

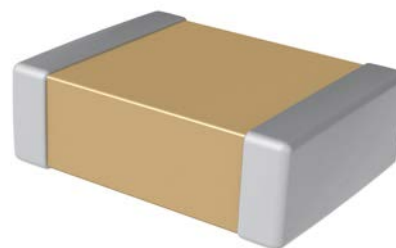
### Overview

KEMET's X7R dielectric features a 125°C maximum operating temperature and is considered temperature stable. The Electronics Components, Assemblies and Materials Association (EIA) characterizes X7R dielectric as a Class II material. Components of this classification are fixed, ceramic dielectric capacitors suited for bypass and decoupling applications or for frequency discriminating

circuits where Q and stability of capacitance characteristics are not critical. X7R exhibits a predictable change in capacitance with respect to time and voltage, boasting a minimal change in capacitance with reference to ambient temperature. Capacitance change is limited to  $\pm 15\%$  from -55°C to +125°C.

### Benefits

- -55°C to +125°C operating temperature range
- Lead (Pb)-free, RoHS, and REACH Compliant
- Temperature stable dielectric
- EIA 0402, 0603, 0805, 1206, 1210, 1808, 1812, 1825, 2220, and 2225 case sizes
- DC voltage ratings of 6.3 V, 10 V, 16 V, 25 V, 35 V, 50 V, 100 V, 200 V, and 250 V
- Capacitance offerings ranging from 10 pF to 47  $\mu$ F
- Available capacitance tolerances of  $\pm 5\%$ ,  $\pm 10\%$ , and  $\pm 20\%$
- Non-polar device, minimizing installation concerns
- 100% pure matte tin-plated termination finish allowing for excellent solderability
- SnPb termination finish option available upon request (5% Pb minimum)



### Applications

Typical applications include decoupling, bypass, filtering and transient voltage suppression.

## Ordering Information

| C       | 1206                                                                                 | C                                  | 106                                         | M                               | 4                                                                                          | R          | A                    | C                               | TU                                            |
|---------|--------------------------------------------------------------------------------------|------------------------------------|---------------------------------------------|---------------------------------|--------------------------------------------------------------------------------------------|------------|----------------------|---------------------------------|-----------------------------------------------|
| Ceramic | Case Size (L" x W")                                                                  | Specification/ Series <sup>1</sup> | Capacitance Code (pF)                       | Capacitance Tolerance           | Rated Voltage (VDC)                                                                        | Dielectric | Failure Rate/ Design | Termination Finish <sup>2</sup> | Packaging/ Grade (C-Spec)                     |
|         | 0402<br>0603<br>0805<br>1206<br>1210<br>1805<br>1808<br>1812<br>1825<br>2220<br>2225 | C = Standard                       | Two significant digits and number of zeros. | J = ±5%<br>K = ±10%<br>M = ±20% | 9 = 6.3<br>8 = 10<br>4 = 16<br>3 = 25<br>6 = 35<br>5 = 50<br>1 = 100<br>2 = 200<br>A = 250 | R = X7R    | A = N/A              | C = 100% Matte Sn               | See "Packaging C-Spec Ordering Options Table" |

<sup>1</sup> Flexible termination option is available. Please see FT-CAP product bulletin C1013\_X7R\_FT-CAP\_SMD.

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

## Packaging C-Spec Ordering Options Table

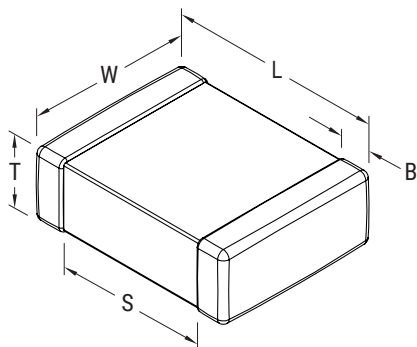
| Packaging Type <sup>1</sup>               | Packaging/Grade Ordering Code (C-Spec)                                          |
|-------------------------------------------|---------------------------------------------------------------------------------|
| Bulk Bag/Unmarked                         | Not required (Blank)                                                            |
| 7" Reel/Unmarked                          | TU                                                                              |
| 13" Reel/Unmarked                         | 7411 (EIA 0603 and smaller case sizes)<br>7210 (EIA 0805 and larger case sizes) |
| 7" Reel/Marked                            | TM                                                                              |
| 13" Reel/Marked                           | 7040 (EIA 0603)<br>7215 (EIA 0805 and larger case sizes)                        |
| 7" Reel/Unmarked/2 mm pitch <sup>2</sup>  | 7081                                                                            |
| 13" Reel/Unmarked/2 mm pitch <sup>2</sup> | 7082                                                                            |

<sup>1</sup> Default packaging is "Bulk Bag." An ordering code C-Spec is not required for "Bulk Bag" packaging.

<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. Please contact KEMET if you require a laser marked option. For more information see "Capacitor Marking."

<sup>2</sup> The 2 mm pitch option allows for double the packaging quantity of capacitors on a given reel size. This option is limited to EIA 0603 (1608 metric) case size devices. For more information regarding 2 mm pitch option see "Tape & Reel Packaging Information."

## Dimensions – Millimeters (Inches)



| EIA Size Code     | Metric Size Code | L Length                      | W Width                       | T Thickness                  | B Bandwidth                   | S Separation Minimum | Mounting Technique              |
|-------------------|------------------|-------------------------------|-------------------------------|------------------------------|-------------------------------|----------------------|---------------------------------|
| 0402              | 1005             | 1.00 (0.040)<br>±0.05 (0.002) | 0.50 (0.020)<br>±0.05 (0.002) | See Table 2<br>for Thickness | 0.30 (0.012)<br>±0.10 (0.004) | 0.30 (0.012)         | Solder reflow only              |
| 0603              | 1608             | 1.60 (0.063)<br>±0.15 (0.006) | 0.80 (0.032)<br>±0.15 (0.006) |                              | 0.35 (0.014)<br>±0.15 (0.006) | 0.70 (0.028)         | Solder wave or<br>Solder reflow |
| 0805 <sup>1</sup> | 2012             | 2.00 (0.079)<br>±0.20 (0.008) | 1.25 (0.049)<br>±0.20 (0.008) |                              | 0.50 (0.02)<br>±0.25 (0.010)  | 0.75 (0.030)         |                                 |
| 1206 <sup>2</sup> | 3216             | 3.20 (0.126)<br>±0.20 (0.008) | 1.60 (0.063)<br>±0.20 (0.008) |                              | 0.50 (0.02)<br>±0.25 (0.010)  | N/A                  | Solder reflow only              |
| 1210 <sup>3</sup> | 3225             | 3.20 (0.126)<br>±0.20 (0.008) | 2.50 (0.098)<br>±0.20 (0.008) |                              | 0.50 (0.02)<br>±0.25 (0.010)  |                      |                                 |
| 1805              | 4513             | 4.50 (0.177)<br>±0.50 (0.020) | 1.27 (0.050)<br>±0.38 (0.015) |                              | 0.60 (0.024)<br>±0.35 (0.014) |                      |                                 |
| 1808              | 4520             | 4.70 (0.185)<br>±0.50 (0.020) | 2.00 (0.079)<br>±0.20 (0.008) |                              | 0.60 (0.024)<br>±0.35 (0.014) |                      |                                 |
| 1812              | 4532             | 4.50 (0.177)<br>±0.30 (0.012) | 3.20 (0.126)<br>±0.30 (0.012) |                              | 0.60 (0.024)<br>±0.35 (0.014) |                      |                                 |
| 1825              | 4564             | 4.50 (0.177)<br>±0.30 (0.012) | 6.40 (0.252)<br>±0.40 (0.016) |                              | 0.60 (0.024)<br>±0.35 (0.014) |                      |                                 |
| 2220              | 5650             | 5.70 (0.224)<br>±0.40 (0.016) | 5.00 (0.197)<br>±0.40 (0.016) |                              | 0.60 (0.024)<br>±0.35 (0.014) |                      |                                 |
| 2225              | 5664             | 5.60 (0.220)<br>±0.40 (0.016) | 6.40 (0.248)<br>±0.40 (0.016) |                              | 0.60 (0.024)<br>±0.35 (0.014) |                      |                                 |

<sup>1</sup> For capacitance values  $\geq 2.2 \mu\text{F}$  add 0.10 (0.004) to the length tolerance dimension.

<sup>2</sup> For capacitance value  $10 \mu\text{F}$  16 V add 0.10 (0.004) to the length tolerance dimension and for Capacitance value  $1.0\mu\text{F}$  add 0.10 (0.004) to Length tolerance dimension.

<sup>3</sup> For capacitance value  $2.2\mu\text{F}$  100 V add 0.10 to the Length tolerance dimension, for capacitance values  $\geq 4.7 \mu\text{F}$  add 0.02 (0.001) to the width tolerance dimension and 0.10 (0.004) to the length tolerance dimension, except for capacitance value  $10\mu\text{F}$  50 V add 0.10 (0.004) to the width tolerance dimension and 0.20 (0.008) to the length tolerance dimension.

## 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.



**Table 1A – Capacitance Range/Selection Waterfall (0402 – 1206 Case Sizes)**

| Cap            | Cap Code    | Case Size/<br>Series |   |   | C0402C                                                                                    |    |    |    |    |     | C0603C |        |    |    |    |     |     |     | C0805C |     |    |    |    |    |     |        | C1206C |     |     |    |    |    |    |     |     |     |     |
|----------------|-------------|----------------------|---|---|-------------------------------------------------------------------------------------------|----|----|----|----|-----|--------|--------|----|----|----|-----|-----|-----|--------|-----|----|----|----|----|-----|--------|--------|-----|-----|----|----|----|----|-----|-----|-----|-----|
|                |             | Voltage Code         |   |   | 9                                                                                         | 8  | 4  | 3  | 5  | 1   | 9      | 8      | 4  | 3  | 5  | 1   | 2   | A   | 9      | 8   | 4  | 3  | 6  | 5  | 1   | 2      | A      | 9   | 8   | 4  | 3  | 6  | 5  | 1   | 2   | A   |     |
|                |             | Rated Voltage (VDC)  |   |   | 6.3                                                                                       | 10 | 16 | 25 | 50 | 100 | 6.3    | 10     | 16 | 25 | 50 | 100 | 200 | 250 | 6.3    | 10  | 16 | 25 | 35 | 50 | 100 | 200    | 250    | 6.3 | 10  | 16 | 25 | 35 | 50 | 100 | 200 | 250 |     |
|                |             | Cap Tolerance        |   |   | Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions |    |    |    |    |     |        |        |    |    |    |     |     |     |        |     |    |    |    |    |     |        |        |     |     |    |    |    |    |     |     |     |     |
| 10 - 20 pF*    | 100 - 200*  | J                    | K | M | BB                                                                                        | BB | BB | BB | BB |     | CF     | CF     | CF | CF | CF | CF  | CF  |     | DN     | DN  | DN | DN | DN | DN | DN  | DN     |        | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| 22 pF          | 220         | J                    | K | M | BB                                                                                        | BB | BB | BB | BB |     | CF     | CF     | CF | CF | CF | CF  | CF  |     | DM     | DM  | DM | DM | DM | DM | DM  | DM     |        | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| 24 - 91pF      | 240 - 910*  | J                    | K | M | BB                                                                                        | BB | BB | BB | BB |     | CF     | CF     | CF | CF | CF | CF  | CF  |     | DN     | DN  | DN | DN | DN | DN | DN  | DN     |        | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| 100 - 150 pF** | 101 - 151** | J                    | K | M | BB                                                                                        | BB | BB | BB | BB |     | CF     | CF     | CF | CF | CF | CF  | CF  |     | DN     | DN  | DN | DN | DN | DN | DN  | DN     |        | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| 180 - 820 pF** | 181 - 821** | J                    | K | M | BB                                                                                        | BB | BB | BB | BB |     | CF     | CF     | CF | CF | CF | CF  | CF  |     | DN     | DN  | DN | DN | DN | DN | DN  | DN     | DN     | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| 1000pF         | 102         | J                    | K | M | BB                                                                                        | BB | BB | BB | BB |     | CF     | CF     | CF | CF | CF | CF  | CF  | CF  | DN     | DN  | DN | DN | DN | DN | DN  | DN     | DN     | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| 1200 pF        | 122         | J                    | K | M | BB                                                                                        | BB | BB | BB | BB |     | CF     | CF     | CF | CF | CF | CF  | CF  | CF  | DN     | DN  | DN | DN | DN | DN | DN  | DN     | DN     | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| 1500 pF        | 152         | J                    | K | M | BB                                                                                        | BB | BB | BB | BB |     | CF     | CF     | CF | CF | CF | CF  | CF  | CF  | DN     | DN  | DN | DN | DN | DN | DN  | DN     | DN     | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| 1800 pF        | 182         | J                    | K | M | BB                                                                                        | BB | BB | BB | BB |     | CF     | CF     | CF | CF | CF | CF  | CF  | CF  | DN     | DN  | DN | DN | DN | DN | DN  | DN     | DN     | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| 2200 pF        | 222         | J                    | K | M | BB                                                                                        | BB | BB | BB | BB |     | CF     | CF     | CF | CF | CF | CF  | CF  | CF  | DN     | DN  | DN | DN | DN | DN | DN  | DN     | DN     | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| 2700 pF        | 272         | J                    | K | M | BB                                                                                        | BB | BB | BB | BB |     | CF     | CF     | CF | CF | CF | CF  | CF  | CF  | DN     | DN  | DN | DN | DN | DN | DN  | DN     | DN     | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| 3300 pF        | 332         | J                    | K | M | BB                                                                                        | BB | BB | BB | BB |     | CF     | CF     | CF | CF | CF | CF  | CF  | CF  | DN     | DN  | DN | DN | DN | DN | DN  | DN     | DN     | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| 3900 pF        | 392         | J                    | K | M | BB                                                                                        | BB | BB | BB | BB |     | CF     | CF     | CF | CF | CF | CF  | CF  | CF  | DN     | DN  | DN | DN | DN | DN | DN  | DN     | DN     | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| 4700 pF        | 472         | J                    | K | M | BB                                                                                        | BB | BB | BB | BB |     | CF     | CF     | CF | CF | CF | CF  | CF  | CF  | DN     | DN  | DN | DN | DN | DN | DN  | DN     | DN     | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| 5600 pF        | 562         | J                    | K | M | BB                                                                                        | BB | BB | BB | BB | BB  | CF     | CF     | CF | CF | CF | CF  | CF  | CF  | DN     | DN  | DN | DN | DN | DN | DN  | DN     | DN     | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| 6800 pF        | 682         | J                    | K | M | BB                                                                                        | BB | BB | BB | BB | BB  | CF     | CF     | CF | CF | CF | CF  | CF  | CF  | DN     | DN  | DN | DN | DN | DN | DN  | DN     | DN     | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| 8200 pF        | 822         | J                    | K | M | BB                                                                                        | BB | BB | BB | BB | BB  | CF     | CF     | CF | CF | CF | CF  | CF  | CF  | DN     | DN  | DN | DN | DN | DN | DN  | DN     | DN     | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| 10000 pF       | 103         | J                    | K | M | BB                                                                                        | BB | BB | BB | BB | BB  | CG     | CG     | CG | CG | CG | CG  | CF  | CF  | DN     | DN  | DN | DN | DN | DN | DN  | DN     | DN     | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| 12000 pF       | 123         | J                    | K | M | BB                                                                                        | BB | BB | BB | BB | BB  | CF     | CF     | CF | CF | CF | CF  | CF  | CF  | DN     | DN  | DN | DN | DN | DN | DN  | DN     | DN     | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| 15000 pF       | 153         | J                    | K | M | BB                                                                                        | BB | BB | BB | BB | BB  | CF     | CF     | CF | CF | CF | CF  | CF  | CF  | DN     | DN  | DN | DN | DN | DN | DN  | DN     | DN     | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| 18000 pF       | 183         | J                    | K | M | BB                                                                                        | BB | BB | BB | BB | BB  | CF     | CF     | CF | CF | CF | CF  | CF  | CF  | DN     | DN  | DN | DN | DN | DN | DN  | DN     | DN     | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| 22000 pF       | 223         | J                    | K | M | BB                                                                                        | BB | BB | BB | BB | BB  | CF     | CF     | CF | CF | CF | CF  | CF  | CF  | DN     | DN  | DN | DN | DN | DN | DN  | DN     | DN     | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| 27000 pF       | 273         | J                    | K | M | BB                                                                                        | BB | BB | BB | BB | BB  | CF     | CF     | CF | CF | CF | CF  | CF  | CF  | DN     | DN  | DN | DN | DN | DN | DN  | DN     | DN     | EB  | EB  | EB | EB | EB | EB | EB  | EB  | EB  |     |
| Cap            | Cap Code    | Rated Voltage (VDC)  |   |   | 6.3                                                                                       | 10 | 16 | 25 | 50 | 100 |        | 6.3    | 10 | 16 | 25 | 50  | 100 | 200 | 250    | 6.3 | 10 | 16 | 25 | 35 | 50  | 100    | 200    | 250 | 6.3 | 10 | 16 | 25 | 35 | 50  | 100 | 200 | 250 |
|                |             | Voltage Code         |   |   | 9                                                                                         | 8  | 4  | 3  | 5  | 1   |        | 9      | 8  | 4  | 3  | 5   | 1   | 2   | A      | 9   | 8  | 4  | 3  | 6  | 5   | 1      | 2      | A   | 9   | 8  | 4  | 3  | 6  | 5   | 1   | 2   | A   |
|                |             | Case Size/<br>Series |   |   | C0402C                                                                                    |    |    |    |    |     |        | C0603C |    |    |    |     |     |     | C0805C |     |    |    |    |    |     | C1206C |        |     |     |    |    |    |    |     |     |     |     |

\*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91).

