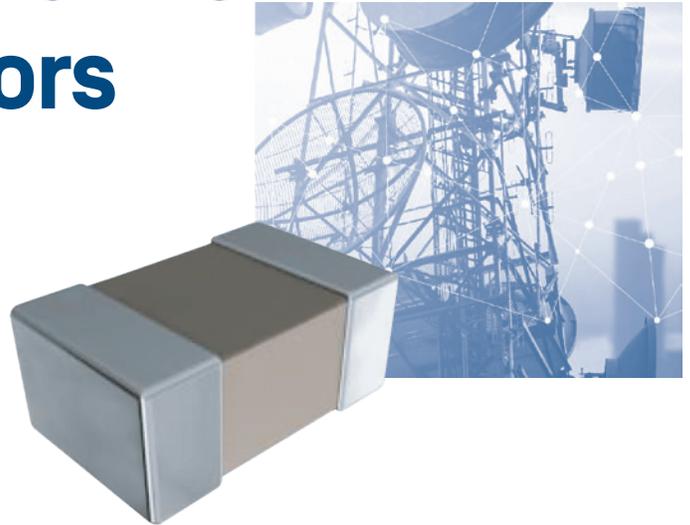


Technical data sheet

# Multilayer Ceramic Chip Capacitors [G Series]

Size 0402~2225, COG/X7R, 100Vdc~630Vdc



Quantic UTC's multilayer ceramic chip capacitors, available in bulk or tape & reel packages, are ideally suited for thick-film hybrid circuits and automatic surface mounting on any printed circuit boards.

The nickel-barrier terminations consist of a nickel barrier layer over the copper metallization, finished by an electroplated solder tin layer to ensure good solderability. The nickel barrier layer in the terminations prevents the dissolution of the termination during extended immersion in molten solder at elevated solder temperatures.

## Features

- A wide selection of sizes is available (0402 to 2225).
- High capacitance in given case size.
- Capacitor with lead-free termination.
- RoHS & HALOGEN compliant.

## Applications

- *For general digital circuit.*
- *For power supply bypass capacitors.*
- *For consumer electronics.*
- *For telecommunication.*
- *DC to DC converter.*



Quantic UTC is a global capacitor provider manufacturing multilayer ceramic capacitors (MLCCs) and leaded devices for use in defense, aerospace, computer, telecommunications, industrial and various high reliability applications. Our offerings include surface mount (SMT) multi-layer ceramic chip capacitors in both custom and EIA standard sizes; switch mode power supply (SMPS) capacitors in accordance with MIL-PRF-49470 and DSCC/DLA 87106, 88011 drawings and customer source controlled drawings (SCDs); SMT high voltage MLCC; radial leaded high voltage capacitors; SMD large body size MLCC; discoidal capacitors; discoidal arrays; and custom molded case radial parts.

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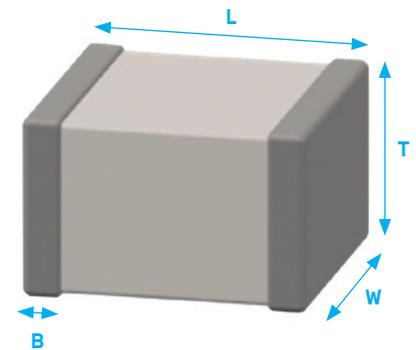
**Quantic™ UTC**

## How to Order

| <b>G</b>      | <b>B</b>      | <b>1812</b> | <b>X7R</b> | <b>102</b>        | <b>K</b>   | <b>W</b>    | <b>T</b>       | <b>-X</b>    |
|---------------|---------------|-------------|------------|-------------------|------------|-------------|----------------|--------------|
| Series        | Rated Voltage | Size Inch   | Dielectric | Capacitance       | Tolerance  | Termination | Packaging      | Special code |
| G=MLCC        | B=100         | 0402        | COG        | Two significant   | A=±0.05pF  | W= Cu/Ni/Sn | T= Tape & Reel | -X           |
| General Type  | R=200         | 0603        | X7R        | digits followed   | B=±0.1pF   | B=Soft      |                |              |
| (Mid-Voltage) | H=250         | 0805        |            | by no. of zeros.  | C=±0.25pF  | termination |                |              |
|               | N=400         | 1206        |            | And R is in place | D=±0.5pF   |             |                |              |
|               | S=500         | 1210        |            | of decimal point. | F=±1%      |             |                |              |
|               | K=630         | 1808        |            |                   | G=±2%      |             |                |              |
|               |               | 1812        |            | eg.:              | J=±5%      |             |                |              |
|               |               | 1825        |            | 0R5=0.5pF         | K=±10%     |             |                |              |
|               |               | 2220        |            | 1R0=1.0pF         | M=±20%     |             |                |              |
|               |               | 2225        |            | 100=10x100        | Z=-20%+80% |             |                |              |
|               |               |             |            | =10pF             |            |             |                |              |

## Thickness Description

| Code | Description         | Code | Description        | Code | Description         |
|------|---------------------|------|--------------------|------|---------------------|
| A    | 0.60 ± 0.10 mm      | I    | 1.25 ± 0.20 mm     | Q    | 0.50 +0.02/-0.05 mm |
| B    | 0.8 + 0.15/-0.10 mm | J    | 1.15 ± 0.15 mm     | R    | 3.10 ± 0.30 mm      |
| C    | 1.25 ± 0.10 mm      | K    | 0.50 ± 0.20 mm     | S    | 0.80 ± 0.07 mm      |
| D    | 1.40 ± 0.15 mm      | L    | 0.30 ± 0.03 mm     | T    | 0.85 ± 0.10 mm      |
| E    | 1.60 ± 0.20 mm      | M    | 0.95 ± 0.10 mm     | U    | 0.50 ± 0.10 mm      |
| F    | 2.00 ± 0.20 mm      | N    | 0.50 ± 0.05 mm     | V    | 0.20 ± 0.02 mm      |
| G    | 2.50 ± 0.30 mm      | O    | 3.50 ± 0.20 mm     | X    | 0.80 ± 0.10 mm      |
| H    | 2.80 ± 0.30 mm      | P    | 1.60 +0.3/-0.10 mm | Z    | 0.25 ± 0.03 mm      |



## Thickness Description

| Size Inch [mm] | L [mm]                         | W [mm]                         | Code / T [mm]                         | M <sub>B</sub> [mm] |
|----------------|--------------------------------|--------------------------------|---------------------------------------|---------------------|
| 0402[1005]     | 1.00±0.10                      | 0.50±0.10                      | Reference<br>to Thickness Description | 0.25 +0.05/-0.10    |
|                | 1.00±0.20 <sup>#1</sup>        | 0.50±0.20 <sup>#1</sup>        |                                       | 0.40±0.15           |
| 0603[1608]     | 1.60±0.15                      | 0.80±0.15                      |                                       | 0.50±0.20           |
| 0805[2012]     | 2.00±0.20                      | 1.25±0.20                      |                                       | 0.60±0.20           |
|                | 3.20±0.20                      | 1.60±0.20                      |                                       | 0.75±0.35           |
| 1206[3216]     | 3.20±0.20                      | 1.60±0.20                      |                                       | 0.75±0.35           |
|                | 3.20 +0.30/-0.10 <sup>#2</sup> | 1.60 +0.30/-0.10 <sup>#2</sup> |                                       | 0.75±0.35           |
| 1210[3225]     | 3.20±0.30                      | 2.50±0.30                      |                                       | 0.75±0.35           |
| 1808[4520]     | 4.50±0.40                      | 2.00±0.25                      |                                       | 0.85±0.35           |
| 1812[4532]     | 4.50±0.40                      | 3.20±0.30                      |                                       | 0.85±0.35           |
| 1825[4563]     | 4.50±0.40                      | 6.30±0.40                      |                                       | 0.85±0.35           |
| 2220[5750]     | 5.70±0.40                      | 5.00±0.40                      |                                       | 0.85±0.35           |
| 2225[5763]     | 5.70±0.40                      | 6.30±0.40                      |                                       | 0.85±0.35           |

#1. For 0402 size K thickness products.

#2. For 1206 size P thickness products.

## Dielectric Properties & Electrical Summary

| Dielectric                        | COG  | X7R  |
|-----------------------------------|--|--|
| <b>Size</b>                       | 0402, 0603, 0805, 1206, 1210, 1808, 1812, 1825, 2220, 2225             | 0402, 0603, 0805, 1206, 1210, 1812, 1825, 2220, 2225 |
| <b>Rated voltage (WVDC)</b>       | 100V, 200V, 250V, 400V, 500V, 630V                                     | 100V, 200V, 250V, 400V, 500V, 630V                   |
| <b>Capacitance range*</b>         | 0.5 pF ~ 100 nF  | 100pF ~ 10uF   |
| <b>Capacitance tolerance**</b>    | B[±0.1pF], C[±0.25pF], D[±0.5pF]<br>F[±1%], G[±2%]<br>J[±5% ], K[±10%] | J[±5% ], K[±10%],<br>M[±20%]                         |
| <b>Tan δ*</b>                     | Cap.<30pF :<br>Q≥400+20C<br>Cap.≥30pF : Q≥1000                         | ≤2.5 % ~ ≤10%  |
| <b>Operating temperature</b>      | -55 to +125°C  | -55 to +125°C  |
| <b>Capacitance characteristic</b> | ±30ppm/°C  | ±15%   |
| <b>Termination</b>                | Cu/Ni/Sn (lead-free termination)                                       |  |

\* Measured at the condition of 30~70% related humidity.

COG : Apply 1.0±0.2Vrms, 1.0MHz±10% for Cap.≤1000pF and 1.0±0.2Vrms, 1.0KHz±10% for Cap.>1000pF, at 25°C ambient temperature. X7R : Apply 1.0±0.2Vrms, 1.0KHz±10%, at 25°C ambient temperature.

\*\* Preconditioning for Class II MLCC : Perform a heat treatment at 150±10°C for 1 hour, then leave in ambient condition for 24±2 hours before measurement.

