr><tr><td>0805</td><td>< 0.15 µF</td><td>≥ 0.15 µF</td></tr><tr><td>1206</td><td>< 0.39 µF</td><td>≥ 0.39 µF</td></tr><tr><td>1210</td><td>< 0.82 µF</td><td>≥ 0.82 µF</td></tr><tr><td>1812</td><td>< 1.8 µF</td><td>≥ 1.8 µF</td></tr><tr><td>2220</td><td>< 1.8 µF</td><td>≥ 1.8 µF</td></tr></table></td></tr>
<tr><td>Temperature Coefficient of Capacitance (TCC)</td><td>KEMET Internal</td><td>C ≤ 10µF<br>Frequency: 1 kHz ±50 Hz<br>Voltage*:1.0 ±0.2 Vrms, 0.5 ±0.2 Vrms, 0.2 ±0.1 Vrms<br>C > 10µF<br>Frequency: 120 Hz ±10 Hz<br>Voltage: 0.5 ±0.1 Vrms<br><br>* See part number specification sheet for voltage<br><table><tr><th>Step</th><th>Temperature (°C)</th></tr><tr><td>1</td><td>+25°C</td></tr><tr><td>2</td><td>−55°C</td></tr><tr><td>3</td><td>+25°C (Reference Temperature)</td></tr><tr><td>4</td><td>+125°C</td></tr></table></td><td>Capacitance ±15% over −55°C to +125°C</td></tr>
<tr><td>Dielectric Withstanding Voltage (DWV)</td><td>KEMET Internal</td><td>250% of rated voltage<br>(5 ±1 seconds and charge/discharge not exceeding 50 mA)</td><td>Cap: Initial Limit<br>DF: Initial Limit<br>IR: Initial Limit<br><br>Withstand test voltage without insulation breakdown or damage.</td></tr>
</table>

## Table 4 – HRA Performance and Reliability: SMD Test Methods and Conditions cont.

<table>
<tr><th>Test</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>Aging Rate (Maximum % Capacitance Loss/ Decade Hour)</td><td>KEMET Internal</td><td>Capacitance measurements (including tolerance) are indexed to a referee time of 1,000 hours.</td><td>3%</td></tr>
<tr><td>Terminal Strength</td><td>AEC-Q200</td><td>Shear stress test per specific case size, Time: 10±1 second.
<table>
<tr><th>Case Size</th><th>Force</th></tr>
<tr><td>0402</td><td>3N</td></tr>
<tr><td>0603</td><td>5N</td></tr>
<tr><td>0805</td><td>9N</td></tr>
<tr><td>1206</td><td>10N</td></tr>
<tr><td>1210</td><td>10N</td></tr>
<tr><td>>1210</td><td>18N</td></tr>
</table>
</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Board Flex</td><td>MIL-PRF-32535</td><td>Standard Termination system 2.0 mm<br>Flexible Termination System 3.0 mm<br>Test time: 60 ±5 seconds Ramp time: 1 mm/second</td><td>No evidence of mechanical damage</td></tr>
<tr><td>Solderability</td><td>J-STD-002</td><td>Method B,B1: 4 hours ±15 minutes at 155°C dry bake<br>Test 245 ±5°C (SnPb & Pb-Free)<br>Method D</td><td>Visual Inspection. 95% coverage on termination. No leaching</td></tr>
<tr><td>Temperature Cycling</td><td>AEC-Q200</td><td>1,000 cycles (–55°C to +125°C)<br>Measurement at 24 ±4 hours after test conclusion.<br>15 minutes minimum.<br>1 min. maximum transition time.</td><td>Measurement at 24 hours ±4 hours after test conclusion.<br>Cap: ±20% shift<br>DF: Initial Limit<br>IR: Initial Limit</td></tr>
<tr><td>Biased Humidity</td><td>MIL-STD-202 Method 103</td><td>Load Humidity: 1,000 hours 85°C/85% RH and rated voltage.</td><td>Measurement at 24 hours ±4 hours after test conclusion.<br>Within Post Environmental Limits<br>Cap: ±20% shift<br>IR: 10% of Initial Limit
<table>
<tr><th colspan="2">DF Limits Maximum (%)</th></tr>
<tr><td>Initial</td><td>Post</td></tr>
<tr><td>2.5%</td><td>3.0%</td></tr>
<tr><td>3.5%</td><td>5.0%</td></tr>
<tr><td>5.0%</td><td>7.5%</td></tr>
</table></td></tr>
</table>