\*\*Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, and 82).

xx<sup>1</sup> Available only in K and M tolerance.

**Table 1A – Capacitance Range/Selection Waterfall (0402 – 1206 Case Sizes) cont.**

| Cap      | Cap Code | Case Size/<br>Series |        | C0402C                                                                                    |                 |                 |                 |                 |     |        | C0603C          |                 |    |                 |     |     |        | C0805C |                 |                 |    |                 |                 |                 | C1206C |     |     |                 |                 |                 |                 |                 |                 |     |     |    |    |
|----------|----------|----------------------|--------|-------------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----|--------|-----------------|-----------------|----|-----------------|-----|-----|--------|--------|-----------------|-----------------|----|-----------------|-----------------|-----------------|--------|-----|-----|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----|-----|----|----|
|          |          | Voltage Code         |        | 9                                                                                         | 8               | 4               | 3               | 5               | 1   | 9      | 8               | 4               | 3  | 5               | 1   | 2   | A      | 9      | 8               | 4               | 3  | 6               | 5               | 1               | 2      | A   | 9   | 8               | 4               | 3               | 6               | 5               | 1               | 2   | A   |    |    |
|          |          | Rated Voltage (VDC)  |        | 6.3                                                                                       | 10              | 16              | 25              | 50              | 100 | 6.3    | 10              | 16              | 25 | 50              | 100 | 200 | 250    | 6.3    | 10              | 16              | 25 | 35              | 50              | 100             | 200    | 250 | 6.3 | 10              | 16              | 25              | 35              | 50              | 100             | 200 | 250 |    |    |
|          |          | Cap Tolerance        |        | Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions |                 |                 |                 |                 |     |        |                 |                 |    |                 |     |     |        |        |                 |                 |    |                 |                 |                 |        |     |     |                 |                 |                 |                 |                 |                 |     |     |    |    |
| 33000 pF | 333      | J                    | K      | M                                                                                         | BB              | BB              | BB              | BB              |     |        | CF              | CF              | CF | CF              | CF  | CF  |        |        | DN              | DN              | DN | DN              | DN              | DN              | DP     | DE  | DG  | EB              | EB              | EB              | EB              | EB              | EB              | EB  | EB  | EB |    |
| 39000 pF | 393      | J                    | K      | M                                                                                         | BB              | BB              | BB              | BB              |     |        | CF              | CF              | CF | CF              | CF  | CF  |        |        | DN              | DN              | DN | DN              | DN              | DN              | DP     | DE  | DG  | EB              | EB              | EB              | EB              | EB              | EB              | EB  | EC  | EB | EB |
| 47000 pF | 473      | J                    | K      | M                                                                                         | BB              | BB              | BB              | BB              |     |        | CG              | CG              | CG | CG              | CJ  | CF  |        |        | DO              | DO              | DO | DO              | DO              | DO              | DE     | DG  | DG  | EB              | EB              | EB              | EB              | EB              | EB              | EB  | EC  | ED | ED |
| 56000 pF | 563      | J                    | K      | M                                                                                         | BB              | BB              | BB              |                 |     |        | CF              | CF              | CF | CF              | CF  | CF  | CJ     |        | DP              | DP              | DP | DP              | DP              | DP              | DE     | DG  | DG  | EB              | EB              | EB              | EB              | EB              | EB              | EB  | EB  | ED | ED |
| 68000 pF | 683      | J                    | K      | M                                                                                         | BB              | BB              | BB              |                 |     |        | CF              | CF              | CF | CF              | CF  | CF  | CJ     |        | DP              | DP              | DP | DP              | DP              | DP              | DE     | DG  | DG  | EB              | EB              | EB              | EB              | EB              | EB              | EB  | EB  | ED | ED |
| 82000 pF | 823      | J                    | K      | M                                                                                         | BB              | BB              | BB              |                 |     |        | CF              | CF              | CF | CF              | CF  | CF  | CJ     |        | DP              | DP              | DP | DP              | DP              | DP              | DE     |     |     | EB              | EB              | EB              | EB              | EB              | EB              | EB  | EB  | ED | ED |
| 0.1 µF   | 104      | J                    | K      | M                                                                                         | BB              | BB              | BB              | BB <sup>1</sup> |     |        | CJ              | CJ              | CJ | CJ              | CJ  | CJ  |        |        | DN              | DN              | DN | DN              | DN              | DN              | DE     |     |     | EB              | EB              | EB              | EB              | EB              | EB              | EB  | EB  | EM | EM |
| 0.12 µF  | 124      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        | CF              | CF              | CF | CF              | CF  | CF  |        |        | DN              | DN              | DN | DN              | DP              | DP              | DG     |     |     | EC              | EC              | EC              | EC              | EC              | EC              | EC  | EC  | EG | EM |
| 0.15 µF  | 154      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        | CF              | CF              | CF | CF              | CF  | CF  |        |        | DN              | DN              | DN | DN              | DP              | DP              | DG     |     |     | EC              | EC              | EC              | EC              | EC              | EC              | EC  | EC  | EG | EG |
| 0.18 µF  | 184      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        | CF              | CF              | CF | CF              | CF  |     |        |        | DN              | DN              | DN | DN              | DG              | DG              | DG     |     |     | EC              | EC              | EC              | EC              | EC              | EC              | EC  | EC  | EM | EM |
| 0.22 µF  | 224      | J                    | K      | M                                                                                         | BB <sup>2</sup> | BB <sup>2</sup> | BB <sup>2</sup> | BB <sup>2</sup> |     |        | CF              | CF              | CF | CF              | CF  |     |        |        | DN              | DN              | DN | DN              | DG              | DG              | DG     |     |     | EC              | EC              | EC              | EC              | EC              | EC              | EC  | EC  | EG | EG |
| 0.27 µF  | 274      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        | CF              | CF              | CF |                 |     |     |        |        | DP              | DP              | DP | DP              | DP              | DP              |        |     |     | EB              | EB              | EB              | EB              | EB              | EB              | EB  | EB  | EM |    |
| 0.33 µF  | 334      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        | CF              | CF              | CF |                 |     |     |        |        | DG              | DG              | DG | DG              | DP              | DP              |        |     |     | EB              | EB              | EB              | EB              | EC              | EC              | EG  |     |    |    |
| 0.39 µF  | 394      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        | CF              | CF              | CF |                 |     |     |        |        | DG              | DG              | DG | DG              | DE              | DE              |        |     |     | EB              | EB              | EB              | EB              | EC              | EC              | EG  |     |    |    |
| 0.47 µF  | 474      | J                    | K      | M                                                                                         | BB <sup>1</sup> | BB <sup>1</sup> |                 |                 |     |        | CF              | CF              | CF | CG <sup>1</sup> |     |     |        |        | DG              | DG              | DG | DG              | DE              | DE              |        |     |     | EC              | EC              | EC              | EC              | EC              | EC              | EC  | EG  |    |    |
| 0.56 µF  | 564      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        |                 |                 |    |                 |     |     |        |        | DP              | DP              | DP | DG              | DH              | DH              |        |     |     | ED              | ED              | ED              | ED              | EC              | EC              | EM  |     |    |    |
| 0.68 µF  | 684      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        |                 |                 |    |                 |     |     |        |        | DP              | DP              | DP | DG              | DH              | DH              |        |     |     | EE              | EE              | EE              | EE              | ED              | ED              | EM  |     |    |    |
| 0.82 µF  | 824      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        |                 |                 |    |                 |     |     |        |        | DP              | DP              | DP | DG              |                 |                 |        |     |     | EF              | EF              | EF              | EF              | ED              | ED              | EH  |     |    |    |
| 1 µF     | 105      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        | CG              | CG              | CG | CJ <sup>1</sup> |     |     |        |        | DH              | DH              | DH | DH              | DH <sup>1</sup> | DH <sup>1</sup> |        |     |     | EP              | EP              | EP              | EP              | ED              | ED              | EH  |     |    |    |
| 1.2 µF   | 125      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        |                 |                 |    |                 |     |     |        |        | DE              | DE              | DE |                 |                 |                 |        |     |     | ED              | ED              | ED              | EG              | EH              | EH              |     |     |    |    |
| 1.5 µF   | 155      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        |                 |                 |    |                 |     |     |        |        | DG              | DG              | DG |                 |                 |                 |        |     |     | ED              | ED              | ED              | EG              | EH              | EH              |     |     |    |    |
| 1.8 µF   | 185      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        |                 |                 |    |                 |     |     |        |        | DG              | DG              | DG |                 |                 |                 |        |     |     | ED              | ED              | ED              | EF              | EH              | EH              |     |     |    |    |
| 2.2 µF   | 225      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        | CG <sup>1</sup> | CG <sup>1</sup> |    |                 |     |     |        |        | DG              | DG              | DG | DH <sup>1</sup> | DH <sup>1</sup> | DH <sup>1</sup> |        |     |     | EH              | EH              | EH <sup>1</sup> | EH <sup>1</sup> | EH              | EH              |     |     |    |    |
| 2.7 µF   | 275      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        |                 |                 |    |                 |     |     |        |        |                 |                 |    |                 |                 |                 |        |     |     | EN              | EN              | EN              | EH              |                 |                 |     |     |    |    |
| 3.3 µF   | 335      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        |                 |                 |    |                 |     |     |        |        |                 |                 |    |                 |                 |                 |        |     |     | ED              | ED              | ED              | EH              |                 |                 |     |     |    |    |
| 3.9 µF   | 395      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        |                 |                 |    |                 |     |     |        |        |                 |                 |    |                 |                 |                 |        |     |     | EF              | EF              | EF              | EH              |                 |                 |     |     |    |    |
| 4.7 µF   | 475      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        |                 |                 |    |                 |     |     |        |        | DH              | DH              | DH | DH              |                 |                 |        |     |     | EH              | EH              | EH              | EH              | EH <sup>1</sup> | EH <sup>1</sup> |     |     |    |    |
| 5.6 µF   | 565      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        |                 |                 |    |                 |     |     |        |        |                 |                 |    |                 |                 |                 |        |     |     | EH              | EH              | EH              |                 |                 |                 |     |     |    |    |
| 6.8 µF   | 685      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        |                 |                 |    |                 |     |     |        |        |                 |                 |    |                 |                 |                 |        |     |     | EH              | EH              | EH              |                 |                 |                 |     |     |    |    |
| 8.2 µF   | 825      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        |                 |                 |    |                 |     |     |        |        |                 |                 |    |                 |                 |                 |        |     |     | EH              | EH              | EH              |                 |                 |                 |     |     |    |    |
| 10 µF    | 106      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        |                 |                 |    |                 |     |     |        |        | DH <sup>1</sup> | DH <sup>1</sup> |    |                 |                 |                 |        |     |     | EH              | EH              | EH              | EH              |                 |                 |     |     |    |    |
| 22 µF    | 226      | J                    | K      | M                                                                                         |                 |                 |                 |                 |     |        |                 |                 |    |                 |     |     |        |        |                 |                 |    |                 |                 |                 |        |     |     | EH <sup>1</sup> | EH <sup>1</sup> |                 |                 |                 |                 |     |     |    |    |
| Cap      | Cap Code | Rated Voltage (VDC)  | 6.3    | 10                                                                                        | 16              | 25              | 50              | 100             |     | 6.3    | 10              | 16              | 25 | 50              | 100 | 200 | 250    | 6.3    | 10              | 16              | 25 | 35              | 50              | 100             | 200    | 250 | 6.3 | 10              | 16              | 25              | 35              | 50              | 100             | 200 | 250 |    |    |
|          |          | Voltage Code         | 9      | 8                                                                                         | 4               | 3               | 5               | 1               |     | 9      | 8               | 4               | 3  | 5               | 1   | 2   | A      | 9      | 8               | 4               | 3  | 6               | 5               | 1               | 2      | A   | 9   | 8               | 4               | 3               | 6               | 5               | 1               | 2   | A   |    |    |
|          |          | Case Size/<br>Series | C0402C |                                                                                           |                 |                 |                 |                 |     | C0603C |                 |                 |    |                 |     |     | C0805C |        |                 |                 |    |                 |                 | C1206C          |        |     |     |                 |                 |                 |                 |                 |                 |     |     |    |    |

\*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91).

\*\*Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, and 82).

xx<sup>1</sup> Available only in K and M tolerance.

xx<sup>2</sup> Available only in M tolerance.

**Table 1B – Capacitance Range/Selection Waterfall (1210 – 1812 Case Sizes)**

| Cap            | Cap Code    | Case Size/<br>Series |   |   | C1210C                                                                                    |    |    |    |    |     |     |     | C1805C |     |     | C1808C |     |     | C1812C <sup>2</sup> |    |     |     |     |
|----------------|-------------|----------------------|---|---|-------------------------------------------------------------------------------------------|----|----|----|----|-----|-----|-----|--------|-----|-----|--------|-----|-----|---------------------|----|-----|-----|-----|
|                |             | Voltage Code         |   |   | 9                                                                                         | 8  | 4  | 3  | 5  | 1   | 2   | A   | 5      | 1   | 2   | 5      | 1   | 2   | 3                   | 5  | 1   | 2   | A   |
|                |             | Rated Voltage (VDC)  |   |   | 6.3                                                                                       | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 50     | 100 | 200 | 50     | 100 | 200 | 25                  | 50 | 100 | 200 | 250 |
|                |             | Cap Tolerance        |   |   | Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions |    |    |    |    |     |     |     |        |     |     |        |     |     |                     |    |     |     |     |
| 10 - 20 pF*    | 100 - 200*  | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     |        |     |     |        |     |     |                     |    |     |     |     |
| 22 pF          | 220         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     |        |     |     |        |     |     |                     |    |     |     |     |
| 24 - 91pF      | 240 - 910*  | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     |        |     |     |        |     |     |                     |    |     |     |     |
| 100 - 150 pF** | 101 - 151** | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     |        |     |     |        |     |     |                     |    |     |     |     |
| 220 pF         | 221         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NC     | NC  | NC  |        |     |     |                     |    |     |     |     |
| 270 pF         | 271         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NC     | NC  | NC  |        |     |     |                     |    |     |     |     |
| 330 pF         | 331         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NC     | NC  | NC  | LF     | LF  | LF  |                     |    |     |     |     |
| 390 pF         | 391         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NC     | NC  | NC  | LF     | LF  | LF  |                     |    |     |     |     |
| 470 pF         | 471         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NC     | NC  | NC  | LF     | LF  | LF  | GB                  | GB | GB  | GB  |     |
| 560 pF         | 561         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NC     | NC  | NC  | LF     | LF  | LF  | GB                  | GB | GB  | GB  |     |
| 680 pF         | 681         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NC     | NC  | NC  | LF     | LF  | LF  | GB                  | GB | GB  | GB  |     |
| 820 pF         | 821         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NC     | NC  | NC  | LF     | LF  | LF  | GB                  | GB | GB  | GB  |     |
| 1000pF         | 102         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NC     | NC  | NC  | LF     | LF  | LF  | GB                  | GB | GB  | GB  |     |
| 1200 pF        | 122         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NC     | NC  |     | LF     | LF  | LF  | GB                  | GB | GB  | GB  |     |
| 1500 pF        | 152         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FE  |     | NC     | NC  |     | LF     | LF  | LF  | GB                  | GB | GB  | GB  |     |
| 1800 pF        | 182         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FE  |     | NC     | NC  |     | LF     | LF  | LF  | GB                  | GB | GB  | GB  |     |
| 2200 pF        | 222         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NC     | NC  |     | LF     | LF  | LF  | GB                  | GB | GB  | GB  |     |
| 2700 pF        | 272         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NA     | NA  | NA  | LF     | LF  | LF  | GB                  | GB | GB  | GB  |     |
| 3300 pF        | 332         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NA     | NA  | NA  | LF     | LF  |     | GB                  | GB | GB  | GB  |     |
| 3900 pF        | 392         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NA     | NA  | NA  | LF     | LF  |     | GB                  | GB | GB  | GB  |     |
| 4700 pF        | 472         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NA     | NA  | NA  | LD     | LD  | LD  | GB                  | GB | GB  | GD  |     |
| 5600 pF        | 562         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NA     | NA  | NA  | LD     | LD  | LD  | GB                  | GB | GB  | GH  |     |
| 6800 pF        | 682         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NA     | NA  |     | LD     | LD  | LD  | GB                  | GB | GB  | GB  | GB  |
| 8200 pF        | 822         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NA     | NA  |     | LD     | LD  | LD  | GB                  | GB | GB  | GB  | GB  |
| 10000 pF       | 103         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NA     | NA  |     | LD     | LD  | LD  | GB                  | GB | GB  | GB  | GB  |
| 12000 pF       | 123         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NA     | NA  |     | LD     | LD  | LD  | GB                  | GB | GB  | GB  | GB  |
| 15000 pF       | 153         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NA     | NA  |     | LD     | LD  | LD  | GB                  | GB | GB  | GB  | GB  |
| 18000 pF       | 183         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NA     | NA  |     | LD     | LD  | LD  | GB                  | GB | GB  | GB  | GB  |
| 22000 pF       | 223         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NA     | NA  |     | LD     | LD  |     | GB                  | GB | GB  | GB  | GB  |
| 27000 pF       | 273         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NA     | NA  |     | LD     | LD  |     | GB                  | GB | GB  | GB  | GB  |
| 33000 pF       | 333         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NA     |     |     | LD     | LD  |     | GB                  | GB | GB  | GB  | GB  |
| 39000 pF       | 393         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FB  |     | NA     |     |     | LD     | LD  |     | GB                  | GB | GB  | GB  | GB  |
| 47000 pF       | 473         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FC  | FC  | NA     |     |     | LD     | LD  |     | GB                  | GB | GB  | GB  | GB  |
| 56000 pF       | 563         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FC  | FC  | NA     |     |     | LD     | LD  |     | GB                  | GB | GB  | GB  | GB  |
| 68000 pF       | 683         | J                    | K | M | FB                                                                                        | FB | FB | FB | FB | FB  | FC  | FC  | NA     |     |     | LD     |     |     | GB                  | GB | GB  | GB  | GB  |
| Cap            | Cap Code    | Rated Voltage (VDC)  |   |   | 6.3                                                                                       | 10 | 16 | 25 | 50 | 100 | 200 | 250 | 50     | 100 | 200 | 50     | 100 | 200 | 25                  | 50 | 100 | 200 | 250 |
|                |             | Voltage Code         |   |   | 9                                                                                         | 8  | 4  | 3  | 5  | 1   | 2   | A   | 5      | 1   | 2   | 5      | 1   | 2   | 3                   | 5  | 1   | 2   | A   |
|                |             | Case Size/Series     |   |   | C1210C                                                                                    |    |    |    |    |     |     |     | C1805C |     |     | C1808C |     |     | C1812C <sup>2</sup> |    |     |     |     |