## Capacitance Range COG

| Dimension |      | 0402 |      |      | 0603 |      |      | 0805 |      |      |      |      | 1206 |      |      |      |      |
|-----------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Cap[pF]   | code | 100V | 200V | 250V | 100V | 200V | 250V | 100V | 200V | 250V | 500V | 630V | 100V | 200V | 250V | 500V | 630V |
| 0.5       | 0R5  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    |      |      |      |      |      |
| 1.0       | 1R0  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    |      |      |      |      |      |
| 1.2       | 1R2  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    | X    |      |      | X    |      |
| 1.5       | 1R5  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    | X    | X    | X    | X    | X    |
| 1.8       | 1R8  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    | X    | X    | X    | X    | X    |
| 2.2       | 2R2  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    | X    | X    | X    | X    | X    |
| 2.7       | 2R7  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    | X    | X    | X    | X    | X    |
| 3.3       | 3R3  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    | X    | X    | X    | X    | X    |
| 3.9       | 3R9  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    | X    | X    | X    | X    | X    |
| 4.7       | 4R7  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    | X    | X    | X    | X    | X    |
| 5.6       | 5R6  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    | X    | X    | X    | X    | X    |
| 6.8       | 6R8  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    | X    | X    | X    | X    | X    |
| 8.2       | 8R2  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    | X    | X    | X    | X    | X    |
| 10        | 100  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    | X    | X    | X    | X    | X    |
| 12        | 120  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    | X    | X    | X    | X    | X    |
| 15        | 150  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    | X    | X    | X    | X    | X    |
| 18        | 180  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    | X    | X    | X    | X    | X    |
| 22        | 220  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    | X    | X    | X    | X    | X    |
| 27        | 270  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    | X    | X    | X    | X    | X    |
| 33        | 330  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    | X    | X    | X    | X    | X    |
| 39        | 390  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    | X    | X    | X    | X    | X    |
| 47        | 470  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    | X    | X    | X    | X    | X    |
| 56        | 560  | N    | N    | N    | S    | S    | S    | A    | A    | A    | A    | A    | X    | X    | X    | X    | X    |
| 68        | 680  | N    | N    |      | S    | S    | S    | A    | A    | A    | A    | A    | X    | X    | X    | X    | X    |
| 82        | 820  | N    | N    |      | S    | S    | S    | A    | A    | A    | X    | X    | X    | X    | X    | X    | X    |
| 100       | 101  | N    | N    |      | S    | S    | S    | A    | A    | X    | X    | X    | X    | X    | X    | X    | X    |
| 120       | 121  | N    |      |      | S    | S    | S    | A    | A    | X    | C    | C    | X    | X    | X    | X    | X    |
| 150       | 151  | N    |      |      | S    | S    | S    | A    | X    | X    | C    | C    | X    | X    | X    | X    | X    |
| 180       | 181  | N    |      |      | S    | S    | S    | A    | X    | C    | C    | C    | X    | X    | X    | X    | X    |
| 220       | 221  | N    |      |      | S    | S    | S    | A    | C    | C    | C    | C    | X    | X    | X    | X    | X    |
| 270       | 271  |      |      |      | S    | B    | B    | A    | C    | C    | C    | C    | X    | X    | M    | M    | M    |
| 330       | 331  |      |      |      | S    | B    | B    | A    | C    | C    | C    | C    | X    | X    | M    | M    | M    |
| 390       | 391  |      |      |      | S    | B    | B    | X    | C    | C    | C    | C    | X    | X    | M    | M    | M    |
| 470       | 471  |      |      |      | S    | B    | B    | X    | C    | C    | I    | I    | X    | M    | M    | M    | M    |
| 560       | 561  |      |      |      | S    | B    | B    | X    | C    | C    | I    | I    | X    | M    | C    | C    | C    |
| 680       | 681  |      |      |      | S    | B    | B    | X    | C    | C    | I    | I    | X    | M    | C    | C    | C    |
| 820       | 821  |      |      |      | S    | B    | B    | X    | C    | C    | I    | I    | X    | M    | E    | E    | E    |
| 1000      | 102  |      |      |      | S    | B    | B    | X    | C    | C    | I    | I    | X    | M    | E    | E    | E    |
| 1200      | 122  |      |      |      | B    | B    | B    | X    | C    | C    | I    | I    | X    | M    | E    | E    | E    |
| 1500      | 152  |      |      |      | B    | B    | B    | X    | C    | C    | I    | I    | X    | C    | E    | E    | E    |
| 1800      | 182  |      |      |      | B    | B    | B    | X    | C    | C    | I    | I    | X    | C    | E    | E    | E    |
| 2200      | 222  |      |      |      | B    | B    | B    | X    | C    | C    | I    | I    | M    | C    | E    | E    | E    |
| 2700      | 272  |      |      |      |      |      |      | C    | C/I  | C/I  |      |      | M    | C    | E    | E    | E    |
| 3300      | 332  |      |      |      |      |      |      | C    | I    | I    |      |      | C    | C    | E    | E    | E    |
| 3900      | 392  |      |      |      |      |      |      | C    | I    | I    |      |      | C    | E    | E    | E    | E    |
| 4700      | 472  |      |      |      |      |      |      | C    | I    | I    |      |      | C    | E    | E    | E    | E    |
| 5600      | 562  |      |      |      |      |      |      | C    |      |      |      |      | E    | E    | E    | E    | E    |
| 6800      | 682  |      |      |      |      |      |      | C    |      |      |      |      | E    | E    | E    | E    | C/E  |
| 8200      | 822  |      |      |      |      |      |      | C    |      |      |      |      | E    | E    | E    | E    | E    |
| 10000     | 103  |      |      |      |      |      |      | C    |      |      |      |      | E    | E    | E    | E    | E    |
| 12000     | 123  |      |      |      |      |      |      | C    |      |      |      |      | P    |      |      |      |      |
| 15000     | 153  |      |      |      |      |      |      | C    |      |      |      |      | P    |      |      |      |      |
| 18000     | 183  |      |      |      |      |      |      | C    |      |      |      |      | P    |      |      |      |      |
| 22000     | 223  |      |      |      |      |      |      | C    |      |      |      |      | P    |      |      |      |      |
| 27000     | 273  |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 33000     | 333  |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |

## Capacitance Range [Con.] COG

| Dimension |      | 1210  |       |       |       |       | 1808  |       |       |       |       | 1812  |       |       |       |       |
|-----------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Cap(pF)   | code | 100 V | 200 V | 250 V | 500 V | 630 V | 100 V | 200 V | 250 V | 500 V | 630 V | 100 V | 200 V | 250 V | 500 V | 630 V |
| 2.2       | 2R2  |       |       |       |       |       | C     | C     | C     | C     | C     |       |       |       |       |       |
| 2.7       | 2R7  |       |       |       |       |       | C     | C     | C     | C     | C     |       |       |       |       |       |
| 3.3       | 3R3  |       |       |       |       |       | C     | C     | C     | C     | C     |       |       |       |       |       |
| 3.9       | 3R9  |       |       |       |       |       | C     | C     | C     | C     | C     |       |       |       |       |       |
| 4.7       | 4R7  |       |       |       |       |       | C     | C     | C     | C     | C     |       |       |       |       |       |
| 5.6       | 5R6  |       |       |       |       |       | C     | C     | C     | C     | C     |       |       |       |       |       |
| 6.8       | 6R8  |       |       |       |       |       | C     | C     | C     | C     | C     |       |       |       |       |       |
| 8.2       | 8R2  |       |       |       |       |       | C     | C     | C     | C     | C     |       |       |       |       |       |
| 10        | 100  | M     | M     | M     | M     | M     | C     | C     | C     | C     | C     | C     | C     | C     | C     | C     |
| 12        | 120  | M     | M     | M     | M     | M     | C     | C     | C     | C     | C     | C     | C     | C     | C     | C     |
| 15        | 150  | M     | M     | M     | M     | M     | C     | C     | C     | C     | C     | C     | C     | C     | C     | C     |
| 18        | 180  | M     | M     | M     | M     | M     | C     | C     | C     | C     | C     | C     | C     | C     | C     | C     |
| 22        | 220  | M     | M     | M     | M     | M     | C     | C     | C     | C     | C     | C     | C     | C     | C     | C     |
| 27        | 270  | M     | M     | M     | M     | M     | C     | C     | C     | C     | C     | C     | C     | C     | C     | C     |
| 33        | 330  | M     | M     | M     | M     | M     | C     | C     | C     | C     | C     | C     | C     | C     | C     | C     |
| 39        | 390  | M     | M     | M     | M     | M     | C     | C     | C     | C     | C     | C     | C     | C     | C     | C     |
| 47        | 470  | M     | M     | M     | M     | M     | C     | C     | C     | C     | C     | C     | C     | C     | C     | C     |
| 56        | 560  | M     | M     | M     | M     | M     | C     | C     | C     | C     | C     | C     | C     | C     | C     | C     |
| 68        | 680  | M     | M     | M     | M     | M     | C     | C     | C     | C     | C     | C     | C     | C     | C     | C     |
| 82        | 820  | M     | M     | M     | M     | M     | C     | C     | C     | C     | C     | C     | C     | C     | C     | C     |
| 100       | 101  | M     | M     | M     | M     | M     | C     | C     | C     | C     | C     | C     | C     | C     | C     | C     |
| 120       | 121  | M     | M     | M     | M     | M     | C     | C     | C     | C     | C     | C     | C     | C     | C     | C     |
| 150       | 151  | M     | M     | M     | M     | M     | C     | C     | C     | C     | C     | C     | C     | C     | C     | C     |
| 180       | 181  | M     | M     | M     | M     | M     | C     | C     | C     | C     | C     | C     | C     | C     | C     | C     |
| 220       | 221  | M     | M     | M     | M     | M     | C     | C     | C     | C     | C     | C     | C     | C     | C     | C     |
| 270       | 271  | M     | M     | M     | M     | M     | C     | C     | C     | F     | F     | C     | C     | C     | C     | C     |
| 330       | 331  | M     | M     | M     | M     | M     | C     | C     | C     | F     | F     | C     | C     | C     | C     | C     |
| 390       | 391  | M     | M     | M     | M     | M     | C     | C     | C     | F     | F     | C     | C     | C     | C     | C     |
| 470       | 471  | M     | M     | M     | M     | M     | C     | C     | C     | F     | F     | C     | C     | C     | C     | C     |
| 560       | 561  | M     | M     | M     | M     | M     | C     | C     | C     | F     | F     | C     | C     | C     | C     | C     |
| 680       | 681  | M     | M     | M     | M     | M     | C     | C     | C     | F     | F     | C     | C     | C     | C     | C     |
| 820       | 821  | M     | M     | M     | M     | M     | C     | C     | C     | F     | F     | C     | C     | C     | C     | C     |
| 1000      | 102  | M     | C     | C     | C     | C     | C     | C     | C     | F     | F     | C     | C     | C     | C     | C     |
| 1200      | 122  | M     | C     | C     | C     | C     | C     | C     | C     | F     | F     | C     | C     | C     | C     | C     |
| 1500      | 152  | M     | C     | C     | C     | C     | C     | C     | C     | F     | F     | C     | C     | C     | C     | C     |
| 1800      | 182  | M     | C     | C     | C     | C     | C     | C     | C     | F     | F     | C     | C     | C     | C     | C     |
| 2200      | 222  | M     | C     | C     | C     | C     | C     | C     | C     | F     | F     | C     | C     | C     | C     | C     |
| 2700      | 272  | M     | C     | C     | C     | C     | C     | C     | C     | F     | F     | C     | C     | C     | C     | C     |
| 3300      | 332  | M     | C     | C     | C     | C     | C     | C     | C     | F     | F     | C     | C     | C     | C     | C     |
| 3900      | 392  | M     | C     | C     | C     | C     | C     | C     | C     |       |       | C     | C     | C     | C     | C     |
| 4700      | 472  | M     | E/C   | E/C   | C     | C     | C     | C     | C     |       |       | C     | C     | C     | C     | C     |
| 5600      | 562  | C     | E/C   | E/C   | C     | C     | C     | E     | E     |       |       | C     | C     | C     | C     | C     |
| 6800      | 682  | C     | E     | E     | E/C   | E/C   | C     | E     | E     |       |       | C     | C     | C     | C     | C     |
| 8200      | 822  | C     | E     | E     | E     | E     | E     | F     | F     |       |       | C     | C     | C     | C     | C     |
| 10000     | 103  | E     | F     | F     | F     | F     | E     | F     | F     |       |       | C     | C     | C     | C     | C     |
| 12000     | 123  | E     | C/E/F | C/E/F | F     | F     |       |       |       |       |       | C     | E     | E     | E     | E     |
| 15000     | 153  | F     | C/E/F | C/E/F | G     | G     |       |       |       |       |       | C     | E     | E     | E     | E     |
| 18000     | 183  | F/G   | E/F/G | E/F   | G     | G     |       |       |       |       |       | E     | F     | F     | F     | F     |
| 22000     | 223  | F/G   | E/F/G | E/F   | G     | G     |       |       |       |       |       | E     | F     | F     | F     | F     |
| 27000     | 273  | F     | F     | F     | G     | G     |       |       |       |       |       | F     | G     | G     |       |       |
| 33000     | 333  | F     | F/G   | F/G   | G     | G     |       |       |       |       |       | F     |       |       |       |       |
| 39000     | 393  | F     | F     | F     |       |       |       |       |       |       |       | G     |       |       |       |       |
| 47000     | 473  | F     | F     | F     |       |       |       |       |       |       |       | G     |       |       |       |       |
| 56000     | 563  |       |       |       |       |       |       |       |       |       |       | G     |       |       |       |       |
| 68000     | 683  |       |       |       |       |       |       |       |       |       |       | G     |       |       |       |       |
| 82000     | 823  |       |       |       |       |       |       |       |       |       |       | G     |       |       |       |       |
| 100000    | 104  |       |       |       |       |       |       |       |       |       |       | G     |       |       |       |       |