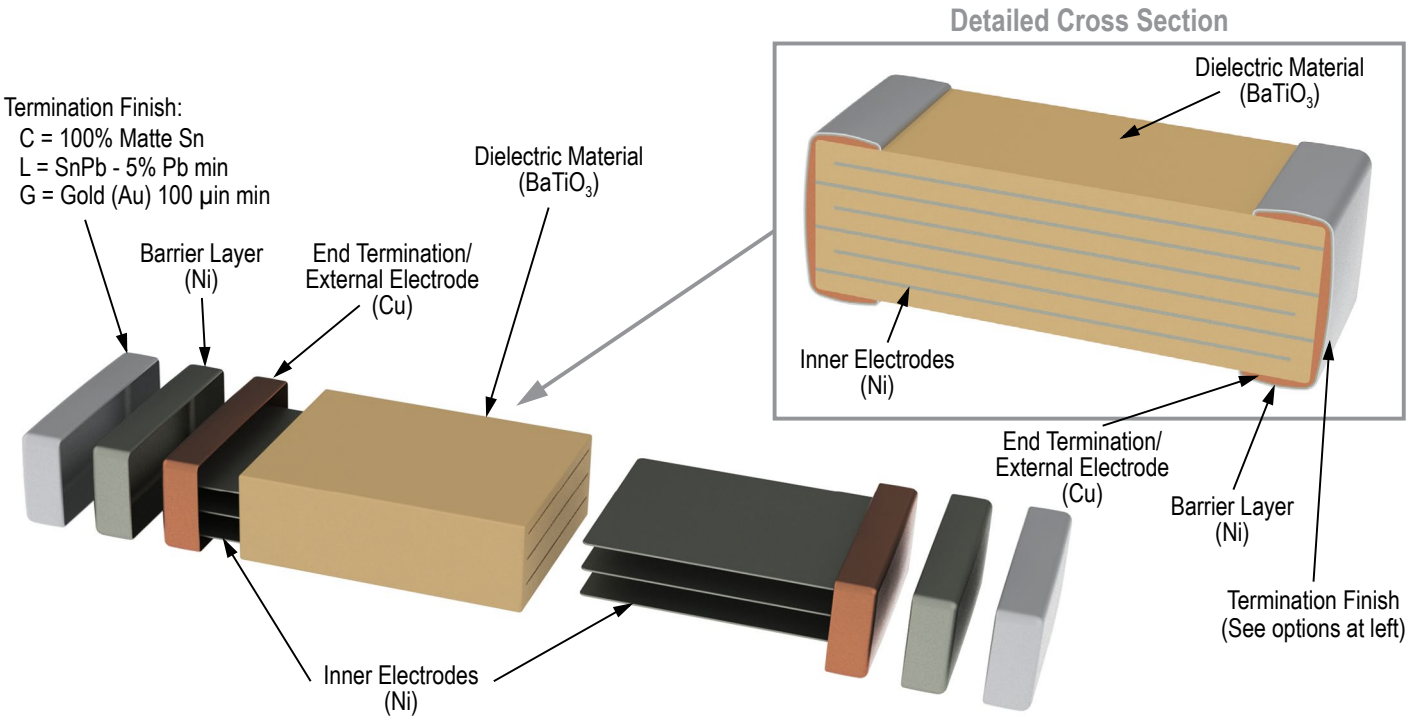
## Table 4 – HRA Performance and Reliability: SMD Test Methods and Conditions cont.

<table>
<tr><th>Test</th><th>Reference</th><th>Test Condition</th><th>Limits</th></tr>
<tr><td>High Temperature Life</td><td>MIL-STD-202 Method 108</td><td>X-Level: 1,000 hours at 125°C with 2 X rated voltage<br>Z-Level: 2,000 hours at 125°C with 2 X rated voltage</td><td>Within Post Environmental Limits<br>Cap: ±20% shift<br>IR: 10% of Initial Limit<br><table><tr><th colspan="2">DF Limits Maximum (%)</th></tr><tr><td>Initial</td><td>Post</td></tr><tr><td>2.5%</td><td>3.0%</td></tr><tr><td>3.5%</td><td>5.0%</td></tr><tr><td>5.0%</td><td>7.5%</td></tr></table></td></tr>
<tr><td>Vibration</td><td>MIL-STD-202 Method 204</td><td>5 g's for 20 minutes, 12 cycles each of 3 orientations.<br>Test from 10 – 2,000 Hz</td><td>Cap: ±20% shift<br>DF: Initial Limit<br>IR: Initial Limit</td></tr>
<tr><td>Mechanical Shock</td><td>AEC-Q200</td><td>100g’s 6 ms Half-sine, Velocity Change 12.3 ft/sec<br>(Condition C)</td><td>Cap: ±20% shift<br>DF: Initial Limit<br>IR: Initial Limit</td></tr>
</table>