\*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91).

\*\*Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, and 82).

xx<sup>1</sup> Available only in K and M tolerance.<sup>2</sup> Available capacitance values available in [X7R with KONNEKT Technology](#).

**Table 1B – Capacitance Range/Selection Waterfall (1210 – 1812 Case Sizes) cont.**

| Cap      | Cap Code | Case Size/<br>Series |   |   | C1210C                                                                                    |                 |                 |                 |                 |                 |     |     |    | C1805C |     |    | C1808C |     |    | C1812C <sup>2</sup> |                 |     |     |  |
|----------|----------|----------------------|---|---|-------------------------------------------------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----|-----|----|--------|-----|----|--------|-----|----|---------------------|-----------------|-----|-----|--|
|          |          | Voltage Code         |   |   | 9                                                                                         | 8               | 4               | 3               | 5               | 1               | 2   | A   | 5  | 1      | 2   | 5  | 1      | 2   | 3  | 5                   | 1               | 2   | A   |  |
|          |          | Rated Voltage (VDC)  |   |   | 6.3                                                                                       | 10              | 16              | 25              | 50              | 100             | 200 | 250 | 50 | 100    | 200 | 50 | 100    | 200 | 25 | 50                  | 100             | 200 | 250 |  |
|          |          | Cap Tolerance        |   |   | Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions |                 |                 |                 |                 |                 |     |     |    |        |     |    |        |     |    |                     |                 |     |     |  |
| 82000 pF | 823      | J                    | K | M | FB                                                                                        | FB              | FB              | FB              | FB              | FC              | FF  | FF  | NA |        |     | LD |        |     | GB | GB                  | GB              | GB  | GB  |  |
| 0.1 µF   | 104      | J                    | K | M | FB                                                                                        | FB              | FB              | FB              | FB              | FD              | FG  | FG  | NA |        |     | LD |        |     | GB | GB                  | GB              | GB  | GB  |  |
| 0.12 µF  | 124      | J                    | K | M | FB                                                                                        | FB              | FB              | FB              | FB              | FD              | FH  | FH  |    |        |     | LD |        |     | GB | GB                  | GB              | GB  | GB  |  |
| 0.15 µF  | 154      | J                    | K | M | FC                                                                                        | FC              | FC              | FC              | FC              | FD              | FM  | FM  |    |        |     | LD |        |     | GB | GB                  | GB              | GE  | GE  |  |
| 0.18 µF  | 184      | J                    | K | M | FC                                                                                        | FC              | FC              | FC              | FC              | FD              | FK  | FK  |    |        |     | LD |        |     | GB | GB                  | GB              | GG  | GG  |  |
| 0.22 µF  | 224      | J                    | K | M | FC                                                                                        | FC              | FC              | FC              | FC              | FD              | FK  | FK  |    |        |     |    |        |     | GB | GB                  | GB              | GG  | GG  |  |
| 0.27 µF  | 274      | J                    | K | M | FC                                                                                        | FC              | FC              | FC              | FC              | FD              | FP  | FP  |    |        |     |    |        |     | GB | GB                  | GG              | GG  | GG  |  |
| 0.33 µF  | 334      | J                    | K | M | FD                                                                                        | FD              | FD              | FD              | FD              | FD              | FM  | FM  |    |        |     |    |        |     | GB | GB                  | GG              | GG  | GG  |  |
| 0.39 µF  | 394      | J                    | K | M | FD                                                                                        | FD              | FD              | FD              | FD              | FD              | FK  | FK  |    |        |     |    |        |     | GB | GB                  | GG              | GG  | GG  |  |
| 0.47 µF  | 474      | J                    | K | M | FD                                                                                        | FD              | FD              | FD              | FD              | FD              | FS  | FS  |    |        |     |    |        |     | GB | GB                  | GG              | GJ  | GJ  |  |
| 0.56 µF  | 564      | J                    | K | M | FD                                                                                        | FD              | FD              | FD              | FD              | FF              |     |     |    |        |     |    |        |     | GC | GC                  | GG              |     |     |  |
| 0.68 µF  | 684      | J                    | K | M | FD                                                                                        | FD              | FD              | FD              | FD              | FG              |     |     |    |        |     |    |        |     | GC | GC                  | GG              |     |     |  |
| 0.82 µF  | 824      | J                    | K | M | FF                                                                                        | FF              | FF              | FF              | FF              | FL              |     |     |    |        |     |    |        |     | GE | GE                  | GG              |     |     |  |
| 1 µF     | 105      | J                    | K | M | FH                                                                                        | FH              | FH              | FH              | FH              | FM              |     |     |    |        |     |    |        |     | GE | GE                  | GG              |     |     |  |
| 1.2 µF   | 125      | J                    | K | M | FH                                                                                        | FH              | FH              | FH              | FG              | FH              |     |     |    |        |     |    |        |     | GB | GB                  | GB              |     |     |  |
| 1.5 µF   | 155      | J                    | K | M | FH                                                                                        | FH              | FH              | FH              | FG              | FM              |     |     |    |        |     |    |        |     | GC | GC                  | GC              |     |     |  |
| 1.8 µF   | 185      | J                    | K | M | FH                                                                                        | FH              | FH              | FH              | FG              | FJ              |     |     |    |        |     |    |        |     | GE | GE                  | GE              |     |     |  |
| 2.2 µF   | 225      | J                    | K | M | FJ                                                                                        | FJ              | FJ              | FJ              | FG              | FY <sup>1</sup> |     |     |    |        |     |    |        |     | GO | GO                  | GO <sup>1</sup> |     |     |  |
| 2.7 µF   | 275      | J                    | K | M | FE                                                                                        | FE              | FE              | FG              | FH              |                 |     |     |    |        |     |    |        |     | GJ | GJ                  | GJ              |     |     |  |
| 3.3 µF   | 335      | J                    | K | M | FF                                                                                        | FF              | FF              | FM              | FM              |                 |     |     |    |        |     |    |        |     | GL | GL                  | GL              |     |     |  |
| 3.9 µF   | 395      | J                    | K | M | FG                                                                                        | FG              | FG              | FG              | FK              |                 |     |     |    |        |     |    |        |     | GK | GK                  |                 |     |     |  |
| 4.7 µF   | 475      | J                    | K | M | FC                                                                                        | FC              | FC              | FG              | FS              |                 |     |     |    |        |     |    |        |     | GK | GK                  |                 |     |     |  |
| 5.6 µF   | 565      | J                    | K | M | FF                                                                                        | FF              | FF              | FH              |                 |                 |     |     |    |        |     |    |        |     |    |                     |                 |     |     |  |
| 6.8 µF   | 685      | J                    | K | M | FG                                                                                        | FG              | FG              | FM              |                 |                 |     |     |    |        |     |    |        |     |    |                     |                 |     |     |  |
| 8.2 µF   | 825      | J                    | K | M | FH                                                                                        | FH              | FH              | FK              |                 |                 |     |     |    |        |     |    |        |     |    |                     |                 |     |     |  |
| 10 µF    | 106      | J                    | K | M | FT <sup>1</sup>                                                                           | FT <sup>1</sup> | FT <sup>1</sup> | FS <sup>1</sup> | FS <sup>1</sup> |                 |     |     |    |        |     |    |        |     | GK |                     |                 |     |     |  |
| 15 µF    | 156      | J                    | K | M | FM                                                                                        | FM              |                 |                 |                 |                 |     |     |    |        |     |    |        |     |    |                     |                 |     |     |  |
| 22 µF    | 226      |                      |   |   | FS                                                                                        | FS              | FS <sup>1</sup> | FS <sup>1</sup> |                 |                 |     |     |    |        |     |    |        |     |    |                     |                 |     |     |  |
| 47 µF    | 476      |                      |   |   | FS <sup>1</sup>                                                                           | FS <sup>1</sup> |                 |                 |                 |                 |     |     |    |        |     |    |        |     |    |                     |                 |     |     |  |
| Cap      | Cap Code | Rated Voltage (VDC)  |   |   | 6.3                                                                                       | 10              | 16              | 25              | 50              | 100             | 200 | 250 | 50 | 100    | 200 | 50 | 100    | 200 | 25 | 50                  | 100             | 200 | 250 |  |
|          |          | Voltage Code         |   |   | 9                                                                                         | 8               | 4               | 3               | 5               | 1               | 2   | A   | 5  | 1      | 2   | 5  | 1      | 2   | 3  | 5                   | 1               | 2   | A   |  |
|          |          | Case Size/Series     |   |   | C1210C                                                                                    |                 |                 |                 |                 |                 |     |     |    | C1805C |     |    | C1808C |     |    | C1812C <sup>2</sup> |                 |     |     |  |

\*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91).

\*\*Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, and 82).

xx<sup>1</sup> Available only in K and M tolerance.

<sup>2</sup> Available capacitance values available in [X7R with KONNEKT Technology](#).

**Table 1C – Capacitance Range/Selection Waterfall (1825 – 2225 Case Sizes)**

| Cap      | Cap Code | Case Size/Series    |   |   | C1825C                                                                                    |     |     |     | C2220C |    |     |     |     | C2225C |     |     |     |
|----------|----------|---------------------|---|---|-------------------------------------------------------------------------------------------|-----|-----|-----|--------|----|-----|-----|-----|--------|-----|-----|-----|
|          |          | Voltage Code        |   |   | 5                                                                                         | 1   | 2   | A   | 3      | 5  | 1   | 2   | A   | 5      | 1   | 2   | A   |
|          |          | Rated Voltage (VDC) |   |   | 50                                                                                        | 100 | 200 | 250 | 25     | 50 | 100 | 200 | 250 | 50     | 100 | 200 | 250 |
|          |          | Cap Tolerance       |   |   | Product Availability and Chip Thickness Codes – See Table 2 for Chip Thickness Dimensions |     |     |     |        |    |     |     |     |        |     |     |     |
| 3900 pF  | 392      | J                   | K | M | HB                                                                                        | HB  | HB  |     |        |    |     |     |     | KE     | KE  | KE  |     |
| 4700 pF  | 472      | J                   | K | M | HB                                                                                        | HB  | HB  |     |        |    |     |     |     | KE     | KE  | KE  |     |
| 5600 pF  | 562      | J                   | K | M | HB                                                                                        | HB  | HB  |     |        |    |     |     |     | KE     | KE  | KE  |     |
| 6800 pF  | 682      | J                   | K | M | HB                                                                                        | HB  | HB  |     | JE     | JE | JE  |     |     | KE     | KE  | KE  |     |
| 8200 pF  | 822      | J                   | K | M | HB                                                                                        | HB  | HB  |     | JE     | JE | JE  |     |     | KE     | KE  | KE  |     |
| 10000 pF | 103      | J                   | K | M | HB                                                                                        | HB  | HE  |     | JE     | JE | JE  |     |     | KE     | KE  | KE  |     |
| 12000 pF | 123      | J                   | K | M | HB                                                                                        | HB  | HE  |     | JE     | JE | JE  |     |     | KE     | KE  | KE  |     |
| 15000 pF | 153      | J                   | K | M | HB                                                                                        | HB  |     |     | JE     | JE | JE  |     |     | KE     | KE  | KE  |     |
| 18000 pF | 183      | J                   | K | M | HB                                                                                        | HE  |     |     | JE     | JE | JE  |     |     | KE     | KE  |     |     |
| 22000 pF | 223      | J                   | K | M | HB                                                                                        | HB  | HB  | HB  | JE     | JE | JE  |     |     | KE     | KE  |     |     |
| 27000 pF | 273      | J                   | K | M | HB                                                                                        | HB  | HB  | HB  | JE     | JE | JE  |     |     | KE     | KE  |     |     |
| 33000 pF | 333      | J                   | K | M | HB                                                                                        | HB  | HB  | HB  | JB     | JB | JB  |     |     | KE     |     |     |     |
| 39000 pF | 393      | J                   | K | M | HB                                                                                        | HB  | HB  | HB  | JB     | JB | JB  |     |     |        |     |     |     |
| 47000 pF | 473      | J                   | K | M | HB                                                                                        | HB  | HB  | HB  | JB     | JB | JB  |     |     |        |     |     |     |
| 56000 pF | 563      | J                   | K | M | HB                                                                                        | HB  | HB  | HB  | JB     | JB | JB  |     |     |        |     |     |     |
| 68000 pF | 683      | J                   | K | M | HB                                                                                        | HB  | HB  | HB  | JB     | JB | JB  |     |     |        |     |     |     |
| 82000 pF | 823      | J                   | K | M | HB                                                                                        | HB  | HB  | HB  | JC     | JC | JC  | JC  | JC  |        |     |     |     |
| 0.1 µF   | 104      | J                   | K | M | HB                                                                                        | HB  | HB  | HB  | JC     | JC | JC  | JC  | JC  | KC     | KC  | KC  | KC  |
| 0.12 µF  | 124      | J                   | K | M | HB                                                                                        | HB  | HB  | HB  | JC     | JC | JC  | JC  | JC  | KC     | KC  | KC  | KC  |
| 0.15 µF  | 154      | J                   | K | M | HB                                                                                        | HB  | HB  | HB  | JC     | JC | JC  | JC  | JC  | KC     | KC  | KC  | KC  |
| 0.18 µF  | 184      | J                   | K | M | HB                                                                                        | HB  | HB  | HB  | JC     | JC | JC  | JC  | JC  | KC     | KC  | KC  | KC  |
| 0.22 µF  | 224      | J                   | K | M | HB                                                                                        | HB  | HB  | HB  | JC     | JC | JC  | JC  | JC  | KC     | KC  | KC  | KC  |
| 0.27 µF  | 274      | J                   | K | M | HB                                                                                        | HB  | HB  | HB  | JC     | JC | JC  | JC  | JC  | KB     | KC  | KC  | KC  |
| 0.33 µF  | 334      | J                   | K | M | HB                                                                                        | HB  | HB  | HB  | JC     | JC | JC  | JC  | JC  | KB     | KC  | KC  | KC  |
| 0.39 µF  | 394      | J                   | K | M | HB                                                                                        | HB  | HD  | HD  | JC     | JC | JC  | JC  | JC  | KB     | KC  | KC  | KC  |
| 0.47 µF  | 474      | J                   | K | M | HB                                                                                        | HB  | HD  | HD  | JC     | JC | JC  | JC  | JC  | KB     | KC  | KD  | KD  |
| 0.56 µF  | 564      | J                   | K | M | HB                                                                                        | HD  | HD  | HD  | JC     | JC | JC  | JD  | JD  | KB     | KC  | KD  | KD  |
| 0.68 µF  | 684      | J                   | K | M | HB                                                                                        | HD  | HD  | HD  | JC     | JC | JD  | JD  | JD  | KB     | KC  | KD  | KD  |
| 0.82 µF  | 824      | J                   | K | M | HB                                                                                        | HF  | HF  | HF  | JC     | JC | JF  | JF  | JF  | KB     | KC  | KE  | KE  |
| 1.0 µF   | 105      | J                   | K | M | HB                                                                                        | HF  | HF  | HF  | JC     | JC | JF  | JF  | JF  | KB     | KD  | KE  | KE  |
| 1.2 µF   | 125      | J                   | K | M | HB                                                                                        |     |     |     | JC     | JC |     |     |     | KB     | KE  | KE  | KE  |
| 1.5 µF   | 155      | J                   | K | M | HC                                                                                        |     |     |     | JC     | JC |     |     |     | KC     |     |     |     |
| 1.8 µF   | 185      | J                   | K | M | HD                                                                                        |     |     |     | JD     | JD |     |     |     | KD     |     |     |     |
| 2.2 µF   | 225      | J                   | K | M | HF                                                                                        |     |     |     | JF     | JF |     |     |     | KD     |     |     |     |
| 4.7 µF   | 475      | J                   | K | M |                                                                                           |     |     |     | JF     | JF |     |     |     |        |     |     |     |
| 10 µF    | 106      | J                   | K | M |                                                                                           |     |     |     | JF     | JO |     |     |     |        |     |     |     |
| 15 µF    | 156      | J                   | K | M |                                                                                           |     |     |     | JO     | JO |     |     |     |        |     |     |     |
| 22 µF    | 226      | J                   | K | M |                                                                                           |     |     |     | JO     |    |     |     |     |        |     |     |     |
| Cap      | Cap Code | Rated Voltage (VDC) |   |   | 50                                                                                        | 100 | 200 | 250 | 25     | 50 | 100 | 200 | 250 | 50     | 100 | 200 | 250 |
|          |          | Voltage Code        |   |   | 5                                                                                         | 1   | 2   | A   | 3      | 5  | 1   | 2   | A   | 5      | 1   | 2   | A   |
|          |          | Case Size/Series    |   |   | C1825C                                                                                    |     |     |     | C2220C |    |     |     |     | C2225C |     |     |     |