## Capacitance Range [Con.] COG

| Dimension |      | 1825  |       |       |       |       | 2220  |       |       |       |       | 2225  |       |       |       |       |
|-----------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Cap[pF]   | code | 100 V | 200 V | 250 V | 500 V | 630 V | 100 V | 200 V | 250 V | 500 V | 630 V | 100 V | 200 V | 250 V | 500 V | 630 V |
| 10        | 100  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 12        | 120  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 15        | 150  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 18        | 180  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 22        | 220  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 27        | 270  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 33        | 330  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 39        | 390  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 47        | 470  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 56        | 560  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 68        | 680  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 82        | 820  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 100       | 101  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 120       | 121  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 150       | 151  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 180       | 181  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 220       | 221  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 270       | 271  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 330       | 331  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 390       | 391  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 470       | 471  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 560       | 561  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 680       | 681  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 820       | 821  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 100 0     | 102  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 120 0     | 122  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 150 0     | 152  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 180 0     | 182  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 220 0     | 222  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 270 0     | 272  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 330 0     | 332  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 390 0     | 392  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 470 0     | 472  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 560 0     | 562  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 680 0     | 682  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 820 0     | 822  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 100 00    | 103  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 120 00    | 123  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 150 00    | 153  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 180 00    | 183  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 220 00    | 223  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 270 00    | 273  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 330 00    | 333  | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     | F     |
| 390 00    | 393  | F     | F     | F     | G     | G     | F     | F     | F     | G     | F     | F     | F     | F     | F     | F     |
| 470 00    | 473  | F     | F     | F     |       |       | F     | G     | G     | G     | F     | F     | F     | F     | F     | F     |
| 560 00    | 563  | F     | G     | G     |       |       | F     | G     | G     |       | G     | F     | G     | G     | G     | G     |
| 680 00    | 683  | F     | G     | G     |       |       | F     | G     | G     |       | H     | F     | G     | G     | G     | G     |
| 820 00    | 823  | G     |       |       |       |       | G     |       |       |       | H     | F     | G     | G     | G     |       |
| 100000    | 104  | G     |       |       |       |       | G     |       |       |       | H     | G     | G     | G     |       |       |
| 120000    | 124  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 150000    | 154  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 180000    | 184  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 220000    | 224  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |

## Capacitance Range (Con.) X7R

| Dimension |      | 0402 | 0603 |      |      | 0805 |      |      |      |      | 1206 |      |      |      |      |      |
|-----------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Cap[pF]   | code | 100V | 100V | 200V | 250V | 100V | 200V | 250V | 500V | 630V | 100V | 200V | 250V | 500V | 450V | 630V |
| 100       | 101  | N    | S    | B    | B    | X    | X    | X    | X    | X    | X    | C    | C    | C    |      | C    |
| 120       | 121  | N    | S    | B    | B    | X    | X    | X    | X    | X    | X    | C    | C    | C    |      | C    |
| 150       | 151  | N    | S    | B    | B    | X    | X    | X    | X    | X    | X    | C    | C    | C    |      | C    |
| 180       | 181  | N    | S    | B    | B    | X    | X    | X    | X    | X    | X    | C    | C    | C    |      | C    |
| 220       | 221  | N    | S    | B    | B    | X    | X    | X    | X    | X    | X    | C    | C    | C    |      | C    |
| 270       | 271  | N    | S    | B    | B    | X    | X    | X    | X    | X    | X    | C    | C    | C    |      | C    |
| 330       | 331  | N    | S    | B    | B    | X    | X    | X    | X    | X    | X    | C    | C    | C    |      | C    |
| 390       | 391  | N    | S    | B    | B    | X    | X    | X    | X    | X    | X    | C    | C    | C    |      | C    |
| 470       | 471  | N    | S    | B    | B    | X    | X    | X    | X    | X    | X    | C    | C    | C    |      | C    |
| 560       | 561  | N    | S    | B    | B    | X    | X    | X    | X    | X    | X    | C    | C    | C    |      | C    |
| 680       | 681  | N    | S    | B    | B    | X    | X    | X    | X    | X    | X    | C    | C    | C    |      | C    |
| 820       | 821  | N    | S    | B    | B    | X    | X    | X    | X    | X    | X    | C    | C    | C    |      | C    |
| 1000      | 102  | N    | S    | B    | B    | X    | X    | X    | X    | X    | X    | C    | C    | C    |      | C    |
| 1200      | 122  | N    | S    | B    | B    | X    | X    | X    | X    | X    | X    | C    | C    | C    |      | C    |
| 1500      | 152  | N    | S    | B    | B    | X    | X    | X    | X    | X    | X    | C    | C    | C    |      | C    |
| 1800      | 182  | N    | S    | B    | B    | X    | X    | X    | X    | X    | X    | C    | C    | C    |      | C    |
| 2200      | 222  | N    | S    | B    | B    | X    | X    | X    | X    | X    | X    | C    | C    | C    |      | C    |
| 2700      | 272  | N    | S    | B    | B    | X    | X    | X    | X    | X    | X    | C    | C    | C    |      | C    |
| 3300      | 332  | N    | S    | B    | B    | X    | X    | X    | X    | X    | X    | C    | C    | C    |      | C    |
| 3900      | 392  | N    | S    | B    | B    | X    | X    | X    | X    | X    | X    | C    | C    | C    |      | C    |
| 4700      | 472  | N    | S    | B    | B    | X    | X    | X    | C    | C    | X    | C    | C    | C    |      | C    |
| 5600      | 562  |      | S    | B    | B    | X    | X    | X    | C    | C    | X    | C    | C    | C    |      | C    |
| 6800      | 682  |      | S    | B    | B    | X    | X    | X    | C    | C    | X    | C    | C    | C    |      | C    |
| 8200      | 822  |      | S    | B    | B    | X    | X    | X    | C    | C    | X    | C    | C    | C    |      | C    |
| 10000     | 103  |      | S    | B    | B    | X    | C    | C    | C    | C    | X    | C    | C    | C    |      | C    |
| 12000     | 123  |      | B    |      |      | X    | C    | C    | C    | C    | X    | C    | C    | C    |      | C    |
| 15000     | 153  |      | B    |      |      | X    | C    | C    | C    | C    | X    | C    | C    | C    |      | C    |
| 18000     | 183  |      | B    |      |      | X    | C    | C    | C    | C    | X    | C    | C    | C    |      | C    |
| 22000     | 223  |      | B    |      |      | X    | C    | C    | C    | C    | X    | C    | C    | E    |      | E    |
| 27000     | 273  |      | B    |      |      | C    | C    | C    | C    | C    | X    | C    | C    | E    |      | E    |
| 33000     | 333  |      | B    |      |      | C    | C    | C    | C    |      | X    | E    | E    | E    |      | E    |
| 39000     | 393  |      | B    |      |      | C    | C    | C    |      |      | X    | E    | E    | E    |      | E    |
| 47000     | 473  |      | B    |      |      | C    | C    | C    |      |      | X    | E    | E    | E    |      | E    |
| 56000     | 563  |      | B    |      |      | C    | C    | C    |      |      | X    | E    | E    | E    |      | E    |
| 68000     | 683  |      | B    |      |      | C    | C    | C    |      |      | X    | E    | E    |      | E    |      |
| 82000     | 823  |      | B    |      |      | C    | C    |      |      |      | C    | E    | E    |      | E    |      |
| 100000    | 104  |      | B    |      |      | C    | C    |      |      |      | C    | E    | E    |      | E    |      |
| 120000    | 124  |      |      |      |      | I    |      |      |      |      | C    | E    | E    |      |      |      |
| 150000    | 154  |      |      |      |      | I    |      |      |      |      | E    | E    | E    |      |      |      |
| 180000    | 184  |      |      |      |      | I    |      |      |      |      | E    | E    | E    |      |      |      |
| 220000    | 224  |      |      |      |      | I    |      |      |      |      | E    | E    | E    |      |      |      |
| 270000    | 274  |      |      |      |      | I    |      |      |      |      | E    |      |      |      |      |      |
| 330000    | 334  |      |      |      |      | I    |      |      |      |      | E    |      |      |      |      |      |
| 390000    | 394  |      |      |      |      | I    |      |      |      |      | E    |      |      |      |      |      |
| 470000    | 474  |      |      |      |      | I    |      |      |      |      | E    |      |      |      |      |      |
| 560000    | 564  |      |      |      |      |      |      |      |      |      | P    |      |      |      |      |      |
| 680000    | 684  |      |      |      |      |      |      |      |      |      | P    |      |      |      |      |      |
| 820000    | 824  |      |      |      |      |      |      |      |      |      | P    |      |      |      |      |      |
| 1000000   | 105  |      |      |      |      | I    |      |      |      |      | P    |      |      |      |      |      |
| 1200000   | 125  |      |      |      |      | I    |      |      |      |      | E/P  |      |      |      |      |      |
| 1500000   | 155  |      |      |      |      |      |      |      |      |      | E/P  |      |      |      |      |      |
| 1800000   | 185  |      |      |      |      |      |      |      |      |      | P    |      |      |      |      |      |
| 2200000   | 225  |      |      |      |      |      |      |      |      |      | P    |      |      |      |      |      |