## Storage and Handling

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

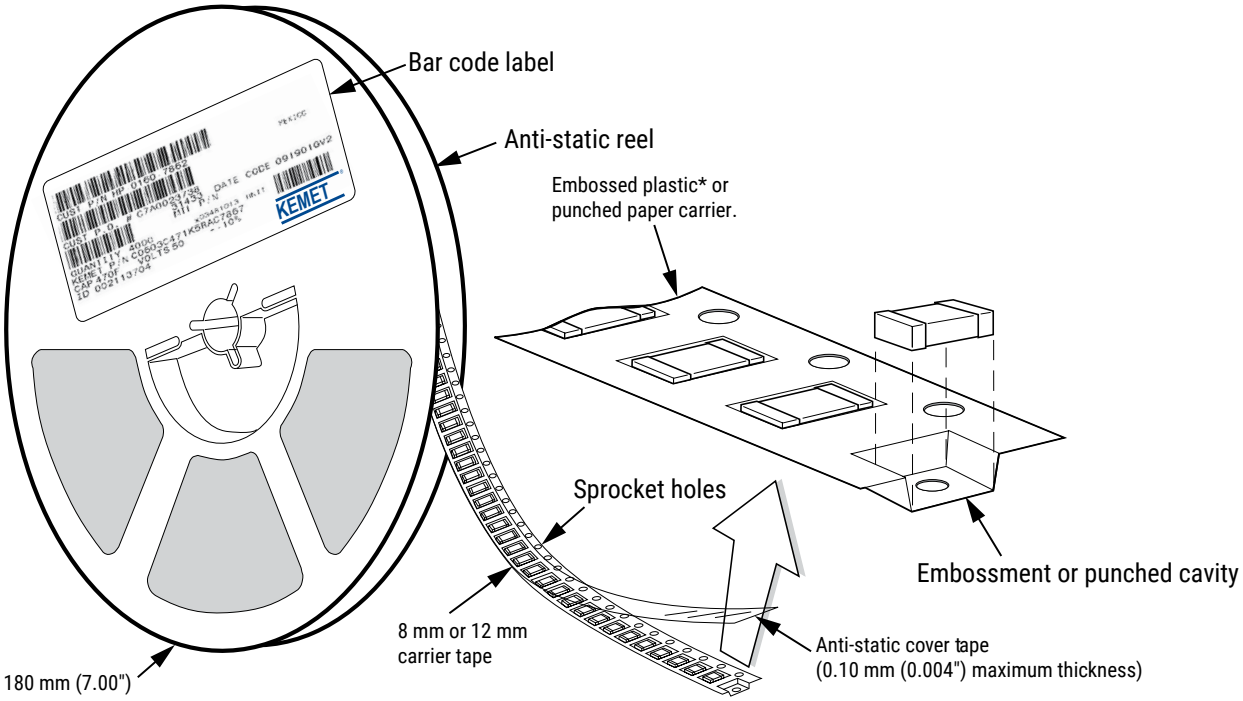
## Construction



## 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.



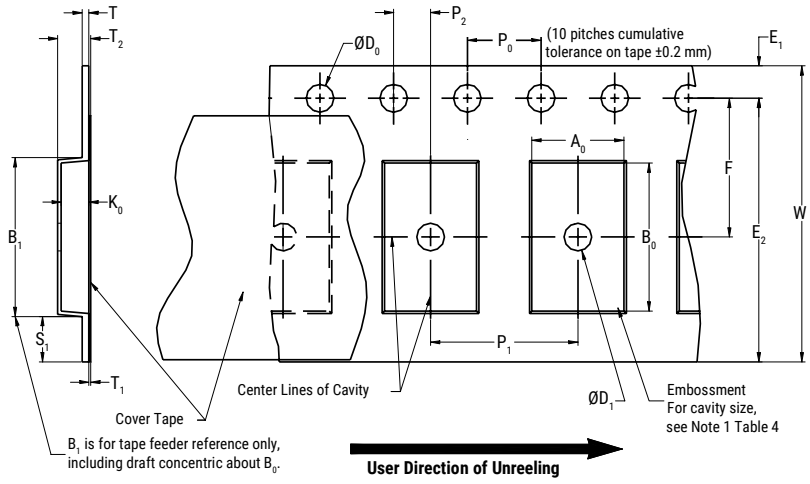

*EIA 0402 and 0603 case sizes available on punched paper carrier only.

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

| EIA Case Size | Tape size (W)* | Embossed Plastic | Punched Paper |
|---|---|---|---|
| | | 7" Reel | |
| | | Pitch (P1)* | |
| 0402 | 8 | | 2 |
| 0603 | 8 | | 4 |
| 0805 | 8 | 4 | 4 |
| 1206 – 1210 | 8 | 4 | 4 |
| ≥ 1812 | 12 | 8 | |

**Refer to Figures 1 and 2 for W and $P_1$ carrier tape reference locations.*
**Refer to Tables 5 & 6 for tolerance specifications.*