\*Capacitance range Includes E24 decade values only. (i.e., 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, and 91).

\*\*Capacitance range Includes E12 decade values only. (i.e., 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, and 82).

xx<sup>1</sup> Available only in K and M tolerance.

<sup>2</sup> Available capacitance values available in [X7R with KONNEKT Technology](#).

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

| Thickness Code | Case Size <sup>1</sup> | Thickness ± Range (mm) | Paper Quantity <sup>1</sup> |          | 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        |
| CJ             | 0603                   | 0.80 ± 0.07            | 4,000                       | 15,000   | 0                | 0        |
| CG             | 0603                   | 0.80 ± 0.10            | 4,000                       | 15,000   | 0                | 0        |
| DM             | 0805                   | 0.70 ± 0.20            | 4,000                       | 15,000   | 0                | 0        |
| DN             | 0805                   | 0.78 ± 0.10            | 4,000                       | 15,000   | 0                | 0        |
| DO             | 0805                   | 0.80 ± 0.10            | 4,000                       | 15,000   | 0                | 0        |
| DP             | 0805                   | 0.90 ± 0.10            | 4,000                       | 15,000   | 0                | 0        |
| DE             | 0805                   | 1.00 ± 0.10            | 0                           | 0        | 2,500            | 10,000   |
| DG             | 0805                   | 1.25 ± 0.15            | 0                           | 0        | 2,500            | 10,000   |
| DH             | 0805                   | 1.25 ± 0.20            | 0                           | 0        | 2,500            | 10,000   |
| EB             | 1206                   | 0.78 ± 0.10            | 0                           | 0        | 4,000            | 10,000   |
| EC             | 1206                   | 0.90 ± 0.10            | 0                           | 0        | 4,000            | 10,000   |
| EN             | 1206                   | 0.95 ± 0.10            | 0                           | 0        | 4,000            | 10,000   |
| ED             | 1206                   | 1.00 ± 0.10            | 0                           | 0        | 2,500            | 10,000   |
| EE             | 1206                   | 1.10 ± 0.10            | 0                           | 0        | 2,500            | 10,000   |
| EF             | 1206                   | 1.20 ± 0.15            | 0                           | 0        | 2,500            | 10,000   |
| EP             | 1206                   | 1.20 ± 0.20            | 0                           | 0        | 2,500            | 10,000   |
| EM             | 1206                   | 1.25 ± 0.15            | 0                           | 0        | 2,500            | 10,000   |
| EG             | 1206                   | 1.60 ± 0.15            | 0                           | 0        | 2,000            | 8,000    |
| EH             | 1206                   | 1.60 ± 0.20            | 0                           | 0        | 2,000            | 8,000    |
| FB             | 1210                   | 0.78 ± 0.10            | 0                           | 0        | 4,000            | 10,000   |
| FC             | 1210                   | 0.90 ± 0.10            | 0                           | 0        | 4,000            | 10,000   |
| FD             | 1210                   | 0.95 ± 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   |
| FL             | 1210                   | 1.40 ± 0.15            | 0                           | 0        | 2,000            | 8,000    |
| FH             | 1210                   | 1.55 ± 0.15            | 0                           | 0        | 2,000            | 8,000    |
| FP             | 1210                   | 1.60 ± 0.20            | 0                           | 0        | 2,000            | 8,000    |
| FM             | 1210                   | 1.70 ± 0.20            | 0                           | 0        | 2,000            | 8,000    |
| FJ             | 1210                   | 1.85 ± 0.20            | 0                           | 0        | 2,000            | 8,000    |
| FT             | 1210                   | 1.90 ± 0.20            | 0                           | 0        | 2,000            | 8,000    |
| FY             | 1210                   | 2.00 ± 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    |
| NA             | 1805                   | 0.90 ± 0.10            | 0                           | 0        | 4,000            | 10,000   |
| NC             | 1805                   | 1.00 ± 0.15            | 0                           | 0        | 4,000            | 10,000   |
| LD             | 1808                   | 0.90 ± 0.10            | 0                           | 0        | 2,500            | 10,000   |
| LF             | 1808                   | 1.00 ± 0.15            | 0                           | 0        | 2,500            | 10,000   |
| GB             | 1812                   | 1.00 ± 0.10            | 0                           | 0        | 1,000            | 4,000    |
| GC             | 1812                   | 1.10 ± 0.10            | 0                           | 0        | 1,000            | 4,000    |
| GD             | 1812                   | 1.25 ± 0.15            | 0                           | 0        | 1,000            | 4,000    |
| GE             | 1812                   | 1.30 ± 0.10            | 0                           | 0        | 1,000            | 4,000    |
| GH             | 1812                   | 1.40 ± 0.15            | 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    |
| GJ             | 1812                   | 1.70 ± 0.15            | 0                           | 0        | 1,000            | 4,000    |
| GL             | 1812                   | 1.90 ± 0.20            | 0                           | 0        | 500              | 2,000    |
| GO             | 1812                   | 2.50 ± 0.20            | 0                           | 0        | 500              | 2,000    |
| Thickness Code | Case Size <sup>1</sup> | Thickness ± Range (mm) | 7" Reel                     | 13" Reel | 7" Reel          | 13" Reel |
|                |                        |                        | Paper Quantity <sup>1</sup> |          | Plastic Quantity |          |

Package quantity based on finished chip thickness specifications.

<sup>1</sup> If ordering using the 2 mm 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 2 mm pitch option see "Tape & Reel Packaging Information."

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

| Thickness Code | Case Size <sup>1</sup> | Thickness ± Range (mm) | Paper Quantity <sup>1</sup> |          | Plastic Quantity |          |
|----------------|------------------------|------------------------|-----------------------------|----------|------------------|----------|
|                |                        |                        | 7" Reel                     | 13" Reel | 7" Reel          | 13" Reel |
| HB             | 1825                   | 1.10 ± 0.15            | 0                           | 0        | 1,000            | 4,000    |
| HC             | 1825                   | 1.15 ± 0.15            | 0                           | 0        | 1,000            | 4,000    |
| HD             | 1825                   | 1.30 ± 0.15            | 0                           | 0        | 1,000            | 4,000    |
| HE             | 1825                   | 1.40 ± 0.15            | 0                           | 0        | 1,000            | 4,000    |
| HF             | 1825                   | 1.50 ± 0.15            | 0                           | 0        | 1,000            | 4,000    |
| JB             | 2220                   | 1.00 ± 0.15            | 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    |
| JE             | 2220                   | 1.40 ± 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    |
| KB             | 2225                   | 1.00 ± 0.15            | 0                           | 0        | 1,000            | 4,000    |
| KC             | 2225                   | 1.10 ± 0.15            | 0                           | 0        | 1,000            | 4,000    |
| KD             | 2225                   | 1.30 ± 0.15            | 0                           | 0        | 1,000            | 4,000    |
| KE             | 2225                   | 1.40 ± 0.15            | 0                           | 0        | 1,000            | 4,000    |
| Thickness Code | Case Size <sup>1</sup> | Thickness ± Range (mm) | 7" Reel                     | 13" Reel | 7" Reel          | 13" Reel |
|                |                        |                        | Paper Quantity <sup>1</sup> |          | Plastic Quantity |          |

Package quantity based on finished chip thickness specifications.

<sup>1</sup> If ordering using the 2 mm 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 2 mm pitch option see "Tape & Reel Packaging Information."

**Table 2B – Bulk Packaging Quantities**

| Packaging Type                |             | Loose Packaging                              |         |
|-------------------------------|-------------|----------------------------------------------|---------|
|                               |             | Bulk Bag (default)                           |         |
| Packaging C-Spec <sup>1</sup> |             | N/A <sup>2</sup>                             |         |
| Case Size                     |             | Packaging Quantities (pieces/unit packaging) |         |
| EIA (in)                      | Metric (mm) | Minimum                                      | Maximum |
| 0402                          | 1005        | 1                                            | 50,000  |
| 0603                          | 1608        |                                              |         |
| 0805                          | 2012        |                                              |         |
| 1206                          | 3216        |                                              |         |
| 1210                          | 3225        |                                              |         |
| 1808                          | 4520        |                                              | 20,000  |
| 1812                          | 4532        |                                              |         |
| 1825                          | 4564        |                                              |         |
| 2220                          | 5650        |                                              |         |
| 2225                          | 5664        |                                              |         |

<sup>1</sup> The "Packaging C-Spec" is a 4 to 8 digit code which identifies the packaging type and/or product grade. When ordering, the proper code must be included in the 15th through 22nd character positions of the ordering code. See "Ordering Information" section of this document for further details. Commercial grade product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging. Contact KEMET if you require a bulk bag packaging option for automotive grade products.

<sup>2</sup> A packaging C-Spec (see note 1 above) is not required for "Bulk Bag" packaging (excluding anti-static Bulk Bag and automotive grade products). The 15th through 22nd character positions of the ordering code should be left blank. All product ordered without a packaging C-Spec will default to our standard "Bulk Bag" packaging.

**Table 3 – Chip Capacitor Land Pattern Design Recommendations per IPC–7351**

| EIA<br>Size<br>Code | Metric<br>Size<br>Code | Density Level A:<br>Maximum (Most)<br>Land Protrusion (mm) |      |      |      |      | Density Level B:<br>Median (Nominal)<br>Land Protrusion (mm) |      |      |      |      | Density Level C:<br>Minimum (Least)<br>Land Protrusion (mm) |      |      |      |      |
|---------------------|------------------------|------------------------------------------------------------|------|------|------|------|--------------------------------------------------------------|------|------|------|------|-------------------------------------------------------------|------|------|------|------|
|                     |                        | C                                                          | Y    | X    | V1   | V2   | C                                                            | Y    | X    | V1   | V2   | C                                                           | Y    | X    | V1   | V2   |
| 0402                | 1005                   | 0.50                                                       | 0.72 | 0.72 | 2.20 | 1.20 | 0.45                                                         | 0.62 | 0.62 | 1.90 | 1.00 | 0.40                                                        | 0.52 | 0.52 | 1.60 | 0.80 |
| 0603                | 1608                   | 0.90                                                       | 1.15 | 1.10 | 4.00 | 2.10 | 0.80                                                         | 0.95 | 1.00 | 3.10 | 1.50 | 0.60                                                        | 0.75 | 0.90 | 2.40 | 1.20 |
| 0805                | 2012                   | 1.00                                                       | 1.35 | 1.55 | 4.40 | 2.60 | 0.90                                                         | 1.15 | 1.45 | 3.50 | 2.00 | 0.75                                                        | 0.95 | 1.35 | 2.80 | 1.70 |
| 1206                | 3216                   | 1.60                                                       | 1.35 | 1.90 | 5.60 | 2.90 | 1.50                                                         | 1.15 | 1.80 | 4.70 | 2.30 | 1.40                                                        | 0.95 | 1.70 | 4.00 | 2.00 |
| 1210                | 3225                   | 1.60                                                       | 1.35 | 2.80 | 5.65 | 3.80 | 1.50                                                         | 1.15 | 2.70 | 4.70 | 3.20 | 1.40                                                        | 0.95 | 2.60 | 4.00 | 2.90 |
| 1210 <sup>1</sup>   | 3225                   | 1.50                                                       | 1.60 | 2.90 | 5.60 | 3.90 | 1.40                                                         | 1.40 | 2.80 | 4.70 | 3.30 | 1.30                                                        | 1.20 | 2.70 | 4.00 | 3.00 |
| 1808                | 4520                   | 2.30                                                       | 1.75 | 2.30 | 7.40 | 3.30 | 2.20                                                         | 1.55 | 2.20 | 6.50 | 2.70 | 2.10                                                        | 1.35 | 2.10 | 5.80 | 2.40 |
| 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 |
| 1825                | 4564                   | 2.15                                                       | 1.60 | 6.90 | 6.90 | 7.90 | 2.05                                                         | 1.40 | 6.80 | 6.00 | 7.30 | 1.95                                                        | 1.20 | 6.70 | 5.30 | 7.00 |
| 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 |
| 2225                | 5664                   | 2.70                                                       | 1.70 | 6.90 | 8.10 | 7.90 | 2.60                                                         | 1.50 | 6.80 | 7.20 | 7.30 | 2.50                                                        | 1.30 | 6.70 | 6.50 | 7.00 |

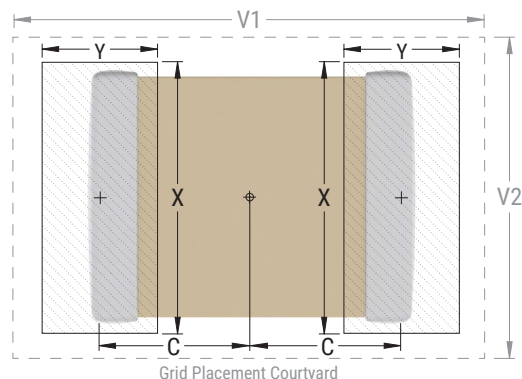
<sup>1</sup> Only for capacitance values  $\geq 22 \mu\text{F}$

**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

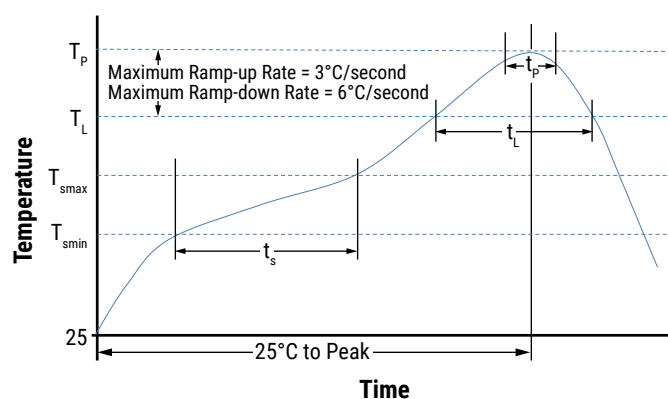
### Recommended Soldering Technique:

- 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/J-STD-020 standard for moisture sensitivity testing. These devices can safely withstand a maximum of three reflow passes at these conditions.

| Profile Feature                                       | Termination Finish |                    |
|-------------------------------------------------------|--------------------|--------------------|
|                                                       | SnPb               | 100% Matte Sn      |
| <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/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 1: All temperatures refer to the center of the package, measured on the capacitor body surface that is facing up during assembly reflow.*

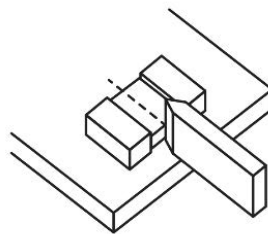
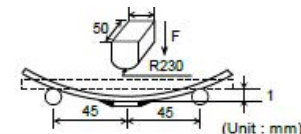
## X7R Performance and Reliability: SMD Test Methods and Conditions

| Test                    | Reference        | Test Condition                                                                                                                                                                                                                                                                                                                                                                                                                                            | Limits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|-------------------------|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|------------------|-------------|--------------------------------|------|------|---------------------|-----|------------------------|------|----|---------------------|-----|------------------------|------|----|---------------------|-----|------------------------|------|------|-----|-----|-------------------|------|---------------------|-----|---------|-----|------|-----|------|------------------------|------|---------|------|-------------------|------|---------------------|-----|---------|---------------------|-----|------|---------------------|-----|------|------------------------|------|---------|------|------|------|-------------------|------|--------------------|-----|---------|--------------------|-----|------|-----|-----|------|-----------------------|------|---------|------|-------------------|------|--------------------|-----|---------|-----|------|-----|------|-----------------------|------|---------|------|-------------|------|-----|-----|---------|-----|------|-----|
| Visual and Mechanical   | KEMET Internal   | No defects that may affect performance (10X)                                                                                                                                                                                                                                                                                                                                                                                                              | Dimensions according KEMET Spec Sheet                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
| Capacitance (Cap)       | KEMET Internal   | $C \leq 10 \mu\text{F}$ 1 kHz $\pm 50 \text{ Hz}$ and $1.0 \pm 0.2 V_{\text{rms}}$<br>or $0.5 \pm 0.2 V_{\text{rms}}$ *<br>$C > 10 \mu\text{F}$ 120 Hz $\pm 10 \text{ Hz}$ and $0.5 \pm 0.1 V_{\text{rms}}$<br>* See part number specification sheet for voltage<br>Capacitance measurements (including tolerance)<br>are indexed to a referee time of 48 or 1,000 hours<br>Please refer to a part number specification sheet<br>for referee time details | Within Tolerance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
| Dissipation Factor (DF) | KEMET Internal   | $C \leq 10 \mu\text{F}$<br>Frequency: 1 kHz $\pm 50 \text{ Hz}$<br>Voltage*: $1.0 \pm 0.2 V_{\text{rms}}$ , $0.5 \pm 0.2 V_{\text{rms}}$<br><br>$C > 10 \mu\text{F}$<br>Frequency: 120 Hz $\pm 10 \text{ Hz}$<br>Voltage: $0.5 \pm 0.1 V_{\text{rms}}$<br><br>* See part number specification sheet for voltage                                                                                                                                           | <p>Within Specification</p> <table> <tr> <th>EIA Case Size</th><th>Rated DC Voltage</th><th>Capacitance</th><th>Dissipation Factor (Maximum %)</th></tr> <tr> <td rowspan="7">0402</td><td rowspan="2">&lt; 16</td><td>&lt; 0.1 <math>\mu\text{F}</math></td><td>5.0</td></tr> <tr> <td><math>\geq 0.1 \mu\text{F}</math></td><td>10.0</td></tr> <tr> <td rowspan="2">16</td><td>&lt; 0.1 <math>\mu\text{F}</math></td><td>3.5</td></tr> <tr> <td><math>\geq 0.1 \mu\text{F}</math></td><td>10.0</td></tr> <tr> <td rowspan="2">25</td><td>&lt; 0.1 <math>\mu\text{F}</math></td><td>3.5</td></tr> <tr> <td><math>\geq 0.1 \mu\text{F}</math></td><td>10.0</td></tr> <tr> <td>&gt; 25</td><td>All</td><td>2.5</td></tr> <tr> <td rowspan="5">0603<sup>1</sup></td><td>&lt; 16</td><td rowspan="3">&lt; 1.0 <math>\mu\text{F}</math></td><td>5.0</td></tr> <tr> <td>16 / 25</td><td>3.5</td></tr> <tr> <td>&gt; 25</td><td>2.5</td></tr> <tr> <td>&lt; 16</td><td rowspan="2"><math>\geq 1.0 \mu\text{F}</math></td><td>10.0</td></tr> <tr> <td>16 / 25</td><td>10.0</td></tr> <tr> <td rowspan="6">0805<sup>2</sup></td><td>&lt; 16</td><td>&lt; 2.2 <math>\mu\text{F}</math></td><td>5.0</td></tr> <tr> <td>16 / 25</td><td>&lt; 2.2 <math>\mu\text{F}</math></td><td>3.5</td></tr> <tr> <td>&gt; 25</td><td>&lt; 1.0 <math>\mu\text{F}</math></td><td>2.5</td></tr> <tr> <td>&lt; 16</td><td rowspan="3"><math>\geq 2.2 \mu\text{F}</math></td><td>10.0</td></tr> <tr> <td>16 / 25</td><td>10.0</td></tr> <tr> <td>&gt; 25</td><td>10.0</td></tr> <tr> <td rowspan="5">1206<sup>3</sup></td><td>&lt; 16</td><td>&lt; 10 <math>\mu\text{F}</math></td><td>5.0</td></tr> <tr> <td>16 / 25</td><td>&lt; 10 <math>\mu\text{F}</math></td><td>3.5</td></tr> <tr> <td>&gt; 25</td><td>All</td><td>2.5</td></tr> <tr> <td>&lt; 16</td><td rowspan="2"><math>\geq 10 \mu\text{F}</math></td><td>10.0</td></tr> <tr> <td>16 / 25</td><td>10.0</td></tr> <tr> <td rowspan="5">1210<sup>4</sup></td><td>&lt; 16</td><td rowspan="3">&lt; 22 <math>\mu\text{F}</math></td><td>5.0</td></tr> <tr> <td>16 / 25</td><td>3.5</td></tr> <tr> <td>&gt; 25</td><td>2.5</td></tr> <tr> <td>&lt; 16</td><td rowspan="2"><math>\geq 22 \mu\text{F}</math></td><td>10.0</td></tr> <tr> <td>16 / 25</td><td>10.0</td></tr> <tr> <td rowspan="3">1805 – 2225</td><td>&lt; 16</td><td rowspan="3">All</td><td>5.0</td></tr> <tr> <td>16 / 25</td><td>3.5</td></tr> <tr> <td>&gt; 25</td><td>2.5</td></tr> </table> <p><sup>1</sup> For Capacitance values 0.22 <math>\mu\text{F}</math> (16 and 25 V) DF is 5%.<br/> <sup>2</sup> For Capacitance value 1.0 <math>\mu\text{F}</math> (16 and 25 V) DF is 5%.<br/> <sup>3</sup> For Capacitance value 2.2 <math>\mu\text{F}</math> (25 V) and <math>\geq 2.2 \mu\text{F}</math> (35 and 50 V) DF is 10%, for Capacitance Value 1.0 <math>\mu\text{F}</math> (100 V) DF is 5.0%.<br/> <sup>4</sup> For Capacitance value 10 <math>\mu\text{F}</math> (25 V) DF is 10%, for Capacitance value 10 <math>\mu\text{F}</math> (50 V) DF is 5%, for Capacitance value 4.7 <math>\mu\text{F}</math> (50 V) DF is 5%, for Capacitance value 2.2 <math>\mu\text{F}</math> (100 V) DF is 10%</p> | EIA Case Size | Rated DC Voltage | Capacitance | Dissipation Factor (Maximum %) | 0402 | < 16 | < 0.1 $\mu\text{F}$ | 5.0 | $\geq 0.1 \mu\text{F}$ | 10.0 | 16 | < 0.1 $\mu\text{F}$ | 3.5 | $\geq 0.1 \mu\text{F}$ | 10.0 | 25 | < 0.1 $\mu\text{F}$ | 3.5 | $\geq 0.1 \mu\text{F}$ | 10.0 | > 25 | All | 2.5 | 0603 <sup>1</sup> | < 16 | < 1.0 $\mu\text{F}$ | 5.0 | 16 / 25 | 3.5 | > 25 | 2.5 | < 16 | $\geq 1.0 \mu\text{F}$ | 10.0 | 16 / 25 | 10.0 | 0805 <sup>2</sup> | < 16 | < 2.2 $\mu\text{F}$ | 5.0 | 16 / 25 | < 2.2 $\mu\text{F}$ | 3.5 | > 25 | < 1.0 $\mu\text{F}$ | 2.5 | < 16 | $\geq 2.2 \mu\text{F}$ | 10.0 | 16 / 25 | 10.0 | > 25 | 10.0 | 1206 <sup>3</sup> | < 16 | < 10 $\mu\text{F}$ | 5.0 | 16 / 25 | < 10 $\mu\text{F}$ | 3.5 | > 25 | All | 2.5 | < 16 | $\geq 10 \mu\text{F}$ | 10.0 | 16 / 25 | 10.0 | 1210 <sup>4</sup> | < 16 | < 22 $\mu\text{F}$ | 5.0 | 16 / 25 | 3.5 | > 25 | 2.5 | < 16 | $\geq 22 \mu\text{F}$ | 10.0 | 16 / 25 | 10.0 | 1805 – 2225 | < 16 | All | 5.0 | 16 / 25 | 3.5 | > 25 | 2.5 |
| EIA Case Size           | Rated DC Voltage | Capacitance                                                                                                                                                                                                                                                                                                                                                                                                                                               | Dissipation Factor (Maximum %)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
| 0402                    | < 16             | < 0.1 $\mu\text{F}$                                                                                                                                                                                                                                                                                                                                                                                                                                       | 5.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         |                  | $\geq 0.1 \mu\text{F}$                                                                                                                                                                                                                                                                                                                                                                                                                                    | 10.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         | 16               | < 0.1 $\mu\text{F}$                                                                                                                                                                                                                                                                                                                                                                                                                                       | 3.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         |                  | $\geq 0.1 \mu\text{F}$                                                                                                                                                                                                                                                                                                                                                                                                                                    | 10.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         | 25               | < 0.1 $\mu\text{F}$                                                                                                                                                                                                                                                                                                                                                                                                                                       | 3.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         |                  | $\geq 0.1 \mu\text{F}$                                                                                                                                                                                                                                                                                                                                                                                                                                    | 10.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         | > 25             | All                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 2.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
| 0603 <sup>1</sup>       | < 16             | < 1.0 $\mu\text{F}$                                                                                                                                                                                                                                                                                                                                                                                                                                       | 5.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         | 16 / 25          |                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 3.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         | > 25             |                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 2.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         | < 16             | $\geq 1.0 \mu\text{F}$                                                                                                                                                                                                                                                                                                                                                                                                                                    | 10.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         | 16 / 25          |                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 10.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
| 0805 <sup>2</sup>       | < 16             | < 2.2 $\mu\text{F}$                                                                                                                                                                                                                                                                                                                                                                                                                                       | 5.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         | 16 / 25          | < 2.2 $\mu\text{F}$                                                                                                                                                                                                                                                                                                                                                                                                                                       | 3.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         | > 25             | < 1.0 $\mu\text{F}$                                                                                                                                                                                                                                                                                                                                                                                                                                       | 2.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         | < 16             | $\geq 2.2 \mu\text{F}$                                                                                                                                                                                                                                                                                                                                                                                                                                    | 10.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         | 16 / 25          |                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 10.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         | > 25             |                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 10.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
| 1206 <sup>3</sup>       | < 16             | < 10 $\mu\text{F}$                                                                                                                                                                                                                                                                                                                                                                                                                                        | 5.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         | 16 / 25          | < 10 $\mu\text{F}$                                                                                                                                                                                                                                                                                                                                                                                                                                        | 3.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         | > 25             | All                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 2.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         | < 16             | $\geq 10 \mu\text{F}$                                                                                                                                                                                                                                                                                                                                                                                                                                     | 10.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         | 16 / 25          |                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 10.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
| 1210 <sup>4</sup>       | < 16             | < 22 $\mu\text{F}$                                                                                                                                                                                                                                                                                                                                                                                                                                        | 5.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         | 16 / 25          |                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 3.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         | > 25             |                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 2.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         | < 16             | $\geq 22 \mu\text{F}$                                                                                                                                                                                                                                                                                                                                                                                                                                     | 10.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         | 16 / 25          |                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 10.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
| 1805 – 2225             | < 16             | All                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 5.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         | 16 / 25          |                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 3.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |
|                         | > 25             |                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 2.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |               |                  |             |                                |      |      |                     |     |                        |      |    |                     |     |                        |      |    |                     |     |                        |      |      |     |     |                   |      |                     |     |         |     |      |     |      |                        |      |         |      |                   |      |                     |     |         |                     |     |      |                     |     |      |                        |      |         |      |      |      |                   |      |                    |     |         |                    |     |      |     |     |      |                       |      |         |      |                   |      |                    |     |         |     |      |     |      |                       |      |         |      |             |      |     |     |         |     |      |     |

## X7R Performance and Reliability: SMD Test Methods and Conditions cont.

| Test                                                                                                            | Reference      | Test Condition                              | Limits                                                                                                                                                                                                                                          |                  |                                    |                                 |                                 |
|-----------------------------------------------------------------------------------------------------------------|----------------|---------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------------------------------|---------------------------------|---------------------------------|
| Insulation Resistance (IR)                                                                                      | KEMET Internal | Apply rated voltage for 120 seconds at 25°C | Within Specification                                                                                                                                                                                                                            |                  |                                    |                                 |                                 |
|                                                                                                                 |                |                                             | To obtain IR limit, divide MΩ - μF value by the capacitance and compare to GΩ limit.<br>Select the lower of the two limits.                                                                                                                     |                  |                                    |                                 |                                 |
|                                                                                                                 |                |                                             | Insulation Resistance (IR) Limits Table                                                                                                                                                                                                         |                  |                                    |                                 |                                 |
|                                                                                                                 |                |                                             | EIA Case Size                                                                                                                                                                                                                                   | Rated DC Voltage | 1,000 megohm microfarads or 100 GΩ | 500 megohm microfarads or 10 GΩ | 100 megohm microfarads or 10 GΩ |
|                                                                                                                 |                |                                             | 0402                                                                                                                                                                                                                                            | < 100 V          | < 0.012 μF                         | ≥ 0.012 μF < 0.47 μf            | ≥ 0.47 μf                       |
|                                                                                                                 |                |                                             |                                                                                                                                                                                                                                                 | 100 V            | N/A                                | ALL                             | N/A                             |
|                                                                                                                 |                |                                             | 0603 <sup>1</sup>                                                                                                                                                                                                                               | ≤ 200 V          | < 0.047 μF                         | ≥ 0.047 μf < 0.47 μf            | ≥ 0.47 μf                       |
|                                                                                                                 |                |                                             |                                                                                                                                                                                                                                                 | 250 V            | N/A                                | N/A                             | ALL                             |
|                                                                                                                 |                |                                             | 0805 <sup>2</sup>                                                                                                                                                                                                                               | ≤ 200 V          | < 0.15 μF                          | ≥ 0.15 μF < 2.2 μf              | ≥ 2.2 μf                        |
|                                                                                                                 |                |                                             |                                                                                                                                                                                                                                                 | 250 V            | < .027 μF                          | N/A                             | ≥ .027 μF                       |
|                                                                                                                 |                |                                             | 1206                                                                                                                                                                                                                                            | ≤ 200 V          | < 0.47 μF                          | ≥ 0.47 μF < 2.2 μf              | ≥ 2.2 μf                        |
|                                                                                                                 |                |                                             |                                                                                                                                                                                                                                                 | 250 V            | < 0.12 μF                          | N/A                             | ≥ 0.12 μF                       |
|                                                                                                                 |                |                                             | 1210 <sup>3</sup>                                                                                                                                                                                                                               | ≤ 200 V          | < 0.39 μF                          | ≥ 0.39 μF < 10 μf               | ≥ 10 μf                         |
|                                                                                                                 |                |                                             |                                                                                                                                                                                                                                                 | 250 V            | < 0.27 μF                          | N/A                             | ≥ 0.27 μF                       |
|                                                                                                                 |                |                                             | 1805                                                                                                                                                                                                                                            | ALL              | ALL                                | N/A                             | N/A                             |
|                                                                                                                 |                |                                             | 1808                                                                                                                                                                                                                                            | ALL              | ALL                                | N/A                             | N/A                             |
|                                                                                                                 |                |                                             | 1812                                                                                                                                                                                                                                            | ALL              | < 2.2 μF                           | ≥ 2.2 μF                        | N/A                             |
|                                                                                                                 |                |                                             | 1825                                                                                                                                                                                                                                            | ALL              | ALL                                | N/A                             | N/A                             |
|                                                                                                                 |                |                                             | 2220                                                                                                                                                                                                                                            | ALL              | < 10 μF                            | ≥ 10 μF                         | N/A                             |
|                                                                                                                 |                |                                             | 2225                                                                                                                                                                                                                                            | ALL              | ALL                                | N/A                             | N/A                             |
|                                                                                                                 |                |                                             | <sup>1</sup> For Capacitance value 10 nF (<= 100 V) IR should be calculated under 500 megohm microfarads or 10 GΩ. For Capacitance values 5.6 nF, 6.8 nF, 8.2 nF & 10 nF (100 V) IR should be calculated under 500 megohm microfarads or 10 GΩ. |                  |                                    |                                 |                                 |
|                                                                                                                 |                |                                             | <sup>2</sup> For Capacitance value 1.0 μF (50 V) IR should be calculated under 100 megohm microfarads or 10 GΩ. For Capacitance value 0.1 μF (<= 50 V ) IR should be calculated under 500 mohms or 10 GOhms                                     |                  |                                    |                                 |                                 |
| <sup>3</sup> For Capacitance value 4.7 μF (50 V) IR should be calculated under 100 megohm microfarads or 10 GΩ. |                |                                             |                                                                                                                                                                                                                                                 |                  |                                    |                                 |                                 |