## Capacitance Range [Con.] X7R

| Dimension |      | 1210 |      |      |      |      |      | 1808 |      | 1812 |      |      |      |      |      |
|-----------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Cap[pF]   | code | 100V | 200V | 250V | 405V | 500V | 630V | 500V | 630V | 100V | 200V | 250V | 450V | 500V | 630V |
| 100       | 101  |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 120       | 121  |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 150       | 151  |      |      |      |      |      |      | C    | C    |      |      |      |      |      |      |
| 180       | 181  |      |      |      |      |      |      | C    | C    |      |      |      |      |      |      |
| 220       | 221  | M    | M    | M    |      | C    | C    | C    | C    |      |      |      |      |      |      |
| 270       | 271  | M    | M    | M    |      | C    | C    | C    | C    | C    | C    | C    | C    | C    | C    |
| 330       | 331  | M    | M    | M    |      | C    | C    | C    | C    | C    | C    | C    | C    | C    | C    |
| 390       | 391  | M    | M    | M    |      | C    | C    | C    | C    | C    | C    | C    | C    | C    | C    |
| 470       | 471  | M    | M    | M    |      | C    | C    | C    | C    | C    | C    | C    | C    | C    | C    |
| 560       | 561  | M    | M    | M    |      | C    | C    | C    | C    | C    | C    | C    | C    | C    | C    |
| 680       | 681  | M    | M    | M    |      | C    | C    | C    | C    | C    | C    | C    | C    | C    | C    |
| 820       | 821  | M    | M    | M    |      | C    | C    | C    | C    | C    | C    | C    | C    | C    | C    |
| 1000      | 102  | M    | M    | M    |      | C    | C    | C    | C    | C    | C    | C    | C    | C    | C    |
| 1200      | 122  | M    | M    | M    |      | C    | C    | C    | C    | C    | C    | C    | C    | C    | C    |
| 1500      | 152  | M    | M    | M    |      | C    | C    | C    | C    | C    | C    | C    | C    | C    | C    |
| 1800      | 182  | M    | M    | M    |      | C    | C    | C    | C    | C    | C    | C    | C    | C    | C    |
| 2200      | 222  | M    | M    | M    |      | C    | C    | C    | C    | C    | C    | C    | C    | C    | C    |
| 2700      | 272  | M    | M    | M    |      | C    | C    | C    | C    | C    | C    | C    | C    | C    | C    |
| 3300      | 332  | M    | M    | M    |      | C    | C    | C    | C    | C    | C    | C    | C    | C    | C    |
| 3900      | 392  | M    | M    | M    |      | C    | C    | C    | C    | C    | C    | C    | C    | C    | C    |
| 4700      | 472  | M    | M    | M    |      | C    | C    | C    | C    | C    | C    | C    | C    | C    | C    |
| 5600      | 562  | M    | M    | M    |      | C    | C    | F    | F    | C    | C    | C    | C    | C    | C    |
| 6800      | 682  | M    | M    | M    |      | C    | C    | F    | F    | C    | C    | C    | C    | C    | C    |
| 8200      | 822  | M    | M    | M    |      | C    | C    | F    | F    | C    | C    | C    | C    | C    | C    |
| 10000     | 103  | M    | M    | M    |      | C    | C    | F    | F    | C    | C    | C    | C    | C    | C    |
| 12000     | 123  | M    | M    | M    |      | C    | C    | F    | F    | C    | C    | C    | C    | C    | C    |
| 15000     | 153  | M    | M    | M    |      | C    | C    | F    | F    | C    | C    | C    | C    | C    | C    |
| 18000     | 183  | M    | M    | M    |      | C    | C    | F    | F    | C    | C    | C    | C    | C    | C    |
| 22000     | 223  | M    | M    | M    |      | C    | C    | F    | F    | C    | C    | C    | C    | C    | C    |
| 27000     | 273  | M    | M    | M    |      | E    | E    | F    | F    | C    | C    | C    | C    | C    | C    |
| 33000     | 333  | M    | M    | M    |      | E    | E    | F    | F    | C    | C    | C    | C    | C    | C    |
| 39000     | 393  | M    | M    | M    |      | E    | E    | F    | F    | C    | C    | C    | C    | C    | C    |
| 47000     | 473  | M    | C    | C    |      | E    | E    | F    | F    | C    | C    | C    | C    | C    | C    |
| 56000     | 563  | M    | C    | E    |      | E    | E    | F    | F    | C    | C    | C    | F    | F    | F    |
| 68000     | 683  | M    | E    | E    |      | F/E  | F/E  | F    | F    | C    | C    | C    | F    | F    | F    |
| 82000     | 823  | M    | E    | E    |      | F    | F    | F    | F    | C    | C    | C    | F    | F    | F    |
| 100000    | 104  | M    | E    | E    |      | F    | F    |      |      | C    | C    | C    | F    | F    | F    |
| 120000    | 124  | M    | E    | E    | G    | G    | G    |      |      | C    | C    | C    | G    | G    | G    |
| 150000    | 154  | C    | G    | G    | G    | G    | G    |      |      | C    | F    | F    | G    | G    | G    |
| 180000    | 184  | C    | G    | G    | G    |      |      |      |      | C    | F    | F    | G    | G    | G    |
| 220000    | 224  | C    | G    | G    | G    |      |      |      |      | C    | F    | F    | G    | G    | G    |
| 270000    | 274  | E    | G    | G    | G    |      |      |      |      | C    | F    | F    | G    | G    |      |
| 330000    | 334  | E    | G    | G    | G    |      |      |      |      | C    | F    | F    | G    | G    |      |
| 390000    | 394  | G    | G    | G    |      |      |      |      |      | C    | F    | F    | G    | G    |      |
| 470000    | 474  | G    | G    | G    |      |      |      |      |      | F    | F    | F    | G    | G    |      |
| 560000    | 564  | G    | G    | G    |      |      |      |      |      | F    | G    | G    | G    |      |      |
| 680000    | 684  | F    | G    | G    |      |      |      |      |      | F    | G    | G    | G    |      |      |
| 820000    | 824  | F    |      |      |      |      |      |      |      | F    | G    | G    | H    |      |      |
| 820000    | 824  | F    |      |      |      |      |      |      |      | F    | G    | G    | H    |      |      |
| 1000000   | 105  | F    |      |      |      |      |      |      |      | F    | G    | G    | H    |      |      |
| 1200000   | 125  | F/G  |      |      |      |      |      |      |      | C    |      |      |      |      |      |
| 1500000   | 155  | G    |      |      |      |      |      |      |      | C    |      |      |      |      |      |
| 1800000   | 185  | G    |      |      |      |      |      |      |      | E    |      |      |      |      |      |
| 2200000   | 225  | G    |      |      |      |      |      |      |      | E    |      |      |      |      |      |
| 2700000   | 275  | G    |      |      |      |      |      |      |      | F    |      |      |      |      |      |
| 3300000   | 335  | G    |      |      |      |      |      |      |      | F    |      |      |      |      |      |
| 3900000   | 395  | G    |      |      |      |      |      |      |      | F    |      |      |      |      |      |
| 4700000   | 475  | G    |      |      |      |      |      |      |      | G    |      |      |      |      |      |

## Capacitance Range (Con.) X7R

| Dimension |      | 1825 |      |      |      |      | 2220 |      |      |      |      | 2225 |      |      |      |      |
|-----------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Cap(pF)   | code | 100V | 200V | 250V | 500V | 630V | 100V | 200V | 250V | 500V | 630V | 100V | 200V | 250V | 500V | 630V |
| 1000      | 102  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 1200      | 122  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 1500      | 152  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 1800      | 182  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 2200      | 222  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 2700      | 272  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 3300      | 332  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 3900      | 392  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 4700      | 472  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 5600      | 562  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 6800      | 682  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 8200      | 822  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 10000     | 103  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 12000     | 123  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 15000     | 153  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 18000     | 183  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 22000     | 223  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 27000     | 273  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 33000     | 333  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 39000     | 393  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 47000     | 473  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 56000     | 563  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 68000     | 683  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 82000     | 823  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 100000    | 104  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 120000    | 124  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 150000    | 154  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 180000    | 184  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 220000    | 224  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 270000    | 274  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 330000    | 334  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 390000    | 394  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 470000    | 474  | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    | F    |
| 560000    | 564  | F    | F    | F    | G    | G    | F    | F    | F    | G    | G    | F    | F    | F    | F    | F    |
| 680000    | 684  | F    | F    | F    |      |      | F    | F    | F    | G    | G    | F    | F    | F    |      |      |
| 820000    | 824  | F    | F    | F    |      |      | F    | F    | F    | H    | H    | F    | F    | F    |      |      |
| 1000000   | 105  | F    | F    | F    |      |      | F    | F    | F    | H    | H    | F    | F    | F    |      |      |
| 1200000   | 125  | F    | G    |      |      |      | F    | G    | G    |      |      | F    | G    | G    |      |      |
| 1500000   | 155  | F    | G    |      |      |      | F    | G    | G    |      |      | F    | G    | G    |      |      |
| 1800000   | 185  | F    | G    |      |      |      | F    | G    | G    |      |      | F    | G    | G    |      |      |
| 2200000   | 225  | F    | G    |      |      |      | F    | G    | G    |      |      | F    | G    | G    |      |      |
| 2700000   | 275  | F    |      |      |      |      | F    |      |      |      |      | F    |      |      |      |      |
| 3300000   | 335  | F    |      |      |      |      | F    |      |      |      |      | F    |      |      |      |      |
| 3900000   | 395  | F    |      |      |      |      | F    |      |      |      |      | F    |      |      |      |      |
| 4700000   | 475  | F    |      |      |      |      | F    |      |      |      |      | F    |      |      |      |      |
| 5600000   | 565  | F    |      |      |      |      | F    |      |      |      |      | F    |      |      |      |      |
| 6800000   | 685  | F    |      |      |      |      | F    |      |      |      |      | F    |      |      |      |      |
| 8200000   | 825  | G    |      |      |      |      | G    |      |      |      |      | G    |      |      |      |      |
| 10000000  | 106  | G    |      |      |      |      | G    |      |      |      |      | G    |      |      |      |      |

\* M Tolerance only

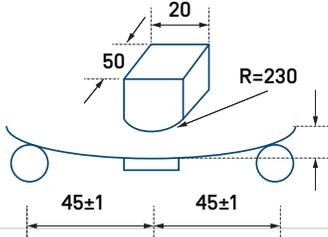
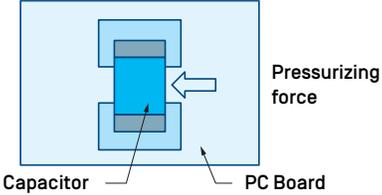
## Reliability test conditions and requirements