## Figure 1 – Embossed (Plastic) Carrier Tape Dimensions




## Table 6 – Embossed (Plastic) Carrier Tape Dimensions

Metric will govern

| Constant Dimensions — Millimeters (Inches) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Tape Size | $D_0$ | $D_1$ Minimum Note 1 | $E_1$ | $P_0$ | $P_2$ | R Reference Note 2 | $S_1$ Minimum Note 3 | T Maximum | $T_1$ Maximum |
| 8 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.0 (0.039) | 1.75 ± 0.10 (0.069 ± 0.004) | 4.0 ± 0.10 (0.157 ± 0.004) | 2.0 ± 0.05 (0.079 ± 0.002) | 25.0 (0.984) | 0.600 (0.024) | 0.600 (0.024) | 0.100 (0.004) |
| 12 mm | | 1.5 (0.059) | | | | 30 (1.181) | | | |

| Variable Dimensions — Millimeters (Inches) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Tape Size | Pitch | $B_1$ Maximum Note 4 | $E_2$ Minimum | F | $P_1$ | $T_2$ Maximum | W Maximum | $A_0$,$B_0$ and $K_0$ |
| 8 mm | Single (4 mm) | 4.35 (0.171) | 6.25 (0.246) | 3.5 ± 0.05 (0.138 ± 0.002) | 4.0 ± 0.10 (0.157 ± 0.004) | 2.5 (0.098) | 8.3 (0.327) | Note 5 |
| 12 mm | Single (4 mm) and Double (8 mm) | 8.2 (0.323) | 10.25 (0.404) | 5.5 ± 0.05 (0.217 ± 0.002) | 8.0 ± 0.10 (0.315 ± 0.004) | 4.6 (0.181) | 12.3 (0.484) | |

*Notes*

*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 A0, B0 and K0 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.*

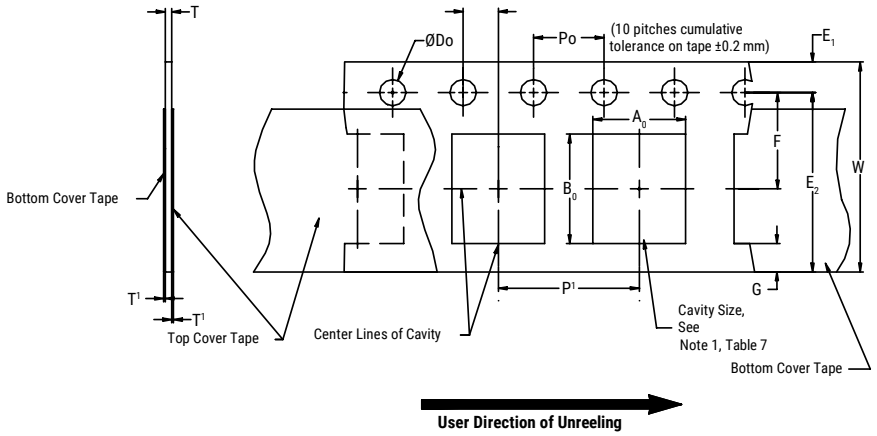
*(c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3).*

*(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.*

## Figure 2 – Punched (Paper) Carrier Tape Dimensions




## Table 7 – Punched (Paper) Carrier Tape Dimensions

(Metric will govern)

| Constant Dimensions — Millimeters (Inches) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Tape Size | $D_0$ | $E_1$ | $P_0$ | $P_2$ | $T_1$ Maximum | G Minimum | R Reference Note 2 |
| 8 mm | 1.5 +0.10/-0.0 (0.059 +0.004/-0.0) | 1.75 ± 0.10 (0.069 ± 0.004) | 4.0 ± 0.10 (0.157 ± 0.004) | 2.0 ± 0.05 (0.079 ± 0.002) | 0.100 (0.004) | 0.75 (0.030) | 25.0 (0.984) |

| Variable Dimensions — Millimeters (Inches) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Tape Size | Pitch | $E_2$ Minimum | F | $P_1$ | T Maximum | W Maximum | $A_0$ and $B_0$ |
| 8 mm | Half (2 mm) | 6.25 (0.246) | 3.5 ± 0.05 (0.138 ± 0.002) | 2.0 ± 0.05 (0.079 ± 0.002) | 1.1 (0.098) | 8.3 (0.327) | Note 1 |
| 8 mm | Single (4 mm) | | | 4.0 ± 0.10 (0.157 ± 0.004) | | 8.3 (0.327) | |

*Notes*

*1 . The cavity defined by A0, B0 and T shall surround the component with sufficient clearance that:*

*a) the component does not protrude beyond either surface of the carrier tape.*

*b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.*

*c) rotation of the component is limited to 20° maximum (see Figure 3).*

*d) lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4).*

*e) see Addendum in EIA Document 481 for standards relating to more precise taping requirements.*

*2. The tape with or without components shall pass around R without damage (see Figure 6).*