## X7R Performance and Reliability: SMD Test Methods and Conditions cont.

| Test                                                | Reference         | Test Condition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Limits                                                                                                                             |                  |      |       |      |       |      |                   |      |        |                                       |     |                                  |
|-----------------------------------------------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|------------------|------|-------|------|-------|------|-------------------|------|--------|---------------------------------------|-----|----------------------------------|
| Temperature Coefficient of Capacitance (TCC)        | KEMET Internal    | <div>C ≤ 10μF<br/>Frequency: 1 kHz ±50 Hz<br/>Voltage*: 1.0 ±0.2 V<sub>rms</sub>, 0.5 ±0.2 V<sub>rms</sub>, 0.2 ±0.1 V<sub>rms</sub><br/>C &gt; 10μF<br/>Frequency: 120 Hz ±10 Hz<br/>Voltage: 0.5 ±0.1 V<sub>rms</sub></div> <div>* See part number specification sheet for voltage</div> <table><tr><th>Step</th><th>Temperature (°C)</th></tr><tr><td>1</td><td>+25°C</td></tr><tr><td>2</td><td>-55°C</td></tr><tr><td>3</td><td>+25°C (Reference)</td></tr><tr><td>4</td><td>+125°C</td></tr></table> | Step                                                                                                                               | Temperature (°C) | 1    | +25°C | 2    | -55°C | 3    | +25°C (Reference) | 4    | +125°C | Capacitance ±15% over -55°C to +125°C |     |                                  |
| Step                                                | Temperature (°C)  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                    |                  |      |       |      |       |      |                   |      |        |                                       |     |                                  |
| 1                                                   | +25°C             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                    |                  |      |       |      |       |      |                   |      |        |                                       |     |                                  |
| 2                                                   | -55°C             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                    |                  |      |       |      |       |      |                   |      |        |                                       |     |                                  |
| 3                                                   | +25°C (Reference) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                    |                  |      |       |      |       |      |                   |      |        |                                       |     |                                  |
| 4                                                   | +125°C            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                    |                  |      |       |      |       |      |                   |      |        |                                       |     |                                  |
| Dielectric Withstanding Voltage (DWV)               | KEMET Internal    | 250% of rated voltage<br>(5 ±1 seconds and charge/discharge not exceeding 50 mA)                                                                                                                                                                                                                                                                                                                                                                                                                           | Cap: Initial Limit<br>DF: Initial Limit<br>IR: Initial Limit<br><br>Withstand test voltage without insulation breakdown or damage. |                  |      |       |      |       |      |                   |      |        |                                       |     |                                  |
| Aging Rate (Maximum % Capacitance Loss/Decade Hour) | KEMET Internal    | Capacitance measurements (including tolerance) are indexed to a referee time of 48 or 1,000 hours.<br>Please refer to a part number specific datasheet for referee time details.                                                                                                                                                                                                                                                                                                                           | Please refer to a part number specification sheet for specific Aging rate                                                          |                  |      |       |      |       |      |                   |      |        |                                       |     |                                  |
| Terminal Strength                                   | KEMET Internal    | Shear stress test per specific case size, Time: 60±1 seconds<br><table><tr><th>Case Size</th><th>Force</th></tr><tr><td>0201</td><td>2N</td></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>18N</td></tr></table>                                                                                                                        | Case Size                                                                                                                          | Force            | 0201 | 2N    | 0402 | 3N    | 0603 | 5N                | 0805 | 9N     | ≥1206                                 | 18N | No evidence of mechanical damage |
| Case Size                                           | Force             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                    |                  |      |       |      |       |      |                   |      |        |                                       |     |                                  |
| 0201                                                | 2N                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                    |                  |      |       |      |       |      |                   |      |        |                                       |     |                                  |
| 0402                                                | 3N                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                    |                  |      |       |      |       |      |                   |      |        |                                       |     |                                  |
| 0603                                                | 5N                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                    |                  |      |       |      |       |      |                   |      |        |                                       |     |                                  |
| 0805                                                | 9N                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                    |                  |      |       |      |       |      |                   |      |        |                                       |     |                                  |
| ≥1206                                               | 18N               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                    |                  |      |       |      |       |      |                   |      |        |                                       |     |                                  |
| Board Flex                                          | AEC-Q200-005      | Standard Termination system 2.0 mm<br>Flexible Termination System 3.0 mm<br>Test time: 60± 5 seconds<br>Ramp time: 1 mm/second<br><br>(Unit : mm)                                                                                                                                                                                                                                                                      | No evidence of mechanical damage                                                                                                   |                  |      |       |      |       |      |                   |      |        |                                       |     |                                  |

## X7R Performance and Reliability: SMD Test Methods and Conditions cont.

| Test                     | Reference                 | Test Condition                                                                                                               | Limits                                                                                                                                                                                                                                                                                                                                                                                           |                          |  |         |      |     |     |     |     |     |     |      |      |
|--------------------------|---------------------------|------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--|---------|------|-----|-----|-----|-----|-----|-----|------|------|
| Solderability            | J-STD-002                 | Condition: 4 hours ± 15 minutes at 155°C dry bake apply all methods<br>Test 245 ±5°C (SnPb and Pb-Free)                      | Visual Inspection.<br>95% coverage on termination.<br>No leaching                                                                                                                                                                                                                                                                                                                                |                          |  |         |      |     |     |     |     |     |     |      |      |
| Temperature Cycling      | JESD22<br>Method JA-104   | 1,000 cycles (–55°C to +125°C)<br>2 – 3 cycles per hour<br>Soak Time 1 or 5 minutes                                          | Measurement at 24 hours ±4 hours after test conclusion.<br>Cap: Initial Limit<br>DF: Initial Limit<br>IR: Initial Limit                                                                                                                                                                                                                                                                          |                          |  |         |      |     |     |     |     |     |     |      |      |
| Biased Humidity          | MIL-STD-202<br>Method 103 | Load Humidity:<br>1,000 hours 85°C/85% RH and rated voltage.<br><br>Low Volt Humidity:<br>1,000 hours 85C°/85% RH and 1.5 V. | Measurement at 24 hours ±4 hours after test conclusion.<br>Within Post Environmental Limits<br>Cap: ±20% shift<br>IR: 10% of Initial Limit<br><table><tr><th colspan="2">DF Limits<br/>Maximum (%)</th></tr><tr><th>Initial</th><th>Post</th></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><tr><td>10.0</td><td>20.0</td></tr></table> | DF Limits<br>Maximum (%) |  | Initial | Post | 2.5 | 3.0 | 3.5 | 5.0 | 5.0 | 7.5 | 10.0 | 20.0 |
| DF Limits<br>Maximum (%) |                           |                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                  |                          |  |         |      |     |     |     |     |     |     |      |      |
| Initial                  | Post                      |                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                  |                          |  |         |      |     |     |     |     |     |     |      |      |
| 2.5                      | 3.0                       |                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                  |                          |  |         |      |     |     |     |     |     |     |      |      |
| 3.5                      | 5.0                       |                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                  |                          |  |         |      |     |     |     |     |     |     |      |      |
| 5.0                      | 7.5                       |                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                  |                          |  |         |      |     |     |     |     |     |     |      |      |
| 10.0                     | 20.0                      |                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                  |                          |  |         |      |     |     |     |     |     |     |      |      |
| Moisture Resistance      | MIL-STD-202<br>Method 106 | Number of cycles required 10, 24 hours per cycle.<br>Steps 7a and 7b not required.                                           | Measurement at 24 hours ±4 hours after test conclusion.<br>Within Post Environmental Limits<br>Cap: ±20% shift<br>IR: 10% of Initial Limit<br><table><tr><th colspan="2">DF Limits<br/>Maximum (%)</th></tr><tr><th>Initial</th><th>Post</th></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><tr><td>10.0</td><td>20.0</td></tr></table> | DF Limits<br>Maximum (%) |  | Initial | Post | 2.5 | 3.0 | 3.5 | 5.0 | 5.0 | 7.5 | 10.0 | 20.0 |
| DF Limits<br>Maximum (%) |                           |                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                  |                          |  |         |      |     |     |     |     |     |     |      |      |
| Initial                  | Post                      |                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                  |                          |  |         |      |     |     |     |     |     |     |      |      |
| 2.5                      | 3.0                       |                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                  |                          |  |         |      |     |     |     |     |     |     |      |      |
| 3.5                      | 5.0                       |                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                  |                          |  |         |      |     |     |     |     |     |     |      |      |
| 5.0                      | 7.5                       |                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                  |                          |  |         |      |     |     |     |     |     |     |      |      |
| 10.0                     | 20.0                      |                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                  |                          |  |         |      |     |     |     |     |     |     |      |      |
| Thermal Shock            | MIL-STD-202<br>Method 107 | Number of cycles required 5, (–55°C to 125°C)<br>Dwell time 15 minutes.                                                      | Cap: Initial Limit<br>DF: Initial Limit<br>IR: Initial Limit                                                                                                                                                                                                                                                                                                                                     |                          |  |         |      |     |     |     |     |     |     |      |      |

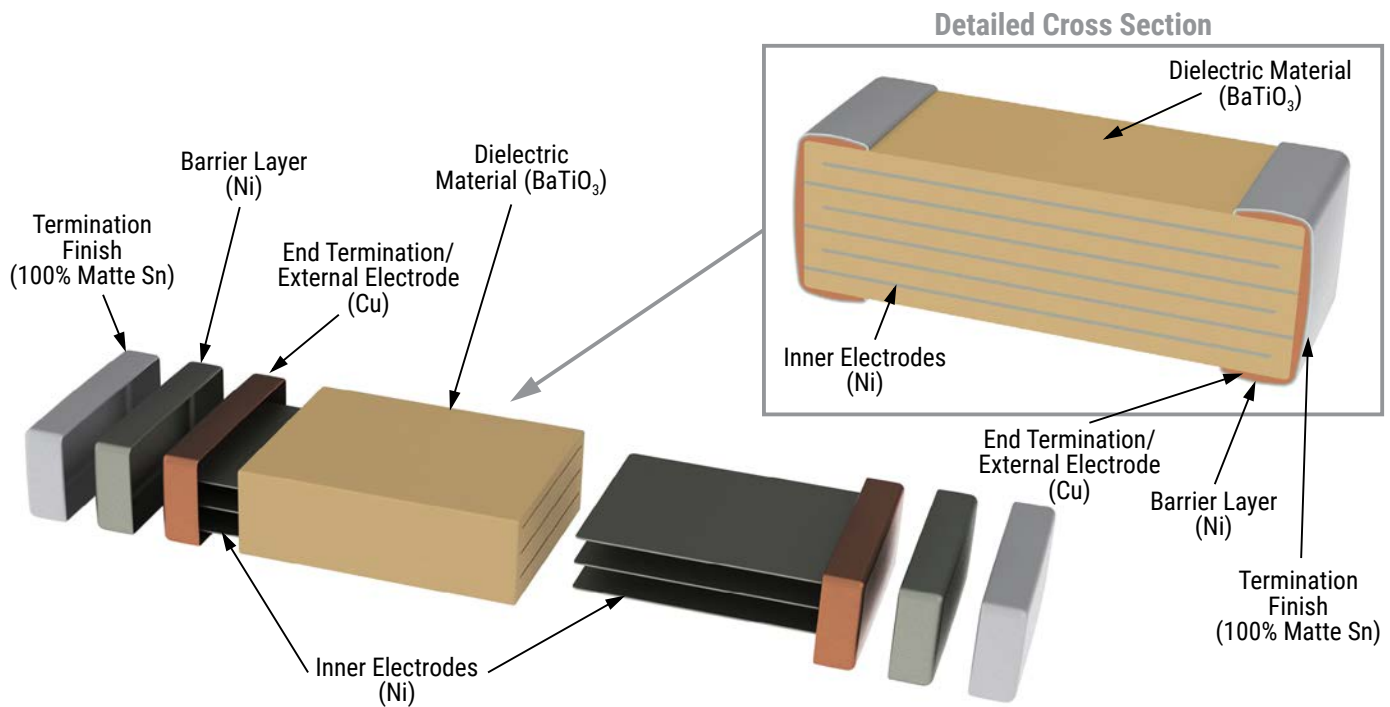
## X7R Performance and Reliability: SMD Test Methods and Conditions cont.