| No.           | Item  | Test Condition  | Requirements  |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
|---------------|---|---|---|-----------------|-------------|-----------------------------|---------------------------|-----------------------------|-----------|-----------------------------|-----------|-----------------------------|---|-------------|---|---|--------------|---|---|-----------------|---|
| 1.            | Visual and Dimensions   |   | <ul style="list-style-type: none"> <li>* No remarkable defect.</li> <li>* Dimensions to confirm to individual specification sheet.6.3V</li> </ul>   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
| 2.            | Capacitance   | <ul style="list-style-type: none"> <li>Class I : COG</li> </ul>   | <ul style="list-style-type: none"> <li>Shall not exceed the limits given in the detailed spec.</li> </ul>   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
| 3.            | Q/ D.F. [Tangent of loss angle]                                     | <ul style="list-style-type: none"> <li>Class I : COG<br/>Cap.≤1000pF, 1.0±0.2Vrms, 1MHz±10%.<br/>Cap.&gt;1000pF, 1.0±0.2Vrms, 1KHz±10%.</li> <li>Class II : [X7R]<br/>1.0±0.2Vrms, 1KHz±10%.</li> </ul>   | <table border="1"> <thead> <tr> <th>Dielectric</th> <th>Q/D.F.</th> <th>Remark</th> </tr> </thead> <tbody> <tr> <td rowspan="2">Class I [COG]</td> <td>Q≥1000</td> <td>Cap.≥30pF</td> </tr> <tr> <td>Q≥400+20C</td> <td>Cap.&lt;30pF</td> </tr> <tr> <td rowspan="4">Class II</td> <td>D.F.≤2.5%</td> <td>X7R items</td> </tr> <tr> <td>D.F.≤3.5%</td> <td>X7R 0603≥0.047μF, 0805=0.1μF, 1206≥0.47μF</td> </tr> <tr> <td>D.F.≤5.0%</td> <td>X7R 0603≥0.068μF, 0805&gt;0.1μF<br/>All Y5V items</td> </tr> <tr> <td>D.F.≤10.0%</td> <td>X7R 0805&gt;0.22μF</td> </tr> </tbody> </table> | Dielectric      | Q/D.F.      | Remark                      | Class I [COG]             | Q≥1000                      | Cap.≥30pF | Q≥400+20C                   | Cap.<30pF | Class II                    | D.F.≤2.5%   | X7R items   | D.F.≤3.5%   | X7R 0603≥0.047μF, 0805=0.1μF, 1206≥0.47μF | D.F.≤5.0%    | X7R 0603≥0.068μF, 0805>0.1μF<br>All Y5V items | D.F.≤10.0%                                | X7R 0805>0.22μF |   |
| Dielectric    | Q/D.F.  | Remark  |   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
| Class I [COG] | Q≥1000  | Cap.≥30pF   |   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
|               | Q≥400+20C   | Cap.<30pF   |   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
| Class II      | D.F.≤2.5%   | X7R items   |   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
|               | D.F.≤3.5%   | X7R 0603≥0.047μF, 0805=0.1μF, 1206≥0.47μF   |   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
|               | D.F.≤5.0%   | X7R 0603≥0.068μF, 0805>0.1μF<br>All Y5V items   |   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
|               | D.F.≤10.0%  | X7R 0805>0.22μF   |   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
| 4.            | Temperature Coefficient [Temperature characteristic of capacitance] | <ul style="list-style-type: none"> <li>With no electrical load.</li> </ul> <table border="1"> <thead> <tr> <th>T.C.</th> <th>Operating Temp.</th> <th>T.C.</th> <th>Capacitance Change</th> </tr> </thead> <tbody> <tr> <td>COG</td> <td>-55~125°C at 25°C</td> <td>COG</td> <td>Within ±30ppm/°C</td> </tr> <tr> <td>X7R</td> <td>-55~125°C at 25°C</td> <td>X7R</td> <td>Within ±15%</td> </tr> </tbody> </table>   | T.C.  | Operating Temp. | T.C.        | Capacitance Change          | COG                       | -55~125°C at 25°C           | COG       | Within ±30ppm/°C            | X7R       | -55~125°C at 25°C           | X7R   | Within ±15% |   |   |              |   |   |                 |   |
| T.C.          | Operating Temp.   | T.C.  | Capacitance Change  |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
| COG           | -55~125°C at 25°C   | COG   | Within ±30ppm/°C  |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
| X7R           | -55~125°C at 25°C   | X7R   | Within ±15%   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
| 5.            | Insulation Resistance   | <table border="1"> <thead> <tr> <th>Rated Vol.(V)</th> <th>Apply Voltage</th> <th>Charge Time</th> </tr> </thead> <tbody> <tr> <td>≤100</td> <td>1 times of U<sub>R</sub></td> <td>Max. 120 sec.</td> </tr> <tr> <td>200≤V≤500</td> <td>1 times of U<sub>R</sub></td> <td>60 sec.</td> </tr> <tr> <td>&gt;500</td> <td>500Vdc</td> <td>60 sec.</td> </tr> </tbody> </table>   | Rated Vol.(V)   | Apply Voltage   | Charge Time | ≤100                        | 1 times of U <sub>R</sub> | Max. 120 sec.               | 200≤V≤500 | 1 times of U <sub>R</sub>   | 60 sec.   | >500                        | 500Vdc  | 60 sec.     | <table border="1"> <thead> <tr> <th>Dielectric</th> <th>Requirements</th> </tr> </thead> <tbody> <tr> <td>Class I</td> <td>≥10GΩ or RxC≥500Ω-F, whichever is smaller</td> </tr> <tr> <td>Class II</td> <td>≥10GΩ or RxC≥100Ω-F, whichever is smaller</td> </tr> </tbody> </table> | Dielectric                                | Requirements | Class I                                       | ≥10GΩ or RxC≥500Ω-F, whichever is smaller | Class II        | ≥10GΩ or RxC≥100Ω-F, whichever is smaller |
| Rated Vol.(V) | Apply Voltage   | Charge Time   |   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
| ≤100          | 1 times of U <sub>R</sub>   | Max. 120 sec.   |   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
| 200≤V≤500     | 1 times of U <sub>R</sub>   | 60 sec.   |   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
| >500          | 500Vdc  | 60 sec.   |   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
| Dielectric    | Requirements  |   |   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
| Class I       | ≥10GΩ or RxC≥500Ω-F, whichever is smaller                           |   |   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
| Class II      | ≥10GΩ or RxC≥100Ω-F, whichever is smaller                           |   |   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
| 6.            | Solderability   | <ul style="list-style-type: none"> <li>Solder temperature : 235±5°C for [0402~1210].</li> <li>Solder temperature : 245±5°C for [1808~2225].</li> <li>Dipping time : 2±0.5 sec.</li> </ul>   | <ul style="list-style-type: none"> <li>75% min. coverage of all metalized area.</li> </ul>  |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
| 7.            | Dielectric Strength [Voltage proof]                                 | <table border="1"> <thead> <tr> <th>Rated Vol.(V)</th> <th>Condition</th> </tr> </thead> <tbody> <tr> <td>≤100</td> <td>2.5 times of U<sub>R</sub></td> </tr> <tr> <td>100&lt;V≤250</td> <td>2.0 times of U<sub>R</sub></td> </tr> <tr> <td>250&lt;V≤500</td> <td>1.5 times of U<sub>R</sub></td> </tr> <tr> <td>=630</td> <td>1.2 times of U<sub>R</sub></td> </tr> </tbody> </table> <ul style="list-style-type: none"> <li>Duration : 1 to 5 sec.</li> <li>Charge and discharge current less than 50mA.</li> </ul> | Rated Vol.(V)   | Condition       | ≤100        | 2.5 times of U <sub>R</sub> | 100<V≤250                 | 2.0 times of U <sub>R</sub> | 250<V≤500 | 1.5 times of U <sub>R</sub> | =630      | 1.2 times of U <sub>R</sub> | <ul style="list-style-type: none"> <li>No evidence of damage or flashover during test.</li> </ul> |             |   |   |              |   |   |                 |   |
| Rated Vol.(V) | Condition   |   |   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
| ≤100          | 2.5 times of U <sub>R</sub>   |   |   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
| 100<V≤250     | 2.0 times of U <sub>R</sub>   |   |   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
| 250<V≤500     | 1.5 times of U <sub>R</sub>   |   |   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
| =630          | 1.2 times of U <sub>R</sub>   |   |   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |
| 8.            | Resistance to Soldering Heat  | <ul style="list-style-type: none"> <li>Solder temperature : 260±5°C.</li> <li>Dipping time : 10±1 sec.</li> <li>Preheating : 120 to 150°C for 1 minute before immerse the capacitor in a eutectic solder.</li> <li>Before initial measurement [Class II only] : Perform 150 +0/-10°C for 1 hr and then set for 48±4 hrs at room temp.</li> <li>Measurement to be made after keeping at room temp. for 24±2 hrs [Class I] or 48±4 hrs [Class II].</li> </ul>   | <ul style="list-style-type: none"> <li>No remarkable damage.</li> <li>Cap. Change :<br/>COG : Within ±2.5% or ±0.25pF, whichever is larger.<br/>X7R : Within ±7.5%.</li> <li>Q/D.F. &amp; I.R. : To meet the initial requirement.</li> <li>25% max. leaching on each edge.</li> </ul>   |                 |             |                             |                           |                             |           |                             |           |                             |   |             |   |   |              |   |   |                 |   |