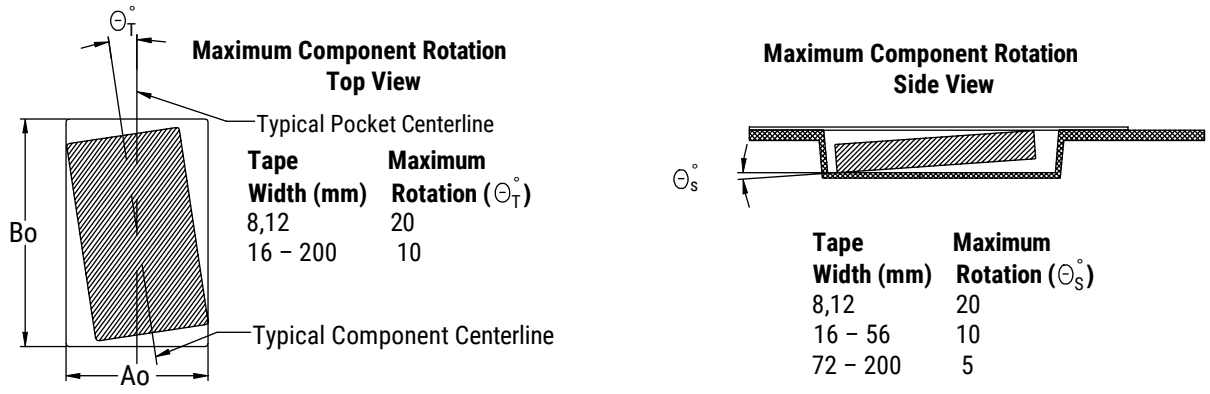
## Packaging Information Performance Notes

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

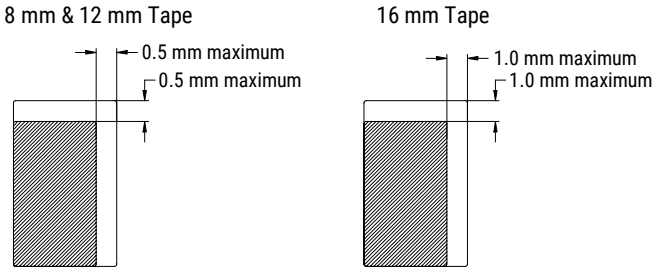
| Tape Width | Peel Strength |
|---|---|
| 8 mm | 0.1 to 1.0 Newton (10 to 100 gf) |
| 12 and 16 mm | 0.1 to 1.3 Newton (10 to 130 gf) |

The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ±10 mm/minute.
**3. Labeling:** Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. Refer to EIA Standards 556 and 624.

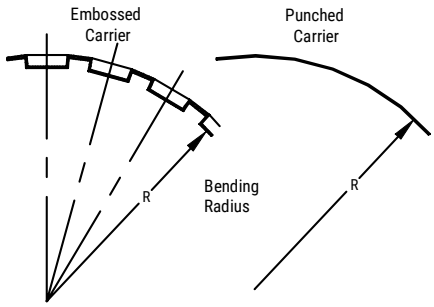
## Figure 3 – Maximum Component Rotation