| Test                   | Reference                       | Test Condition                                                                                                                                                                                                                                                                                   | Limits                                                                                          |             |                 |             |          |       |             |         |                                                                                                                                                                                                                                                                                                                                                           |                       |  |         |      |     |     |     |     |     |     |      |      |
|------------------------|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------|-----------------|-------------|----------|-------|-------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--|---------|------|-----|-----|-----|-----|-----|-----|------|------|
| High Temperature Life  | MIL-STD-202 Method 108          | 1,000 hours at 125°C with 2 X rated voltage applied excluding the following: <table><tr><th>Case Size</th><th>Capacitance</th><th>Applied Voltage</th></tr><tr><td>0603 &amp; 0805</td><td>≥ 1.0 μF</td><td rowspan="2">1.5 X</td></tr><tr><td>1206 &amp; 1210</td><td>≥ 10 μF</td></tr></table> | Case Size                                                                                       | Capacitance | Applied Voltage | 0603 & 0805 | ≥ 1.0 μF | 1.5 X | 1206 & 1210 | ≥ 10 μF | <div>Within Post Environmental Limits</div> <div>Cap: ±20% shift</div> <div>IR: 10% of Initial Limit</div> <table><tr><th colspan="2">DF Limits Maximum (%)</th></tr><tr><th>Initial</th><th>Post</th></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><tr><td>10.0</td><td>20.0</td></tr></table> | DF Limits Maximum (%) |  | Initial | Post | 2.5 | 3.0 | 3.5 | 5.0 | 5.0 | 7.5 | 10.0 | 20.0 |
| Case Size              |                                 | Capacitance                                                                                                                                                                                                                                                                                      | Applied Voltage                                                                                 |             |                 |             |          |       |             |         |                                                                                                                                                                                                                                                                                                                                                           |                       |  |         |      |     |     |     |     |     |     |      |      |
| 0603 & 0805            |                                 | ≥ 1.0 μF                                                                                                                                                                                                                                                                                         | 1.5 X                                                                                           |             |                 |             |          |       |             |         |                                                                                                                                                                                                                                                                                                                                                           |                       |  |         |      |     |     |     |     |     |     |      |      |
| 1206 & 1210            | ≥ 10 μF                         |                                                                                                                                                                                                                                                                                                  |                                                                                                 |             |                 |             |          |       |             |         |                                                                                                                                                                                                                                                                                                                                                           |                       |  |         |      |     |     |     |     |     |     |      |      |
| DF Limits Maximum (%)  |                                 |                                                                                                                                                                                                                                                                                                  |                                                                                                 |             |                 |             |          |       |             |         |                                                                                                                                                                                                                                                                                                                                                           |                       |  |         |      |     |     |     |     |     |     |      |      |
| Initial                | Post                            |                                                                                                                                                                                                                                                                                                  |                                                                                                 |             |                 |             |          |       |             |         |                                                                                                                                                                                                                                                                                                                                                           |                       |  |         |      |     |     |     |     |     |     |      |      |
| 2.5                    | 3.0                             |                                                                                                                                                                                                                                                                                                  |                                                                                                 |             |                 |             |          |       |             |         |                                                                                                                                                                                                                                                                                                                                                           |                       |  |         |      |     |     |     |     |     |     |      |      |
| 3.5                    | 5.0                             |                                                                                                                                                                                                                                                                                                  |                                                                                                 |             |                 |             |          |       |             |         |                                                                                                                                                                                                                                                                                                                                                           |                       |  |         |      |     |     |     |     |     |     |      |      |
| 5.0                    | 7.5                             |                                                                                                                                                                                                                                                                                                  |                                                                                                 |             |                 |             |          |       |             |         |                                                                                                                                                                                                                                                                                                                                                           |                       |  |         |      |     |     |     |     |     |     |      |      |
| 10.0                   | 20.0                            |                                                                                                                                                                                                                                                                                                  |                                                                                                 |             |                 |             |          |       |             |         |                                                                                                                                                                                                                                                                                                                                                           |                       |  |         |      |     |     |     |     |     |     |      |      |
| Storage Life           | 1,000 hours at 125°C, Unpowered |                                                                                                                                                                                                                                                                                                  |                                                                                                 |             |                 |             |          |       |             |         |                                                                                                                                                                                                                                                                                                                                                           |                       |  |         |      |     |     |     |     |     |     |      |      |
| Vibration              | MIL-STD-202 Method 204          | 5 g's for 20 minutes, 12 cycles each of 3 orientations.<br>Test from 10 – 2,000 Hz                                                                                                                                                                                                               | Cap: Initial Limit<br>DF: Initial Limit<br>IR: Initial Limit                                    |             |                 |             |          |       |             |         |                                                                                                                                                                                                                                                                                                                                                           |                       |  |         |      |     |     |     |     |     |     |      |      |
| Mechanical Shock       | MIL-STD-202 Method 213          | 1,500 g's 0.5 ms Half-sine,<br>Velocity Change 15.4 feet/second<br>(Condition F)                                                                                                                                                                                                                 | Cap: Initial Limit<br>DF: Initial Limit<br>IR: Initial Limit                                    |             |                 |             |          |       |             |         |                                                                                                                                                                                                                                                                                                                                                           |                       |  |         |      |     |     |     |     |     |     |      |      |
| Resistance to Solvents | MIL-STD-202 Method 215          | Add Aqueous wash chemical OKEMCLEAN<br>(A 6% concentrated Oakite cleaner) or equivalent.<br>Do not use banned solvents.                                                                                                                                                                          | Visual Inspection 10X<br>Readable marking,<br>no decoloration or stains.<br>No physical damage. |             |                 |             |          |       |             |         |                                                                                                                                                                                                                                                                                                                                                           |                       |  |         |      |     |     |     |     |     |     |      |      |

## 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)



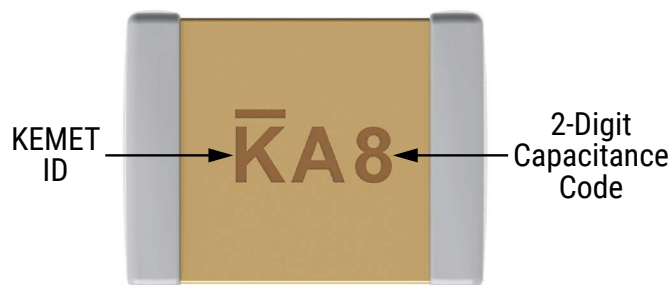
## Capacitor Marking (Optional)

These surface mount multilayer ceramic capacitors are normally supplied unmarked. If required, they can be marked as an extra cost option. Marking is available on most KEMET devices, but must be requested using the correct ordering code identifier(s). If this option is requested, two sides of the ceramic body will be laser marked with a “K” to identify KEMET, followed by two characters (per EIA-198 - see table below) to identify the capacitance value. EIA 0603 case size devices are limited to the “K” character only.

Laser marking option is not available on:

- C0G, 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.
- X7R dielectric products in capacitance values outlined below.

Marking appears in legible contrast. Illustrated below is an example of an MLCC with laser marking of “KA8”, which designates a KEMET device with rated capacitance of 100  $\mu$ F. Orientation of marking is vendor optional.



| EIA Case Size | Metric Size Code | Capacitance          |
|---------------|------------------|----------------------|
| 0603          | 1608             | $\leq 170$ pF        |
| 0805          | 2012             | $\leq 150$ pF        |
| 1206          | 3216             | $\leq 910$ pF        |
| 1210          | 3225             | $\leq 2,000$ pF      |
| 1808          | 4520             | $\leq 3,900$ pF      |
| 1812          | 4532             | $\leq 6,700$ pF      |
| 1825          | 4564             | $\leq 0.018$ $\mu$ F |
| 2220          | 5650             | $\leq 0.027$ $\mu$ F |
| 2225          | 5664             | $\leq 0.033$ $\mu$ F |

## Capacitor Marking (Optional) cont.

| Capacitance (pF) For Various Alpha/Numeral Identifiers |         |     |    |     |       |        |         |           |            |             |
|--------------------------------------------------------|---------|-----|----|-----|-------|--------|---------|-----------|------------|-------------|
| Alpha Character                                        | Numeral |     |    |     |       |        |         |           |            |             |
|                                                        | 9       | 0   | 1  | 2   | 3     | 4      | 5       | 6         | 7          | 8           |
| Capacitance (pF)                                       |         |     |    |     |       |        |         |           |            |             |
| A                                                      | 0.10    | 1.0 | 10 | 100 | 1,000 | 10,000 | 100,000 | 1,000,000 | 10,000,000 | 100,000,000 |
| B                                                      | 0.11    | 1.1 | 11 | 110 | 1,100 | 11,000 | 110,000 | 1,100,000 | 11,000,000 | 110,000,000 |
| C                                                      | 0.12    | 1.2 | 12 | 120 | 1,200 | 12,000 | 120,000 | 1,200,000 | 12,000,000 | 120,000,000 |
| D                                                      | 0.13    | 1.3 | 13 | 130 | 1,300 | 13,000 | 130,000 | 1,300,000 | 13,000,000 | 130,000,000 |
| E                                                      | 0.15    | 1.5 | 15 | 150 | 1,500 | 15,000 | 150,000 | 1,500,000 | 15,000,000 | 150,000,000 |
| F                                                      | 0.16    | 1.6 | 16 | 160 | 1,600 | 16,000 | 160,000 | 1,600,000 | 16,000,000 | 160,000,000 |
| G                                                      | 0.18    | 1.8 | 18 | 180 | 1,800 | 18,000 | 180,000 | 1,800,000 | 18,000,000 | 180,000,000 |
| H                                                      | 0.20    | 2.0 | 20 | 200 | 2,000 | 20,000 | 200,000 | 2,000,000 | 20,000,000 | 200,000,000 |
| J                                                      | 0.22    | 2.2 | 22 | 220 | 2,200 | 22,000 | 220,000 | 2,200,000 | 22,000,000 | 220,000,000 |
| K                                                      | 0.24    | 2.4 | 24 | 240 | 2,400 | 24,000 | 240,000 | 2,400,000 | 24,000,000 | 240,000,000 |
| L                                                      | 0.27    | 2.7 | 27 | 270 | 2,700 | 27,000 | 270,000 | 2,700,000 | 27,000,000 | 270,000,000 |
| M                                                      | 0.30    | 3.0 | 30 | 300 | 3,000 | 30,000 | 300,000 | 3,000,000 | 30,000,000 | 300,000,000 |
| N                                                      | 0.33    | 3.3 | 33 | 330 | 3,300 | 33,000 | 330,000 | 3,300,000 | 33,000,000 | 330,000,000 |
| P                                                      | 0.36    | 3.6 | 36 | 360 | 3,600 | 36,000 | 360,000 | 3,600,000 | 36,000,000 | 360,000,000 |
| Q                                                      | 0.39    | 3.9 | 39 | 390 | 3,900 | 39,000 | 390,000 | 3,900,000 | 39,000,000 | 390,000,000 |
| R                                                      | 0.43    | 4.3 | 43 | 430 | 4,300 | 43,000 | 430,000 | 4,300,000 | 43,000,000 | 430,000,000 |
| S                                                      | 0.47    | 4.7 | 47 | 470 | 4,700 | 47,000 | 470,000 | 4,700,000 | 47,000,000 | 470,000,000 |
| T                                                      | 0.51    | 5.1 | 51 | 510 | 5,100 | 51,000 | 510,000 | 5,100,000 | 51,000,000 | 510,000,000 |
| U                                                      | 0.56    | 5.6 | 56 | 560 | 5,600 | 56,000 | 560,000 | 5,600,000 | 56,000,000 | 560,000,000 |
| V                                                      | 0.62    | 6.2 | 62 | 620 | 6,200 | 62,000 | 620,000 | 6,200,000 | 62,000,000 | 620,000,000 |
| W                                                      | 0.68    | 6.8 | 68 | 680 | 6,800 | 68,000 | 680,000 | 6,800,000 | 68,000,000 | 680,000,000 |
| X                                                      | 0.75    | 7.5 | 75 | 750 | 7,500 | 75,000 | 750,000 | 7,500,000 | 75,000,000 | 750,000,000 |
| Y                                                      | 0.82    | 8.2 | 82 | 820 | 8,200 | 82,000 | 820,000 | 8,200,000 | 82,000,000 | 820,000,000 |
| Z                                                      | 0.91    | 9.1 | 91 | 910 | 9,100 | 91,000 | 910,000 | 9,100,000 | 91,000,000 | 910,000,000 |
| a                                                      | 0.25    | 2.5 | 25 | 250 | 2,500 | 25,000 | 250,000 | 2,500,000 | 25,000,000 | 250,000,000 |
| b                                                      | 0.35    | 3.5 | 35 | 350 | 3,500 | 35,000 | 350,000 | 3,500,000 | 35,000,000 | 350,000,000 |
| d                                                      | 0.40    | 4.0 | 40 | 400 | 4,000 | 40,000 | 400,000 | 4,000,000 | 40,000,000 | 400,000,000 |
| e                                                      | 0.45    | 4.5 | 45 | 450 | 4,500 | 45,000 | 450,000 | 4,500,000 | 45,000,000 | 450,000,000 |
| f                                                      | 0.50    | 5.0 | 50 | 500 | 5,000 | 50,000 | 500,000 | 5,000,000 | 50,000,000 | 500,000,000 |
| m                                                      | 0.60    | 6.0 | 60 | 600 | 6,000 | 60,000 | 600,000 | 6,000,000 | 60,000,000 | 600,000,000 |
| n                                                      | 0.70    | 7.0 | 70 | 700 | 7,000 | 70,000 | 700,000 | 7,000,000 | 70,000,000 | 700,000,000 |
| t                                                      | 0.80    | 8.0 | 80 | 800 | 8,000 | 80,000 | 800,000 | 8,000,000 | 80,000,000 | 800,000,000 |
| y                                                      | 0.90    | 9.0 | 90 | 900 | 9,000 | 90,000 | 900,000 | 9,000,000 | 90,000,000 | 900,000,000 |

## Tape & Reel Packaging Information

KEMET offers multilayer ceramic chip capacitors packaged in 8, 12 and 16 mm tape on 7" and 13" reels in accordance with EIA Standard 481. This packaging system is compatible with all tape-fed automatic pick and place systems. See Table 2 for details on reeling quantities for commercial chips.

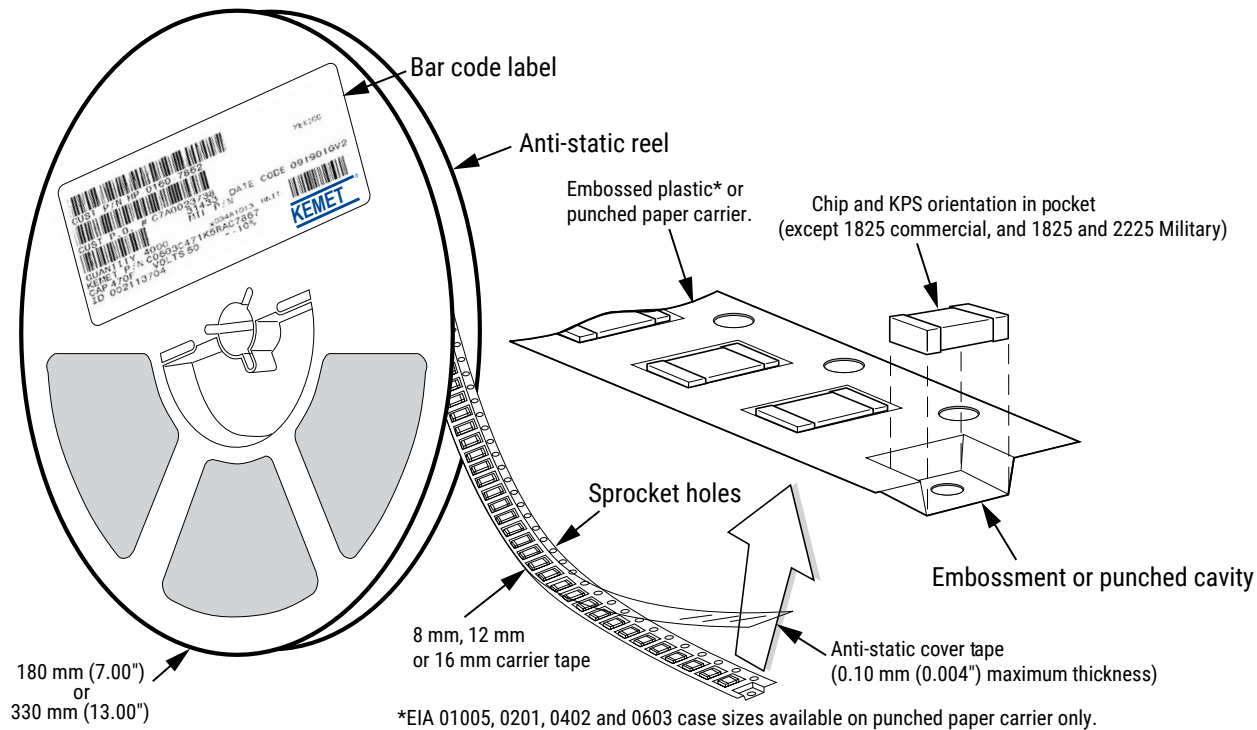


**Table 5 – Carrier Tape Configuration, Embossed Plastic & Punched Paper (mm)**

| EIA Case Size     | Tape Size (W)* | Embossed Plastic         |          | Punched Paper            |          |
|-------------------|----------------|--------------------------|----------|--------------------------|----------|
|                   |                | 7" Reel                  | 13" Reel | 7" Reel                  | 13" Reel |
|                   |                | Pitch (P <sub>1</sub> )* |          | Pitch (P <sub>1</sub> )* |          |
| 01005 – 0402      | 8              |                          |          | 2                        | 2        |
| 0603              | 8              |                          |          | 2/4                      | 2/4      |
| 0805              | 8              | 4                        | 4        | 4                        | 4        |
| 1206 – 1210       | 8              | 4                        | 4        | 4                        | 4        |
| 1805 – 1808       | 12             | 4                        | 4        |                          |          |
| ≥ 1812            | 12             | 8                        | 8        |                          |          |
| KPS 1210          | 12             | 8                        | 8        |                          |          |
| KPS 1812 and 2220 | 16             | 12                       | 12       |                          |          |
| Array 0612        | 8              | 4                        | 4        |                          |          |

### New 2 mm Pitch Reel Options\*

| Packaging Ordering Code (C-Spec) | Packaging Type/Options             |
|----------------------------------|------------------------------------|
| C-3190                           | Automotive grade 7" reel unmarked  |
| C-3191                           | Automotive grade 13" reel unmarked |
| C-7081                           | Commercial grade 7" reel unmarked  |
| C-7082                           | Commercial grade 13" reel unmarked |

\* 2 mm pitch reel only available for 0603 EIA case size.

2 mm pitch reel for 0805 EIA case size under development.

### Benefits of Changing from 4 mm to 2 mm Pitching Spacing

- Lower placement costs.
- Double the parts on each reel results in fewer reel changes and increased efficiency.
- Fewer reels result in lower packaging, shipping and storage costs, reducing waste.

\*Refer to Figures 1 and 2 for W and P<sub>1</sub> carrier tape reference locations.

\*Refer to Tables 6 and 7 for tolerance specifications.