## Reliability test conditions and requirements

| 9.   | Temperature Cycle<br>[Rapid change of temperature] | <ul style="list-style-type: none"> <li>Conduct the five cycles according to the temperatures and time.</li> </ul>  | <ul style="list-style-type: none"> <li>No remarkable damage.</li> <li>Cap. change :<br/>COG : Within <math>\pm 2.5\%</math> or <math>\pm 0.25\text{pF}</math>, whichever is larger.<br/>X7R : Within <math>\pm 7.5\%</math>.</li> <li>Q/D.F. :<br/>COG : To meet the initial requirement.<br/>X7R, Y5V : D.F. <math>\leq 150\%</math> of initial requirement.</li> <li>I.R. : To meet the initial requirement.</li> </ul>   |                            |                    |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
|--|--|--|---|----------------------------|--------------------|---------------|------------|----------------------------|--------------------|-----------------------|--------------------|-----------|--------------------|----------------------------|--------------------|---|------------|-----|
|  |  | <table border="1"> <thead> <tr> <th>Step</th> <th>Temp.[°C]</th> <th>Time(min.)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Min. operating temp. +0/-3</td> <td>30<math>\pm</math>3</td> </tr> <tr> <td>2</td> <td>Room temp.</td> <td>2-3</td> </tr> <tr> <td>3</td> <td>Max. operating temp. +3/-0</td> <td>30<math>\pm</math>3</td> </tr> <tr> <td>4</td> <td>Room temp.</td> <td>2-3</td> </tr> </tbody> </table>  |   | Step                       | Temp.[°C]          | Time(min.)    | 1          | Min. operating temp. +0/-3 | 30 $\pm$ 3         | 2                     | Room temp.         | 2-3       | 3                  | Max. operating temp. +3/-0 | 30 $\pm$ 3         | 4 | Room temp. | 2-3 |
|  |  | Step   |   | Temp.[°C]                  | Time(min.)         |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
|  |  | 1  |   | Min. operating temp. +0/-3 | 30 $\pm$ 3         |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
|  |  | 2  |   | Room temp.                 | 2-3                |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
| 3  | Max. operating temp. +3/-0                         | 30 $\pm$ 3   |   |                            |                    |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
| 4  | Room temp.   | 2-3  |   |                            |                    |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
| <ul style="list-style-type: none"> <li>Before initial measurement (Class II only) : Perform 150 +0/-10°C for 1 hr and then set for 48<math>\pm</math>4 hrs at room temp.</li> <li>Measurement to be made after keeping at room temp. for 24<math>\pm</math>2 hrs (Class I) or 48<math>\pm</math>4 hrs (Class II).</li> </ul> |  |  |   |                            |                    |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
|  |  |  |   |                            |                    |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
|  |  |  |   |                            |                    |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
| 10.  | Humidity<br>[Damp Heat]<br>Steady State            | <ul style="list-style-type: none"> <li>Test temp. : 40<math>\pm</math>2°C.</li> <li>Humidity : 90-95%RH.</li> <li>Test time : 500 +24/-0 hrs.</li> <li>Measurement to be made after keeping at room temp. for 24<math>\pm</math>2 hrs (Class I) or 48<math>\pm</math>4 hrs (Class II).</li> </ul>  | <ul style="list-style-type: none"> <li>No remarkable damage.</li> <li>Cap. change :<br/>COG : Within <math>\pm 5.0\%</math> or <math>\pm 0.5\text{pF}</math>, whichever is larger.<br/>X7R : Within <math>\pm 12.5\%</math>.</li> <li>Q/D.F. :<br/>COG : Cap. &gt;30pF, Q<math>\geq</math>350; 10pF<math>\leq</math>Cap.<math>\leq</math>30pF, Q<math>\geq</math>275+2.5C;<br/>Cap. &lt;10pF, Q<math>\geq</math>200+10C.<br/>X7R : D.F. <math>\leq 200\%</math> of initial requirement.</li> <li>I.R. (Class I) : <math>\geq 10\text{G}\Omega</math> or Rx<math>\geq 500\Omega</math>-F, whichever is smaller.</li> <li>I.R. (Class II) : <math>\geq 1\text{G}\Omega</math> or Rx<math>\geq 10\Omega</math>-F, whichever is smaller.</li> </ul> |                            |                    |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
|  |  |  |   |                            |                    |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
| 11.  | Humidity<br>[Damp Heat]<br>Load                    | <ul style="list-style-type: none"> <li>Test temp. : 40<math>\pm</math>2°C.</li> <li>Humidity : 90-95% RH.</li> <li>Test time : 500 +24/-0hrs.</li> <li>To apply voltage : Rated voltage (Max. 500Vdc).</li> <li>Measurement to be made after keeping at room temp. for 24<math>\pm</math>2 hrs (Class I) or 48<math>\pm</math>4 hrs (Class II).</li> </ul>   | <ul style="list-style-type: none"> <li>No remarkable damage.</li> <li>Cap. change :<br/>COG : Within <math>\pm 7.5\%</math> or <math>\pm 0.75\text{pF}</math>, whichever is larger.<br/>X7R : Within <math>\pm 12.5\%</math>.</li> <li>Q/D.F. :<br/>COG : Cap. <math>\geq 30\text{pF}</math>, Q<math>\geq 200</math>; Cap. &lt;30pF, Q<math>\geq 100+10/3\text{C}</math>.<br/>X7R : D.F. <math>\leq 200\%</math> of initial requirement.</li> <li>I.R. : <math>\geq 500\text{M}\Omega</math> or Rx<math>\geq 25\Omega</math>-F, whichever is smaller.<br/>X7R 100V : <math>\geq 500\text{M}\Omega</math> or Rx<math>\geq 5\Omega</math>-F, whichever is smaller.</li> </ul>   |                            |                    |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
|  |  |  |   |                            |                    |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
| 12.  | High Temperature Load<br>[Endurance]               | <ul style="list-style-type: none"> <li>Test temp. :<br/>COG, X7R : 125<math>\pm</math>3°C.</li> </ul>  | <ul style="list-style-type: none"> <li>No remarkable damage.</li> <li>Cap. change :<br/>COG : Within <math>\pm 3.0\%</math> or <math>\pm 0.3\text{pF}</math>, whichever is larger.<br/>X7R : Within <math>\pm 12.5\%</math>.</li> <li>Q/D.F. :<br/>COG : Cap. &gt;30pF, Q<math>\geq 350</math>; 10pF<math>\leq</math>Cap.<math>\leq</math>30pF, Q<math>\geq 275+2.5\text{C}</math>;<br/>Cap. &lt;10pF, Q<math>\geq 200+10\text{C}</math>.<br/>X7R : D.F. <math>\leq 200\%</math> of initial requirement.</li> <li>I.R. : <math>\geq 1\text{G}\Omega</math> or Rx<math>\geq 50\Omega</math>-F, whichever is smaller.<br/>X7R 100V : <math>\geq 1\text{G}\Omega</math> or Rx<math>\geq 10\Omega</math>-F, whichever is smaller.</li> </ul>        |                            |                    |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
|  |  | <table border="1"> <thead> <tr> <th>Dielectric</th> <th>Rated Vol.[V]</th> <th>Apply Voltage</th> </tr> </thead> <tbody> <tr> <td rowspan="4">COG<br/>X7R</td> <td><math>\leq 100</math></td> <td>2.0 times of <math>U_R</math></td> </tr> <tr> <td><math>200 \leq V \leq 500</math></td> <td>1.5 times of <math>U_R</math></td> </tr> <tr> <td>400V-450V</td> <td>1.2 times of <math>U_R</math></td> </tr> <tr> <td><math>\geq 630</math></td> <td>1.2 times of <math>U_R</math></td> </tr> </tbody> </table> |   | Dielectric                 | Rated Vol.[V]      | Apply Voltage | COG<br>X7R | $\leq 100$                 | 2.0 times of $U_R$ | $200 \leq V \leq 500$ | 1.5 times of $U_R$ | 400V-450V | 1.2 times of $U_R$ | $\geq 630$                 | 1.2 times of $U_R$ |   |            |     |
|  |  | Dielectric   |   | Rated Vol.[V]              | Apply Voltage      |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
|  |  | COG<br>X7R   |   | $\leq 100$                 | 2.0 times of $U_R$ |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
|  |  |  |   | $200 \leq V \leq 500$      | 1.5 times of $U_R$ |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
| 400V-450V  | 1.2 times of $U_R$                                 |  |   |                            |                    |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
| $\geq 630$   | 1.2 times of $U_R$                                 |  |   |                            |                    |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
| <ul style="list-style-type: none"> <li>Exception items :</li> </ul>  |  |  |   |                            |                    |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
| <table border="1"> <thead> <tr> <th>Size</th> <th>Dielectric</th> <th>Rated Voltage</th> </tr> </thead> <tbody> <tr> <td>01005</td> <td>X5R</td> <td>10V</td> </tr> </tbody> </table>  | Size   | Dielectric   | Rated Voltage   | 01005                      | X5R                | 10V           |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
| Size   | Dielectric   | Rated Voltage  |   |                            |                    |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
| 01005  | X5R  | 10V  |   |                            |                    |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |
| <ul style="list-style-type: none"> <li>Test time : 1000 +24/-0 hrs.</li> <li>Measurement to be made after keeping at room temp. for 24<math>\pm</math>2 hrs (Class I) or 48<math>\pm</math>4 hrs (Class II).</li> </ul>  |  |  |   |                            |                    |               |            |                            |                    |                       |                    |           |                    |                            |                    |   |            |     |

## Reliability test conditions and requirements

| No.            | Item   | Test Condition  | Requirements   |            |             |               |  |                |                     |
|----------------|--|---|--|------------|-------------|---------------|--|----------------|---------------------|
| 13.            | <p><b>Resistance to Flexure of Substrate</b><br/>[Substrate bending test]</p>  | <ul style="list-style-type: none"> <li>The middle part of substrate shall be pressurized by means of the pressurizing rod at a rate of about 1mm per second until the deflection becomes 1mm.</li> </ul>   | <ul style="list-style-type: none"> <li>No remarkable damage.</li> </ul> <table border="1" data-bbox="928 415 1516 514"> <thead> <tr> <th>Dielectric</th> <th>Cap. Change</th> </tr> </thead> <tbody> <tr> <td>Class I (C0G)</td> <td>Within <math>\pm 3.0\%</math> or <math>\pm 2.0\text{pF}</math>, whichever is larger</td> </tr> <tr> <td>Class II (X7R)</td> <td>Within <math>\pm 12.5\%</math></td> </tr> </tbody> </table> <p>[This capacitance change means the change of capacitance under specified flexure of substrate from the capacitance measured before the test]</p> | Dielectric | Cap. Change | Class I (C0G) | Within $\pm 3.0\%$ or $\pm 2.0\text{pF}$ , whichever is larger | Class II (X7R) | Within $\pm 12.5\%$ |
| Dielectric     | Cap. Change  |   |  |            |             |               |  |                |                     |
| Class I (C0G)  | Within $\pm 3.0\%$ or $\pm 2.0\text{pF}$ , whichever is larger                 |   |  |            |             |               |  |                |                     |
| Class II (X7R) | Within $\pm 12.5\%$  |   |  |            |             |               |  |                |                     |
| 14.            | <p><b>Adhesive Strength of Termination</b><br/>[Robustness of termination]</p> | <ul style="list-style-type: none"> <li>Capacitors mounted on a substrate. A force of 5N(<math>\leq 0603</math>) or 10N(<math>&gt; 0603</math>) applied perpendicular to the place of substrate and parallel the line joining the center of terminations for <math>10 \pm 1</math> second.</li> </ul>  | <ul style="list-style-type: none"> <li>No remarkable damage or removal of the terminations.</li> </ul>   |            |             |               |  |                |                     |
| 15.            | <p><b>Vibration Resistance</b></p>   | <ul style="list-style-type: none"> <li>Vibration frequency : 10–55 Hz/min.</li> <li>Total amplitude : 1.5mm.</li> <li>Test time : 6 hrs. (Two hrs each in three mutually perpendicular directions)</li> <li>Measurement to be made after keeping at room temp. for <math>24 \pm 2</math> hrs (Class I) or <math>48 \pm 4</math> hrs (Class II).</li> </ul>                              | <ul style="list-style-type: none"> <li>No remarkable damage.</li> <li>Cap. change and Q/D.F. : To meet the initial spec.</li> </ul>  |            |             |               |  |                |                     |

## Package Dimension and Quantity

| Size       | EIA Size Code    | Paper tape |          | Plastic tape |          |
|------------|------------------|------------|----------|--------------|----------|
|            |                  | 7" reel    | 13" reel | 7" reel      | 13" reel |
| 0402[1005] | 0.50±0.05        | 10k        | 50k      | -            | -        |
|            | 0.50 +0.02/-0.05 | 10k        | 50k      | -            | -        |
|            | 0.50±0.20        | 10k        | -        | -            | -        |
| 0603[1608] | 0.50±0.10        | 4k         | -        | -            | -        |
|            | 0.80±0.07        | 4k         | 15k      | -            | -        |
|            | 0.80 +0.15/-0.10 | 4k         | 15k      | -            | -        |
| 0805[2012] | 0.50±0.10        | 4k         | 15k      | -            | -        |
|            | 0.60±0.10        | 4k         | 15k      | -            | -        |
|            | 0.80±0.10        | 4k         | 15k      | -            | -        |
|            | 0.85±0.10        | 4k         | 15k      | -            | -        |
|            | 1.25±0.10        | -          | -        | 3k           | 10k      |
|            | 1.25±0.20        | -          | -        | 3k           | 10k      |
| 1206[3216] | 0.80±0.10        | 4k         | 15k      | -            | -        |
|            | 0.85±0.10        | 4k         | 15k      | -            | -        |
|            | 0.95±0.10        | -          | -        | 3k           | 10k      |
|            | 1.15±0.15        | -          | -        | 3k           | 10k      |
|            | 1.25±0.10        | -          | -        | 3k           | 10k      |
|            | 1.60±0.20        | -          | -        | 2k           | 10k      |
|            | 1.60 +0.30/-0.10 | -          | -        | 2k           | 9k       |
| 1210[3225] | 0.85±0.10        | -          | -        | 3k           | 10k      |
|            | 0.95±0.10        | -          | -        | 3k           | 10k      |
|            | 1.25±0.10        | -          | -        | 3k           | 10k      |
|            | 1.60±0.20        | -          | -        | 2k           | -        |
|            | 2.00±0.20        | -          | -        | 1k           | 6k       |
|            | 2.50±0.30        | -          | -        | 1k           | 6k       |
| 1808[4520] | 1.25±0.10        | -          | -        | 2k           | 10k      |
|            | 1.60±0.20        | -          | -        | 2k           | 8k       |
|            | 2.00±0.20        | -          | -        | 1k           | 6k       |
| 1812[4532] | 1.25±0.10        | -          | -        | 1k           | 5k       |
|            | 1.60±0.20        | -          | -        | 1k           | -        |
|            | 2.00±0.20        | -          | -        | 1k           | -        |
|            | 2.50±0.30        | -          | -        | 0.5k         | 3k       |
|            | 2.80±0.30        | -          | -        | 0.5k         | -        |
| 1825[4563] | 1.60±0.20        | -          | -        | 1k           | -        |
|            | 2.00±0.20        | -          | -        | 1k           | -        |
|            | 2.50±0.30        | -          | -        | 0.5k         | -        |
|            | 2.80±0.30        | -          | -        | 0.5k         | -        |
| 2220[5750] | 1.60±0.20        | -          | -        | 1k           | -        |
|            | 2.00±0.20        | -          | -        | 1k           | -        |
|            | 2.50±0.30        | -          | -        | 0.5k         | -        |
| 2225[5763] | 2.80±0.30        | -          | -        | 0.5k         | -        |
|            | 1.60±0.20        | -          | -        | 1k           | -        |
|            | 2.00±0.20        | -          | -        | 1k           | -        |
|            | 2.50±0.30        | -          | -        | 0.5k         | -        |
| 2225[5763] | 2.80±0.30        | -          | -        | 0.5k         | -        |
|            | 1.60±0.20        | -          | -        | 1k           | -        |
|            | 2.00±0.20        | -          | -        | 1k           | -        |