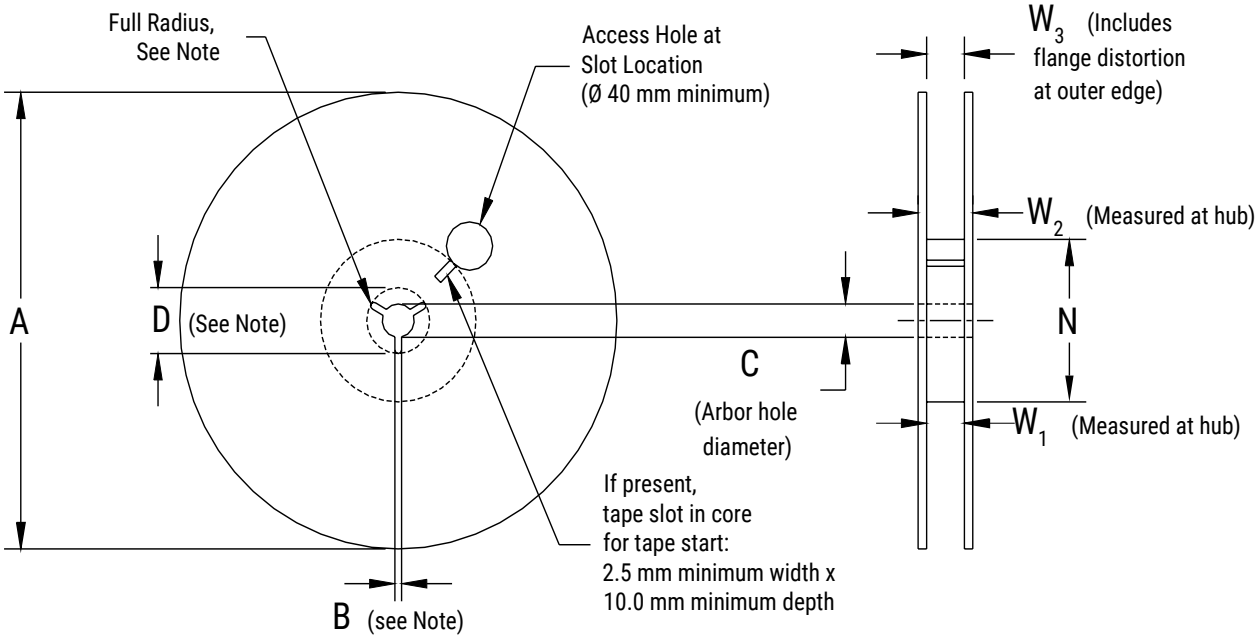

## Figure 4 – Maximum Lateral Movement




## Figure 5 – Bending Radius



## Figure 6 – Reel Dimensions




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

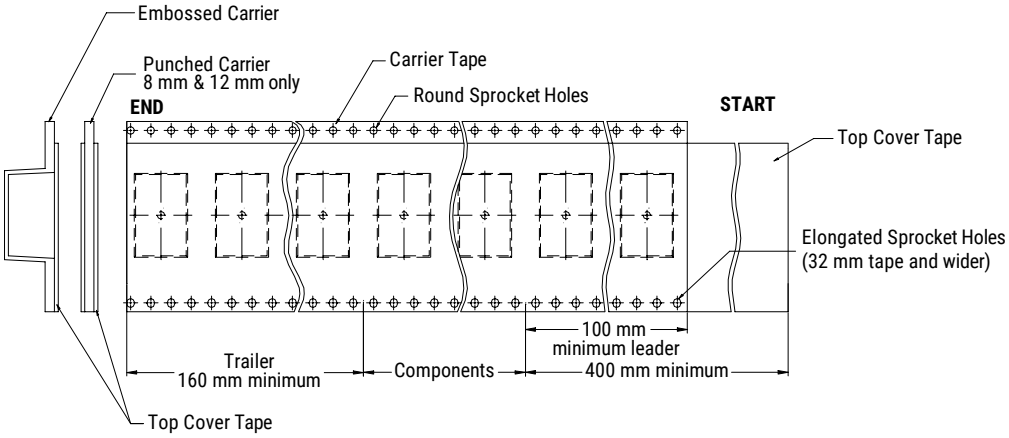
## Table 8 – Reel Dimensions

Metric will govern

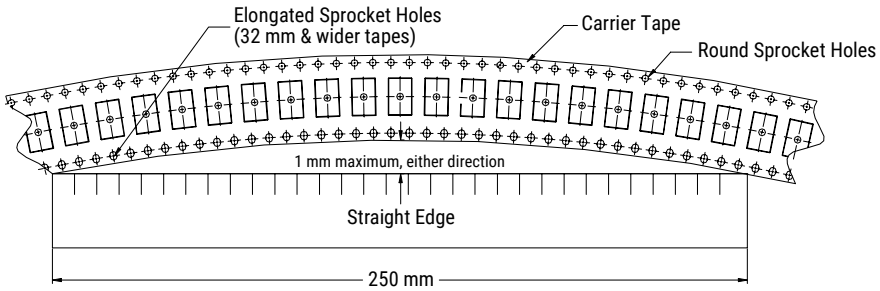
| Constant Dimensions — Millimeters (Inches) | | | | |
|---|---|---|---|---|
| Tape Size | A | B Minimum | C | D Minimum |
| 8 mm | 178 ± 0.20<br>(7.008 ± 0.008)<br>or<br>330 ± 0.20<br>(13.000 ± 0.008) | 1.5<br>(0.059) | 13.0 +0.5/–0.2<br>(0.521 +0.02/–0.008) | 20.2<br>(0.795) |
| 12 mm | | | | |

| Variable Dimensions — Millimeters (Inches) | | | | |
|---|---|---|---|---|
| Tape Size | N Minimum<br>See Note 2, Tables 2–3 | $W_1$ | $W_2$ 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 accomadate tape width without interference |
| 12 mm | | 12.4 +2.0/–0.0<br>(0.488 +0.078/–0.0) | 18.4<br>(0.724) | |