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

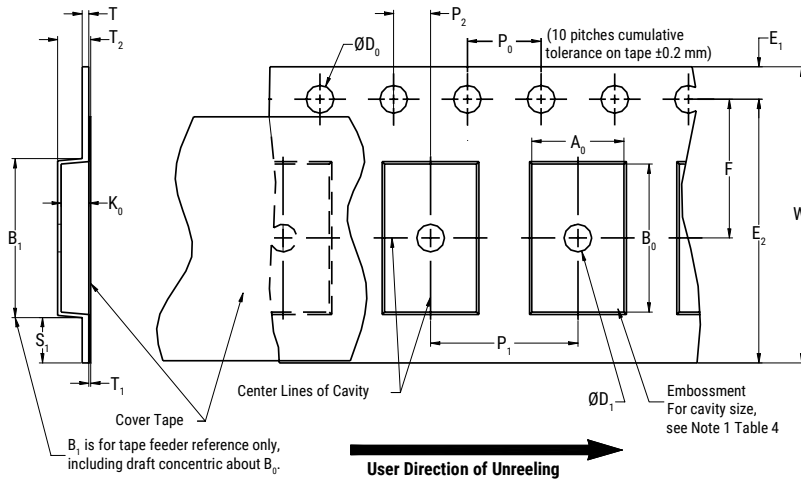


**Table 6 – Embossed (Plastic) Carrier Tape Dimensions**  
Metric will govern

| Constant Dimensions – Millimeters (Inches) |                                       |                                  |                              |                             |                              |                           |                                  |                                                  |                           |
|--------------------------------------------|---------------------------------------|----------------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|----------------------------------|--------------------------------------------------|---------------------------|
| Tape Size                                  | D <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<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><br>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)<br>and 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 the embossment location and the hole location shall be applied independently of each other.
2. The tape with or without components shall pass around R without damage (see Figure 6.)
3. If  $S_1 < 1.0$  mm, there may not be enough area for a cover tape to be properly applied (see EIA Standard 481, paragraph 4.3, section b.)
4.  $B_1$  dimension is a reference dimension for tape feeder clearance only.
5. The cavity defined by  $A_0$ ,  $B_0$  and  $K_0$  shall surround the component with sufficient clearance that:
  - (a) the component does not protrude above the top surface of the carrier tape.
  - (b) the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.
  - (c) rotation of the component is limited to 20° maximum for 8 and 12 mm tapes and 10° maximum for 16 mm tapes (see Figure 3.)
  - (d) lateral movement of the component is restricted to 0.5 mm maximum for 8 and 12 mm wide tape and to 1.0 mm maximum for 16 mm tape (see Figure 4.)
  - (e) for KPS product,  $A_0$  and  $B_0$  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.

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

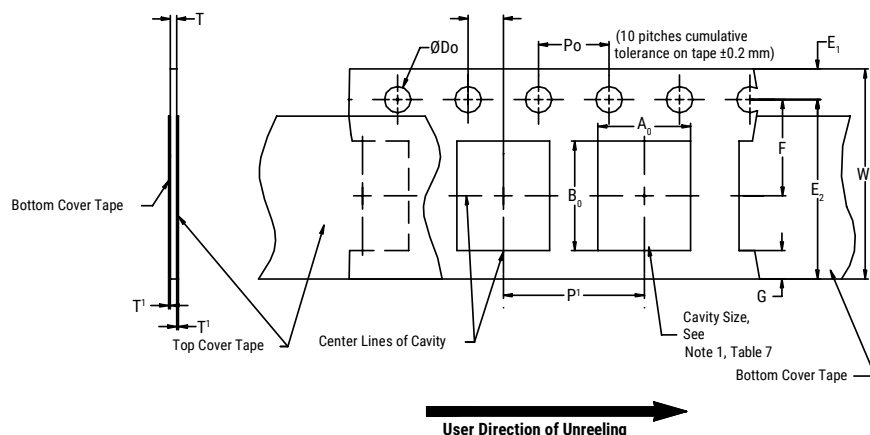


**Table 7 – Punched (Paper) Carrier Tape Dimensions**

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                                       | $1.5 +0.10 -0.0$<br>(0.059 +0.004 -0.0) | $1.75 \pm 0.10$<br>(0.069 ±0.004) | $4.0 \pm 0.10$<br>(0.157 ±0.004) | $2.0 \pm 0.05$<br>(0.079 ±0.002) | $0.10$<br>(0.004)<br>maximum | $0.75$<br>(0.030) | $25$<br>(0.984)    |
| Variable Dimensions – Millimeters (Inches) |                                         |                                   |                                  |                                  |                              |                   |                    |
| Tape Size                                  | Pitch                                   | E2 Minimum                        | F                                | $P_1$                            | T Maximum                    | W Maximum         | $A_0 B_0$          |
| 8 mm                                       | Half (2 mm)                             | $6.25$<br>(0.246)                 | $3.5 \pm 0.05$<br>(0.138 ±0.002) | $2.0 \pm 0.05$<br>(0.079 ±0.002) | $1.1$<br>(0.098)             | $8.3$<br>(0.327)  | Note 1             |
| 8 mm                                       | Single (4 mm)                           |                                   |                                  | $4.0 \pm 0.10$<br>(0.157 ±0.004) |                              | $8.3$<br>(0.327)  |                    |

- The cavity defined by  $A_0$ ,  $B_0$  and  $T$  shall surround the component with sufficient clearance that:
  - the component does not protrude beyond either surface of the carrier tape.
  - the component can be removed from the cavity in a vertical direction without mechanical restriction, after the top cover tape has been removed.
  - rotation of the component is limited to 20° maximum (see Figure 3.)
  - lateral movement of the component is restricted to 0.5 mm maximum (see Figure 4.)
  - see addendum in EIA Standard 481 for standards relating to more precise taping requirements.
- The tape with or without components shall pass around R without damage (see Figure 6.)

## Packaging Information Performance Notes

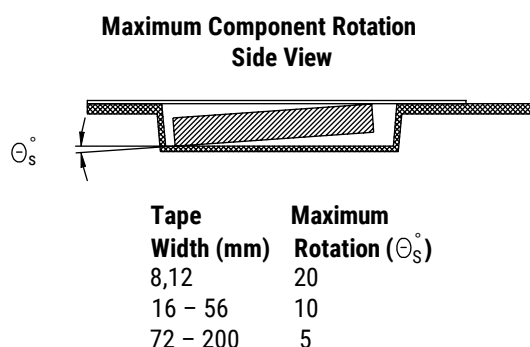
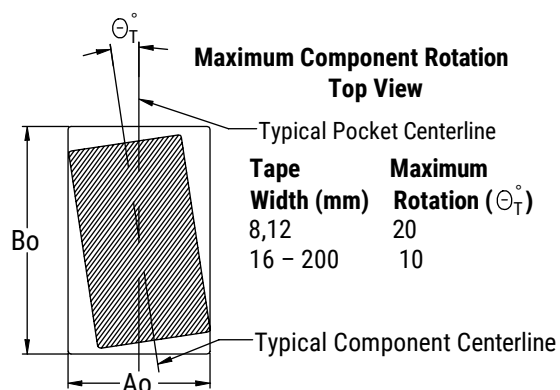
- 1. Cover Tape Break Force:** 1.0 kg minimum.
- 2. Cover Tape Peel Strength:** The total peel strength of the cover tape from the carrier tape shall be:

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

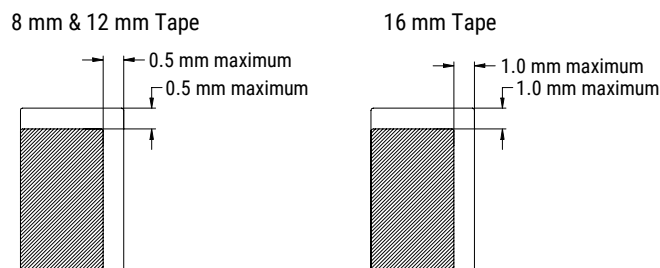
The direction of the pull shall be opposite the direction of the carrier tape travel. The pull angle of the carrier tape shall be 165° to 180° from the plane of the carrier tape. During peeling, the carrier and/or cover tape shall be pulled at a velocity of 300 ±10 mm/minute.

- 3. Labeling:** Bar code labeling (standard or custom) shall be on the side of the reel opposite the sprocket holes. *Refer to EIA Standards 556 and 624.*

## Figure 3 – Maximum Component Rotation



## Figure 4 – Maximum Lateral Movement



## Figure 5 – Bending Radius

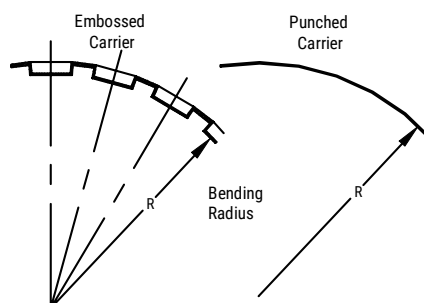
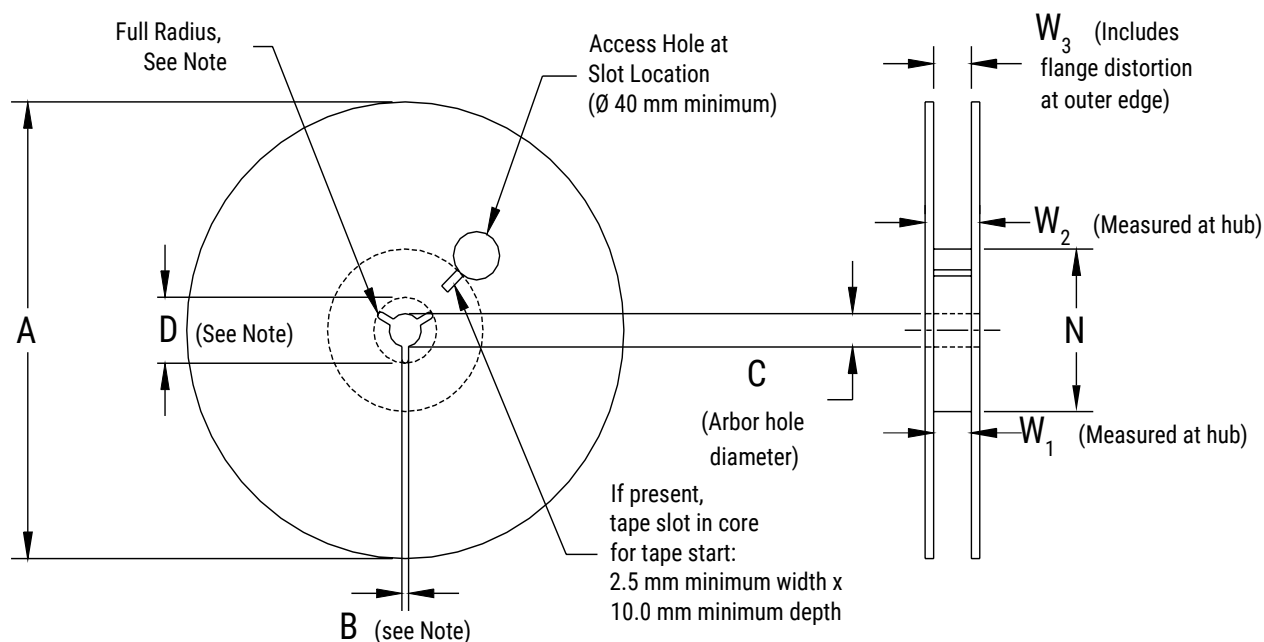


**Figure 6 – Reel Dimensions**



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

**Table 8 – Reel Dimensions**

Metric will govern

| Constant Dimensions – Millimeters (Inches) |                                                                   |                                       |                                        |                                                   |
|--------------------------------------------|-------------------------------------------------------------------|---------------------------------------|----------------------------------------|---------------------------------------------------|
| Tape Size                                  | A                                                                 | B Minimum                             | C                                      | D Minimum                                         |
| 8 mm                                       | 178 ±0.20<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 <sub>1</sub>                        | W <sub>2</sub> Maximum                 | W <sub>3</sub>                                    |
| 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 7 – Tape Leader & Trailer Dimensions**

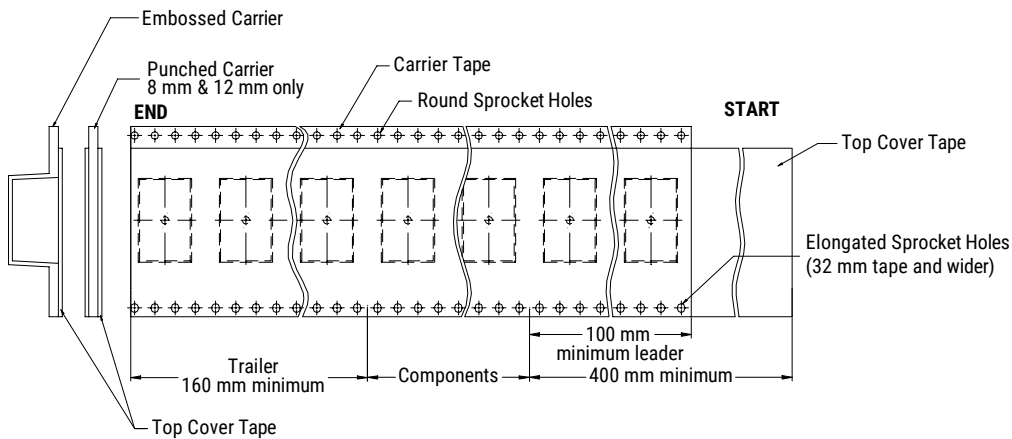
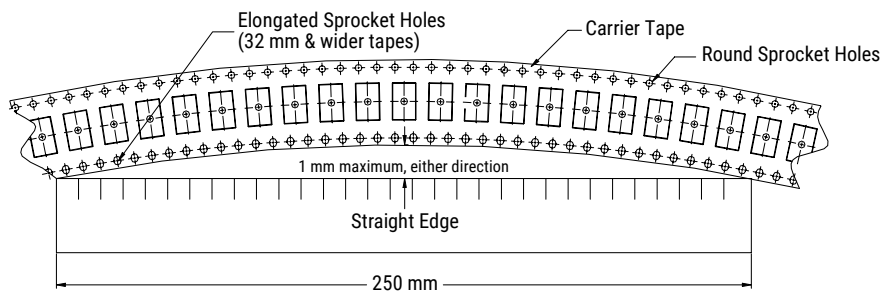


**Figure 8 – Maximum Camber**



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[C0402C222K5RACTU](#) [C0402C181K5RACTU](#) [C0402C181M5RACTU](#) [C0402C152J5RACTU](#) [C0402C152K5RACTU](#)  
[C0402C271J5RACTU](#) [C0402C271K5RACTU](#) [C0402C271K8RACTU](#) [C0402C271M5RACTU](#) [C0402C272J3RACTU](#)  
[C0402C331J5RACTU](#) [C0402C392K3RACTU](#) [C0402C392K5RACTU](#) [C0402C562J4RACTU](#) [C0402C562K3RACTU](#)  
[C0402C562K5RACTU](#) [C0402C682K5RACTU](#) [C0402C272K3RACTU](#) [C0402C272K5RACTU](#) [C0402C331K5RACTU](#)  
[C0402C331M5RACTU](#) [C0402C332J4RACTU](#) [C0402C332K3RACTU](#) [C0402C332K4RACTU](#) [C0402C332K5RACTU](#)  
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[C0603C102J5RAC](#) [C0603C102J5RACTM](#) [C0603C102J5RACTU](#) [C0603C102K1RACTU](#) [C0603C102K2RACTU](#)  
[C0603C102K3RACTM](#) [C0603C102K3RACTU](#) [C0603C102K4RACTM](#) [C0603C102K4RACTU](#) [C0603C102K5RAC7040](#)  
[C0603C102K5RAC7411](#) [C0603C102K5RAC9028](#) [C0603C102K5RACTM](#) [C0603C102K5RACTU](#)  
[C0402C391J5RACTU](#) [C0402C391K5RACTU](#) [C0402C392J3RACTU](#) [C0402C471J5RACTU](#) [C0402C471K3RACTU](#)  
[C0402C471K5RACTU](#) [C0402C471M5RACTU](#) [C0402C472J3RACTU](#) [C0402C472K3RACTU](#) [C0402C472K5RACTU](#)  
[C0402C561J5RACTU](#) [C0402C561K5RACTU](#) [C0402C681J5RACTU](#) [C0402C681K5RACTU](#) [C0402C681M5RACTU](#)  
[C0402C682J3RACTU](#) [C0402C682K3RACTU](#) [C0603C102K8RACTU](#) [C0603C102K9RACTU](#) [C0603C102M1RACTU](#)  
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[C0603C103K4RACTU](#)