Unit : pcs

## Packaging Dimensions & Part Count

### EMBOSSED TAPE DIMENSIONS

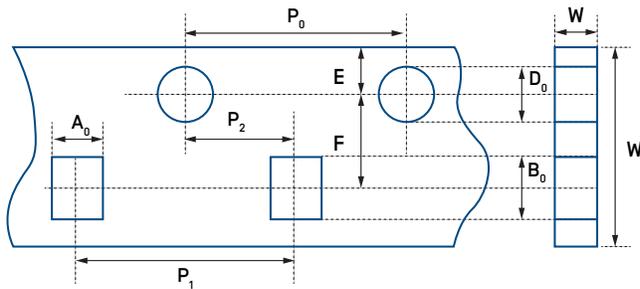


Fig. 9.1 The dimension of paper tape

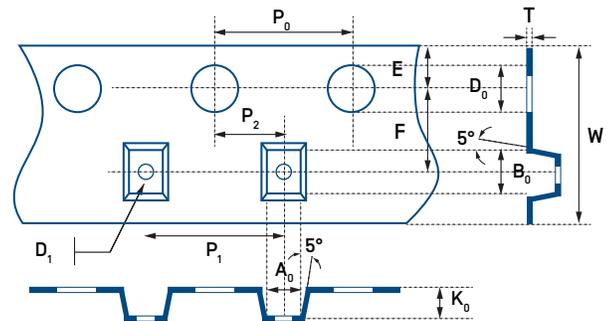


Fig. 9.2 The dimension of plastic tape

| Size              | 0402                   | 0603                         | 0805             |                        |
|-------------------|------------------------|------------------------------|------------------|------------------------|
| Chip Thickness    | 0.50±0.05<br>0.50±0.10 | 0.80±0.07<br>0.80 +0.15/-0.1 | 0.80±0.10        | 1.25±0.10<br>1.25±0.20 |
| A <sub>0</sub>    | 0.70±0.20              | 1.05 ±0.30                   | 1.50±0.20        | <1.80                  |
| B <sub>0</sub>    | 1.20±0.20              | 1.80±0.30                    | 2.30±0.20        | <2.70                  |
| T                 | ≤0.80                  | ≤1.20                        | 0.95±0.05        | 0.23±0.05              |
| K <sub>0</sub>    | -                      | -                            | -                | <2.50                  |
| W                 | 8.00±0.30              | 8.00±0.30                    | 8.00±0.10        | 8.00±0.10              |
| P <sub>0</sub>    | 4.00±0.10              | 4.00±0.10                    | 4.00±0.10        | 4.00±0.10              |
| 10xP <sub>0</sub> | 40.00±0.10             | 40.00±0.20                   | 40.00±0.20       | 40.00±0.20             |
| P <sub>1</sub>    | 2.00±0.05              | 4.00±0.10                    | 4.00±0.10        | 4.00±0.10              |
| P <sub>2</sub>    | 2.00±0.05              | 2.00±0.05                    | 2.00±0.05        | 2.00±0.05              |
| D <sub>0</sub>    | 1.50+0.1/-0            | 1.50+0.1/-0                  | 1.50<br>+0.10/-0 | 1.50<br>+0.10/-0       |
| D <sub>1</sub>    | -                      | -                            | -                | 1.00±0.10              |
| E                 | 1.75±0.10              | 1.75±0.10                    | 1.75±0.05        | 1.75±0.10              |
| F                 | 3.50±0.05              | 3.50±0.05                    | 3.50±0.05        | 3.50±0.05              |
| Unit :            | mm                     | mm                           | mm               | mm                     |

| Size              | 1206             |                        |                                   | 1210                   |               |
|-------------------|------------------|------------------------|-----------------------------------|------------------------|---------------|
| Chip Thickness    | 0.80±0.10        | 0.95±0.10<br>1.25±0.10 | 1.60±0.20<br>1.60 +0.30/<br>-0.10 | 1.25±0.10<br>1.60±0.20 | 2.50±0.30     |
| A <sub>0</sub>    | 2.00±0.10        | <2.00                  | <2.50                             | <3.05                  | <3.20         |
| B <sub>0</sub>    | 3.50±0.50        | <3.70                  | <4.00                             | <3.80                  | <4.00         |
| T                 | 0.95±0.05        | 0.23±0.05              | 0.23±0.05                         | 0.23±0.05              | 0.23±0.05     |
| K <sub>0</sub>    | -                | <2.50                  | <2.50                             | <2.50                  | <3.50         |
| W                 | 8.00±0.10        | 8.00±0.10              | 8.00±0.10                         | 8.00±0.10              | 8.00±0.10     |
| P <sub>0</sub>    | 4.00±0.10        | 4.00±0.10              | 4.00±0.10                         | 4.00±0.10              | 4.00±0.10     |
| 10xP <sub>0</sub> | 40.00±0.20       | 40.00±0.20             | 40.00±0.20                        | 40.00±0.20             | 40.00±0.20    |
| P <sub>1</sub>    | 4.00±0.10        | 4.00±0.10              | 4.00±0.10                         | 4.00±0.10              | 4.00±0.10     |
| P <sub>2</sub>    | 2.00±0.05        | 2.00±0.05              | 2.00±0.05                         | 2.00±0.05              | 2.00±0.05     |
| D <sub>0</sub>    | 1.50<br>+0.10/-0 | 1.50 +0.10/-0          | 1.50 +0.10/-0                     | 1.50 +0.10/-0          | 1.50 +0.10/-0 |
| D <sub>1</sub>    | -                | 1.00±0.10              | 1.50±0.10                         | 1.50±0.10              | 1.00±0.10     |
| E                 | 1.75±0.10        | 1.75±0.10              | 1.75±0.10                         | 1.75±0.10              | 1.75±0.10     |
| F                 | 3.50±0.05        | 3.50±0.05              | 5.50±0.05                         | 5.50±0.05              | 3.50±0.05     |
| Unit :            | mm               | mm                     | mm                                | mm                     | mm            |

## Packaging Dimensions & Part Count

| Size              | 1808                   |               | 1812                                |                        | 1825                   |                        |
|-------------------|------------------------|---------------|-------------------------------------|------------------------|------------------------|------------------------|
| Chip Thickness    | 1.25±0.10<br>1.60±0.20 | 2.00±0.20     | 1.25±0.10<br>1.60±0.20<br>2.00±0.20 | 2.50±0.30<br>2.80±0.30 | 1.60±0.20<br>2.00±0.20 | 2.50±0.30<br>2.80±0.30 |
| A <sub>0</sub>    | <2.50                  | <2.50         | <3.90                               | <3.90                  | <6.80                  | <6.80                  |
| B <sub>0</sub>    | <5.30                  | <5.30         | <5.30                               | <5.30                  | <5.30                  | <5.30                  |
| T                 | 0.25±0.05              | 0.25±0.05     | 0.25±0.05                           | 0.25±0.05              | 0.30±0.10              | 0.30±0.10              |
| K <sub>0</sub>    | <2.50                  | <2.50         | <2.50                               | <3.00                  | <2.50                  | <3.10                  |
| W                 | 12.00±0.20             | 12.00±0.20    | 12.00±0.20                          | 12.00±0.20             | 12.00±0.20             | 12.00±0.20             |
| P <sub>0</sub>    | 4.00±0.10              | 4.00±0.10     | 4.00±0.10                           | 4.00±0.10              | 4.00±0.10              | 4.00±0.10              |
| 10xP <sub>0</sub> | 40.00±0.20             | 40.00±0.20    | 40.00±0.20                          | 40.00±0.20             | 40.00±0.20             | 40.00±0.20             |
| P <sub>1</sub>    | 4.00±0.10              | 4.00±0.10     | 8.00±0.10                           | 8.00±0.10              | 8.00±0.10              | 8.00±0.10              |
| P <sub>2</sub>    | 2.00±0.05              | 2.00±0.05     | 2.00±0.05                           | 2.00±0.05              | 2.00±0.05              | 2.00±0.05              |
| D <sub>0</sub>    | 1.50 +0.10/-0          | 1.50 +0.10/-0 | 1.50 +0.10/-0                       | 1.50 +0.10/-0          | 1.50 +0.10/-0          | 1.50 +0.10/-0          |
| D <sub>1</sub>    | 1.50±0.10              | 1.50±0.10     | 1.50±0.10                           | 1.50±0.10              | 1.50±0.10              | 1.50±0.10              |
| E                 | 1.75±0.10              | 1.75±0.10     | 1.75±0.10                           | 1.75±0.10              | 1.75±0.10              | 1.75±0.10              |
| F                 | 5.50±0.05              | 5.50±0.05     | 5.50±0.05                           | 5.50±0.05              | 5.50±0.05              | 5.50±0.05              |
| Unit :            | mm                     | mm            | mm                                  | mm                     | mm                     | mm                     |

| Size              | 2220                                |                        | 2225                   |                        |
|-------------------|-------------------------------------|------------------------|------------------------|------------------------|
| Chip Thickness    | 1.40±0.15<br>1.60±0.20<br>2.00±0.20 | 2.50±0.30<br>2.80±0.30 | 1.60±0.20<br>2.00±0.20 | 2.50±0.30<br>2.80±0.30 |
| A <sub>0</sub>    | <5.80                               | <6.80                  | <6.80                  | <6.80                  |
| B <sub>0</sub>    | <6.50                               | <6.50                  | <6.50                  | <6.50                  |
| T                 | 0.30±0.10                           | 0.30±0.10              | 0.30±0.10              | 0.30±0.10              |
| K <sub>0</sub>    | <2.50                               | <3.10                  | <2.50                  | <3.10                  |
| W                 | 12.00±0.20                          | 12.00±0.20             | 12.00±0.20             | 12.00±0.20             |
| P <sub>0</sub>    | 4.00±0.10                           | 4.00±0.10              | 4.00±0.10              | 4.00±0.10              |
| 10xP <sub>0</sub> | 40.00±0.20                          | 40.00±0.20             | 40.00±0.20             | 40.00±0.20             |
| P <sub>1</sub>    | 8.00±0.10                           | 8.00±0.10              | 8.00±0.10              | 8.00±0.10              |
| P <sub>2</sub>    | 2.00±0.05                           | 2.00±0.05              | 2.00±0.05              | 2.00±0.05              |
| D <sub>0</sub>    | 1.50 +0.10/-0                       | 1.50 +0.10/-0          | 1.50 +0.10/-0          | 1.50 +0.10/-0          |
| D <sub>1</sub>    | 1.50±0.10                           | 1.50±0.10              | 1.50±0.10              | 1.50±0.10              |
| E                 | 1.75±0.10                           | 1.75±0.10              | 1.75±0.10              | 1.75±0.10              |
| F                 | 5.50±0.05                           | 5.50±0.05              | 5.50±0.05              | 5.50±0.05              |
| Unit :            | mm                                  | mm                     | mm                     | mm                     |