## Figure 7 – Tape Leader & Trailer Dimensions

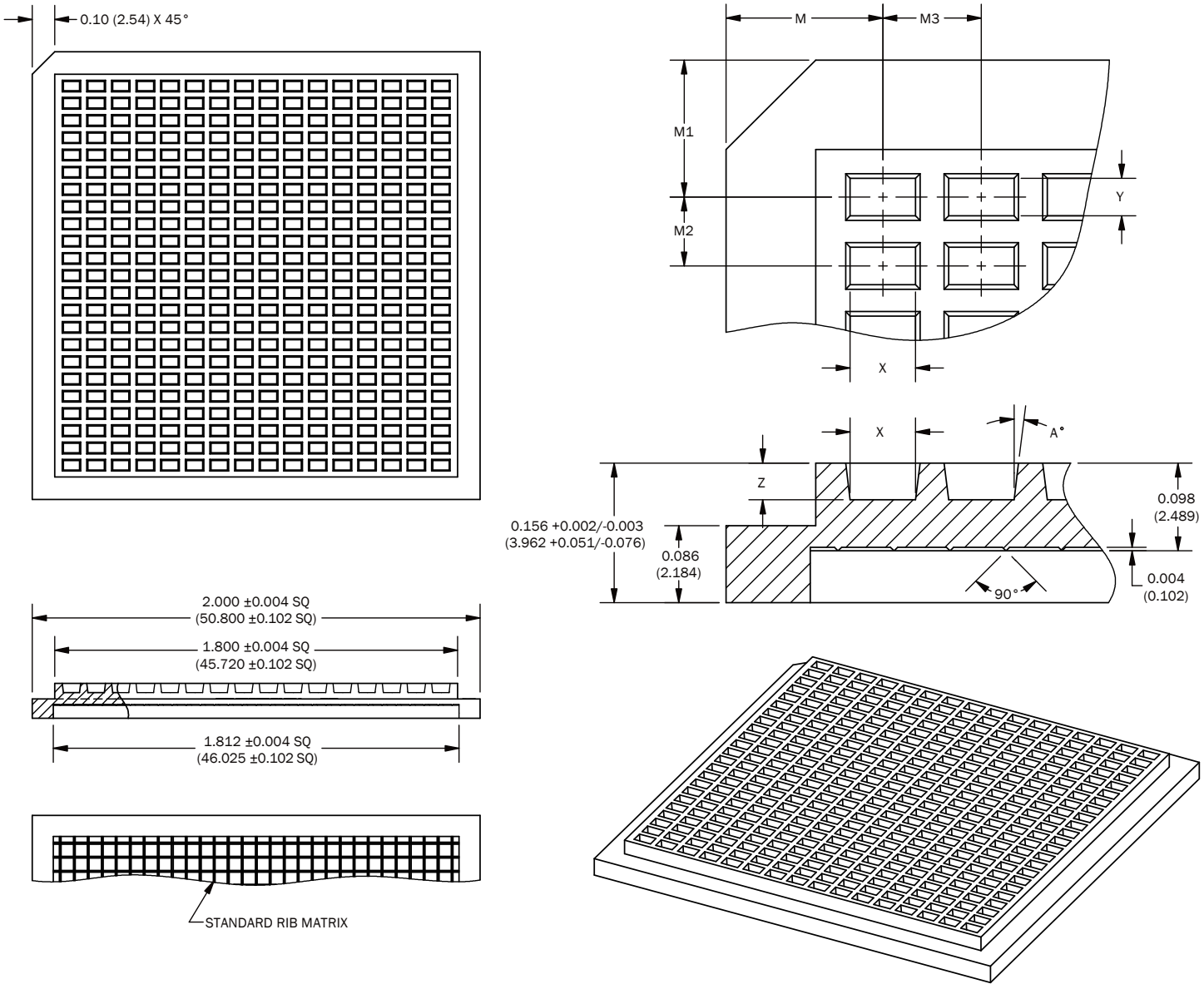



## Figure 8 – Maximum Camber



## Waffle Tray Packaging Information – 2" x 2" w/ Static Protection

### Figure 9 – Waffle Tray Dimensions – Inches (Millimeters)



## Table 9A – Waffle Tray Dimensions – Inches

| Case Size (In) | Case Size (mm) | 2" x 2" Waffle Tray Dimensions – Inches | | | | | | | | | Packaging Quantity (pcs/unit packaging) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | M | M1 | M2 | M3 | X | Y | Z | A° | MATRIX | |
| | | ±0.003 | ±0.003 | ±0.002 | ±0.002 | ±0.002 | ±0.002 | ±0.003 | ±1/2° | (X x Y) | |
| 0402 | 1005 | 0.175 | 0.153 | 0.077 | 0.110 | 0.073 | 0.042 | 0.041 | 7 | 16 X 23 | 368 |
| 0603 | 1608 | 0.175 | 0.153 | 0.077 | 0.110 | 0.073 | 0.042 | 0.041 | 7 | 16 X 23 | 368 |
| 0805 | 2012 | 0.232 | 0.186 | 0.181 | 0.171 | 0.062 | 0.092 | 0.036 | 10 | 10 X 10 | 100 |
| 1206[1,2] | 3216 | 0.194 | 0.228 | 0.193 | 0.124 | 0.067 | 0.130 | 0.065 | 5 | 14 X 9 | 126 |
| 1206[1,3] | 3216 | 0.250 | 0.250 | 0.375 | 0.167 | 0.100 | 0.200 | 0.070 | 5 | 10 X 5 | 50 |
| 1210 | 3225 | 0.217 | 0.244 | 0.215 | 0.174 | 0.110 | 0.145 | 0.080 | 5 | 10 X 8 | 80 |
| 1812 | 4532 | 0.271 | 0.285 | 0.286 | 0.243 | 0.150 | 0.200 | 0.075 | 5 | 7 X 6 | 42 |
| 2220 | 5650 | 0.318 | 0.362 | 0.424 | 0.34 | 0.24 | 0.32 | 0.032 | 5 | 5 X 4 | 20 |