## Packaging Dimensions & Part Count

### REEL DIMENSIONS

| Size      | 01005           | 0201, 0402, 0603,<br>0805, 1206, 1210 |                   | 1808, 1812, 1825,<br>2220, 2225                         |
|-----------|-----------------|---------------------------------------|-------------------|---|
| Reel size | 7               | 7                                     | 13                | 7   |
| C         | 13.0<br>±0.05   | 13.0<br>+0.5/-0.2                     | 13.0<br>+0.5/-0.2 | 13.0<br>+0.7/-0.3                                       |
| W1        | 8.4<br>+1.5     | 8.4<br>+1.5                           | 8.4<br>+1.5       | 12.4<br>+2.0/-0   |
| W         | 14.4max         | 14.4max                               | 14.4max           | shall accommodate<br>tape width without<br>interference |
| A         | 178.0<br>±0.20  | 178.0<br>±0.20                        | 330.0<br>±1.0     | 178.0<br>±0.20  |
| N         | 60.0<br>+1.0/-0 | 60.0<br>+1.0/-0                       | 100<br>±1.0       | 60.0<br>+1.0/-0   |

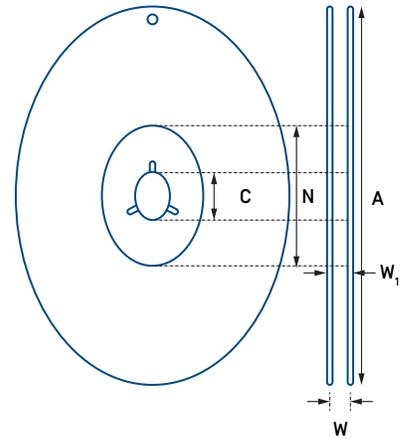


Fig. 9.3 The dimension of reel

## Applications Notes

### Storage

To prevent the damage of solderability of terminations, the following storage conditions are recommended :

- Indoors under 5 ~ 40°C and 20% ~ 70% RH.
- No harmful gases containing sulfuric acid, ammonia, hydrogen sulfide or chlorine.
- Packaging should not be opened until the capacitors are required for use. If opened, the pack should be re-sealed as soon as is practicable. Taped product should be stored out of direct sunlight, which might promote deterioration in tape or adhesion performance. The product is recommended to be used within 12 months after shipment and checked the solderability before use.

### Soldering

Use mildly activated rosin fluxes do not use activated flux. The amount of solder in each solder joint should be controlled to prevent the damage of chip capacitors caused by the stress between solder, chips, and substrate.

a.) Hand soldering :

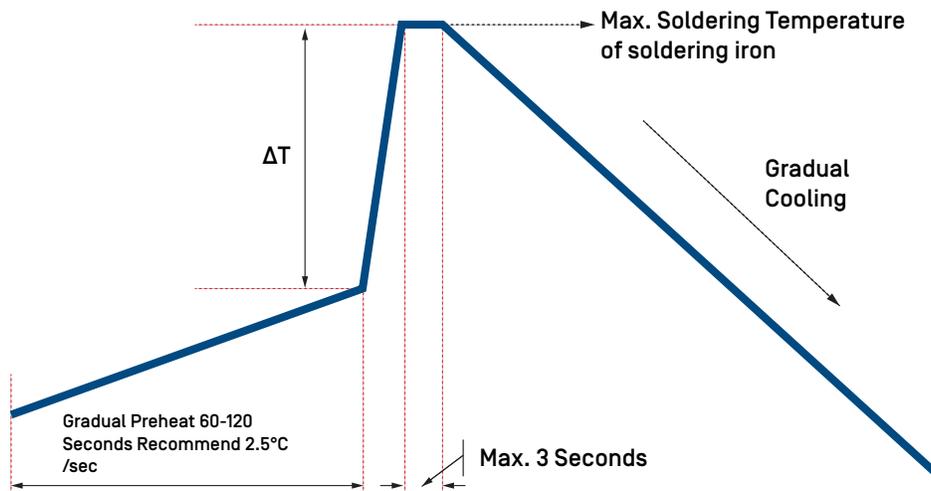
### Handling

Chip capacitors are dense, hard, brittle, and abrasive materials. They are liable to suffer mechanical damage, in the form of cracks or chips. Chip Capacitors should be handled with care to avoid contamination or damage. To use vacuum or plastic tweezers to pick up or plastic tweezers is recommended for manual placement. Tape and reeled packages are suitable for automatic pick and placement machine. with the ceramic capacitor body or termination.

### Preheat

- In order to minimize the risk of thermal shock during soldering, a carefully controlled preheat is required.
- The rate of preheat should not exceed 3°C per second.

Fig. 10.1 Hand Soldering Profile



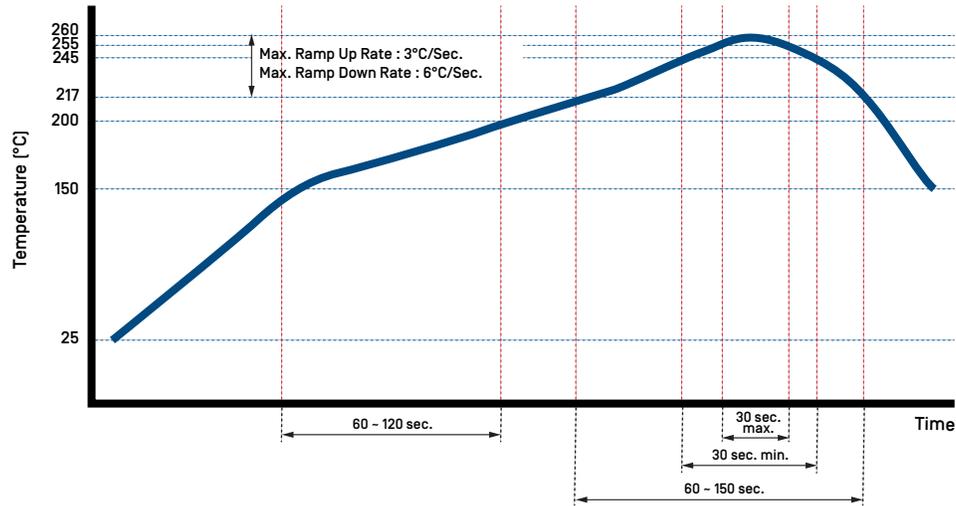
| Chip Size | Pre-Heat temp. | ΔT     | Max. soldering iron temp. |
|-----------|----------------|--------|---------------------------|
| ≤1206     | ≥150°C         | ≤150°C | ≤350°C                    |
| 1210-2225 | ≥150°C         | ≤130°C | ≤280°C                    |

- Soldering iron tip diameter ≤1.0 mm and wattage max. 20W.
- The Capacitors shall be pre-heated and that the temperature gradient between the devices and the tip of the soldering iron.
- The required amount of solder shall be melted on the soldering tip.
- The tip of iron should not contact the ceramic body directly.
- The Capacitors shall be cooled gradually at room temperature after soldering.
- Forced air cooling is not allowed.

## Applications Notes

b.) Reflow soldering :

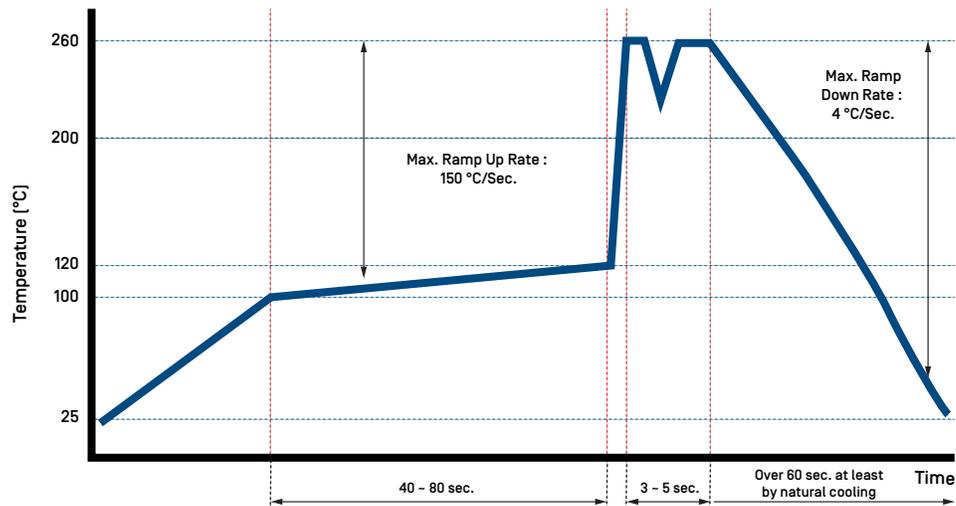
Fig. 10.2 Reflow soldering profile



For Sn/Ag/Cu Series solder paste (Pb-Free)

c.) Wave soldering :

Fig. 10.3 Wave soldering profile



For Sn/Ag/Cu Series solder paste (Pb-Free)

Soldering conditions :

Class I :

| Size Inch [mm]   | Temper. Cher. | Capacitance              | Condition |        |
|------------------|---------------|--------------------------|-----------|--------|
|                  |               |                          | Wave      | Reflow |
| ≤0402 [1005]     | Class I       | All                      | X         | ○      |
| 0603 [1608]      | Class I       | All                      | ○         | ○      |
| 0805 [2012]      | Class I       | All                      | ○         | ○      |
| 1206 [3216]      | Class I       | All<br>Thickness >0.95mm | ○         | ○      |
| ≥1210 [3225]     | Class I       | All                      | X         | ○      |
| Coating Products | All           | mm                       | X         | ○      |

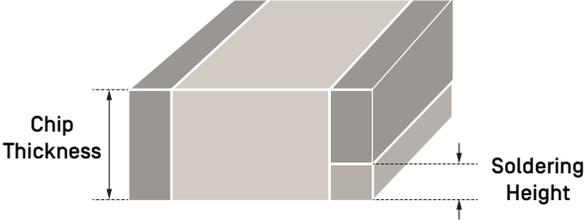
## Applications Notes

Soldering conditions :

Class I :

| Size Inch [mm]   | Temper. Cher. | Capacitance        | Condition |        |
|------------------|---------------|--------------------|-----------|--------|
|                  |               |                    | Wave      | Reflow |
| ≤0402 [1005]     | Class II      | All                | X         | ○      |
| 0603 [1608]      | Class II      | Cap. <2.2μF        | ○         | ○      |
|                  |               | Cap. ≥2.2μF        | X         | ○      |
| 0805 [2012]      | Class II      | Thickness ≤ 0.95mm | ○         | ○      |
|                  |               | Thickness > 0.95mm | X         | ○      |
| 1206 [3216]      | Class II      | Thickness ≤ 0.95mm | ○         | ○      |
|                  |               | Thickness > 0.95mm | X         | ○      |
| ≥1210 [3225]     | Class II      | All                | X         | ○      |
| Coating Products | All           | All                | X         | ○      |

Soldering height :

|  |   |
|--|---|
| <p>The solder climbing minimum height is suggesting to 25% of chip thickness or 500um whichever is less. (Reference from IPC-610E)</p> |  <p>The diagram illustrates a 3D perspective of a chip mounted on a substrate. A vertical double-headed arrow on the left side of the chip is labeled 'Chip Thickness'. A vertical double-headed arrow on the right side, extending from the top surface of the chip down to the substrate, is labeled 'Soldering Height'.</p> |
|--|---|

### Cooling

After soldering, cool the chips and the substrate gradually to room temperature. Natural cooling in air is recommended to minimize stress in the solder joint.

### Cleaning

All flux residues must be removed by using suitable electronic-grade vapor-cleaning solvents to eliminate contamination that could cause electrolytic surface corrosion. Good results can be obtained by using ultrasonic cleaning of the solvent. The choice of the proper system is depends upon many factors such as component mix, flux, and solder paste and assembly method. The ability of the cleaning system to remove flux residues and contamination from under the chips is very important.