*[1] Packaging of 1206 (3216 metric) case size capacitors is dependent upon the nominal chip thickness of the device. See" Capacitance Range/Selection Waterfall" and Chip Thickness/Tape& Reel Packaging Quantitie" to identify the nominal chip thickness of the capacitor.*
*[2] Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of ≤ 1.25mm (0.049 inches).*
*[3] Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of > 1.25mm (0.049 inches).*

## Table 9B – Waffle Tray Dimensions – Millimeters

| Case Size (In) | Case Size (mm) | 2" x 2" Waffle Tray Dimensions – Millimeters | | | | | | | | | Packaging Quantity (pcs/unit packaging) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | M | M1 | M2 | M3 | X | Y | Z | A° | MATRIX | |
| | | ±0.08 | ±0.08 | ±0.05 | ±0.05 | ±0.05 | ±0.05 | ±0.08 | ±1/2° | (X x Y) | |
| 0402 | 1005 | 4.45 | 3.89 | 1.96 | 2.79 | 1.85 | 1.07 | 1.04 | 7 | 16 X 23 | 368 |
| 0603 | 1608 | 4.45 | 3.89 | 1.96 | 2.79 | 1.85 | 1.07 | 1.04 | 7 | 16 X 23 | 368 |
| 0805 | 2012 | 5.89 | 4.72 | 4.60 | 4.34 | 1.57 | 2.34 | 0.91 | 10 | 10 X 10 | 100 |
| 1206[1,2] | 3216 | 4.93 | 5.79 | 4.90 | 3.15 | 1.70 | 3.30 | 1.65 | 5 | 14 X 9 | 126 |
| 1206[1,3] | 3216 | 6.35 | 6.35 | 9.53 | 4.24 | 2.54 | 5.08 | 1.78 | 5 | 10 X 5 | 50 |
| 1210 | 3225 | 5.51 | 6.20 | 5.46 | 4.42 | 2.79 | 3.68 | 2.03 | 5 | 10 X 8 | 80 |
| 1812 | 4532 | 6.88 | 7.24 | 7.26 | 6.17 | 3.81 | 5.08 | 1.91 | 5 | 7 X 6 | 42 |
| 2220 | 5650 | 8.08 | 9.19 | 10.77 | 8.64 | 6.10 | 8.13 | 0.81 | 5 | 5 X 4 | 20 |

*[1] Packaging of 1206 (3216 metric) case size capacitors is dependent upon the nominal chip thickness of the device. See" Capacitance Range/Selection Waterfall" and Chip Thickness/Tape& Reel Packaging Quantities" to identify the nominal chip thickness of the capacitor.*
*[2] Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of ≤ 1.25mm (0.049 inches).*
*[3] Assigned to 1206 (3216 metric) case size capacitors with nominal thickness of > 1.25mm (0.049 inches).*

## KEMET Electronics Corporation Sales Offices

For a complete list of our global sales offices, please visit https://www.yageogroup.com/SalesResources/SalesOffices

## Disclaimer

YAGEO Corporation and its affiliates do not recommend the use of commercial or automotive grade products for high reliability applications or manned space flight.

All product specifications, statements, information and data (collectively, the "Information") in this datasheet are subject to change. The customer is responsible for checking and verifying the extent to which the Information contained in this publication is applicable to an order at the time the order is placed. All Information given herein is believed to be accurate and reliable, but it is presented without guarantee, warranty, or responsibility of any kind, expressed or implied.

Statements of suitability for certain applications are based on KEMET Electronics Corporation's ("KEMET") knowledge of typical operating conditions for such applications, but are not intended to constitute – and KEMET specifically disclaims – any warranty concerning suitability for a specific customer application or use. The Information is intended for use only by customers who have the requisite experience and capability to determine the correct products for their application. Any technical advice inferred from this Information or otherwise provided by KEMET with reference to the use of KEMET's products is given gratis, and KEMET assumes no obligation or liability for the advice given or results obtained.

Although KEMET designs and manufactures its products to the most stringent quality and safety standards, given the current state of the art, isolated component failures may still occur. Accordingly, customer applications which require a high degree of reliability or safety should employ suitable designs or other safeguards (such as installation of protective circuitry or redundancies) in order to ensure that the failure of an electrical component does not result in a risk of personal injury or property damage.

Although all product–related warnings, cautions and notes must be observed, the customer should not assume that all safety measures are indicated or that other measures may not be required.

*KEMET is a registered trademark of KEMET Electronics Corporation.*